ADAPTING INSTITUTIONS:

PROCESSES AND INSTRUMENTS BEHIND URBAN WATER TRANSITIONS

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Forgive me for the rowing analogy. But I have come to realise that undertaking a PhD is much like my sport of choice. It requires technique, strength and stamina. For the technique, I thank my supervisors for their expert guidance. For the strength, I have been endowed with support from my wonderful family, many treasured friends, and much appreciated colleagues and mentors, who never let me think I wasn't up to the task. And for the stamina, I thank my body and brain for hanging in there.

To all the brilliant people in my life, you know who you are, and you know I'm forever grateful.

The cure for anything is salt water: sweat, tears or the sea.

Isak Dinesen

ABSTRACT

If the twentieth century is distinguished by progress and technological advancement, the twenty-first century is becoming known for the widespread societal and environmental change following the industrial revolution. From increasing access to energy to genetic engineering, *Homo sapiens* have discovered multiple means of accelerating their own development. In the process, we have gained notoriety as the first species to affect the global environment. From resource depletion, pollution, population growth, globalised commerce to climate change, humans have created global change in many forms and interconnected ways. Degradation of ecosystems, biodiversity loss, a warming atmosphere and continued reliance on non-renewable energy raise the question: Does human society have the capacity to adapt to the environmental changes it has set in motion?

The future may be uncertain, yet humans have coped with a changing world for tens of thousands of years. Human relationships with the environment have moved from survival, to exploitation, to management, to recognising the complex physical and sociological connections between humans and their natural and built environments. These interdependencies aside, the complexity of human society makes it difficult to coordinate will, ability and effort to adapt to new circumstances. Yet this is what the institutions underlying society do; guide social behaviour, facilitate interaction and enable collective action. Furthermore, as social constructs, institutions reflect society's assumptions, beliefs, needs, and aspirations, and so alter and adjust as the world around them transforms. This thesis posits that if institutions allow society to function, the features by which they change contain the capacity to proactively and collaboratively adapt to global changes.

The research seeks to identify these institutional adaptive capacities in the context of managing water in cities; a morally, environmentally and economically pressing field in need of societal change due to the role water plays in these highly modified landscapes of concentrated human activity. The experience of the Australian cities of Perth and Adelaide, responding to unprecedented drought, was utilised to explore the phenomenon of system adaptation, using institutional adaptive capacity as the central focus. Significant water scarcity throughout the drought exposed areas of technological lock-in and institutional inertia in the water sectors of these cities. This prompted a major rethink of the socio-technical configuration of urban water systems, and how they delivered services to meet societal needs and expectations.

Exploration of these empirical examples of societal systems in transition, revealed some of the institutional roots of system inertia and mechanisms for adaptation. The research found three forms of adaptive capacity were important ingredients of system change; learning, deciding and acting. The results reveal some of the ways these capacities can be created, using a mix of institutional mechanism, to enable system resilience or transformation. With further development, such knowledge of institutional configurations and the change dynamics they generate could yield the building blocks of sustainable societies.

GENERAL DECLARATION

In accordance with Monash University Doctorate Regulation 17 Doctor of Philosophy and Research Master's regulations the following declarations are made:

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes two original papers published in peer reviewed journals and books, and two unpublished publications. The core theme of the thesis is urban water institutional dynamics. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the School of Geography and Environmental Science under the supervision of Professor Rebekah Brown.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

In the case of Chapters 4, 5, and 6 my contribution to the work involved the following:

Chapter	Publication title	Status	Nature and extent of candidate's contribution
4.2	Connecting Levels and Disciplines: Connective Capacity of Institutions And Actors Explored	Published	Formulation of the research problem; position of the research in the literature; data collection, analysis and interpretation; framing the research results and writing
4.3	Water scarcity and institutional change: lessons in adaptive governance from the drought experience of Perth, Western Australia	In press	Formulation of the research problem; interpretation and positioning of the research in the literature; development of assessment framework; data collection, analysis and interpretation; writing
5.1	Understanding institutional capacity for urban water transitions	Under review	Formulation of the research problem; development of assessment framework, interpreting the literature and positioning the research in this context; data collection, analysis and interpretation; writing
6.1	Propositions for a theory of institutional adaptive capacity	Under review	Formulation of the research problem; interpreting the literature and positioning the research in this context; data collection, analysis and interpretation; writing

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- Page 38. Table 3.1 Features of four research logics

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CHAPTER 1: INTRODUCTION

1.1 FOUNDATIONS

The widespread detrimental impacts of human resource consumption on the environment have been known since the 1960s, yet progress to address past damage and prevent further environmental degradation has been slow (Harding, 2006). Unsustainable resource use has turned the spotlight on modern human society, laying bare fundamental imbalances between social, economic and environmental well-being (Becker and Ostrom, 1995). The systemic nature of these problems, embedded as they are in human values, behaviours and social structures, has made it difficult to identify causes and develop solutions.

Resource management problems have been characterised by some as 'wicked' (Rittel and Webber, 1973) or 'persistent' (van der Brugge et al., 2005) problems; those that are complex in their causes, spatial impacts and temporal scope. With complex interdependencies inherent in these problems, solutions often have unintentional impacts. Additionally, the accountability for coordinating a multitude of skills, actions and actors to manage and monitor the problem can rarely be clearly defined, as responsibility does not rest within a single organisation, administrative boundary or discipline (Mitchell, 2005). While resource management problems are anthropogenic, the nature of resources themselves adds to the challenge of managing them to achieve a sustainable way of life. Water, with its ability to move through the natural and built landscape, collecting pollutants and being utilised in many ways relatively freely in its travels, embodies this dilemma.

Humans have settled and flourished around fresh water bodies (Vlachos and Braga, 2001). Not just for access to drinking water to sustain life, but to develop economies and permanently locate societies. Water is used for sanitation, cooking, agricultural and industrial production, power generation, as a transport route, for recreation, spiritual rejuvenation, cultural tradition and religious ceremony. As van der Brugge et al. (2005) note, water has a multiplicity of character. It has multiple manifestations (rainwater, groundwater, stormwater) multiple functions (drinking, cleaning, cooling) and multiple values for multiple users. Given this very nature of water and its vital role in supporting life, managing water in the modern urban environment is an intricate affair (Niemczynowicz, 1999; Vlachos and Braga, 2001; Katko et al., 2010).

To complicate matters, sustainability issues are creating interwoven challenges. Population growth increases human demand for water, while less space is available for the infrastructure needed to capture, treat and deliver it (Makropoulos and Butler, 2010). Resulting land surface changes create micro-hydrological (Niemczynowicz 1999) and micro-climatic conditions (Coutts et al., 2010) to manage, and water quantity and quality impacts are created at the catchment scale through extraction and pollution (Niemczynowicz, 1999; Marsalek et al., 2001).

Climate change also adds further complexity to these challenges (Pahl-Wostl et al.,

2011). As the world enters 'The Urban Millennium' with 50 per cent of its human population living in cities (United Nations Population Fund, 2007), the juxtaposition of development and poverty is stark, particularly regarding access to water and sanitation (Niemczynowicz, 1999; Katko et al., 2010). The environmental drivers, economic imperatives and moral obligations to address the persistent problems of urban water management are undeniable.

1.2 THE URBAN WATER MANAGEMENT PROBLEM

Over the last twenty years urban water management literature has revealed that traditional conveyance water management systems and associated management approaches are becoming increasingly inadequate for addressing the service delivery requirements of modern cities (Gleick, 2000; Mitchell, 2005; Chocat et al., 2007; Makropoulos and Butler, 2010; Pearson et al., 2010). These systems evolved to meet the needs and expectations of past societies, like supplying clean drinking water, removing sewerage and mitigating floods (Brown et al., 2009b; Chanan et al., 2009). However, in the world of post-environmentalism where global citizens are conscious of non-anthropocentric needs, there is the expectation that diverse water services will be achieved alongside protection of ecosystem function and restoration of past degradation (Vlachos and Braga, 2001; Wong and Brown, 2009).

Urban water managers are faced with an increasingly complex dilemma: find new water sources, minimises resulting environmental damage, manage any unforeseen impacts and ameliorate the legacy of damage from past water extraction and consumption (Gleick, 2000; Vlachos and Braga, 2001). The traditional engineering heavy paradigm; of large storages, a centralised reticulated supply system, and separated drainage and sewerage networks, is fundamentally incapable of meeting new social and environmental needs for multiple water use and environmental amenity and protection (Rauch et al., 2005; Brown et al., 2009b). These large 'hard' infrastructure based systems are optimised for efficient, single service delivery objectives; supplying reliable potable water at a high level of quality, and removing sewerage and flood water as quickly as possible (Rauch et al., 2005). Table 1.1. illustrates the divergent philosophies, objectives and resulting infrastructure of these different paradigms of urban water management.

Various alternate management paradigms have emerged to address the inflexibility of current urban water systems (Mitchell, 2006; Bettini et al., 2013). This thesis frames the real-world problem of urban water management in its contemporary Australian context using one of these alternate paradigms, Water Sensitive Cities.

TABLE 1.1 CONTRASTING PARADIGMS OF URBAN WATER MANAGEMENT

Traditional stance	Emerging stance
Human waste is a nuisance It should be disposed of after treatment	Human waste is a resource It should be captured and processed effectively, used to nourish land and crops
Stormwater is a nuisance Convey stormwater away from urban area as rapidly as possible	Stormwater is a resource Harvest stormwater as a water supply, and infiltrate or retain it to support aquifers, waterways and vegetation
Demand is a matter of quantity Amount of water required or produced by different end-users is the only parameter relevant to infrastructure choices. Treat all supply side water to potable quality, and collect all waste water for treatment	Demand is multifaceted Infrastructure choice should match the varying characteristics of water required or produced for different end-users in terms of quantity, quality, level of reliability, etc.
One use (throughput) Water follows one-way path from supply, to a single use, to treatment and disposal to the environment	Reuse and reclamation Water can be used multiple times, by cascading from higher to lower quality needs, and reclamation treatment for return to the supply side of infrastructure
Grey infrastructure Infrastructure is made of concrete, metal, or plastic	Green infrastructure Infrastructure includes not only pipes and treatment plants, made of concrete, metal, and plastic, but also soils and vegetation
Bigger/centralised is better for collection system and treatment plants	Small/decentralised is possible, often desirable, for collection system and treatment plants
Limit complexity and employ standard solutions Small number of technologies by urban water professionals defines water infrastructure	Allow diverse solutions Decision makers are multidisciplinary. Allow new management strategies and technologies
Integration by accident Water supply, wastewater and stormwater may be managed by the same agency as matter of historical happenstance. Physically, however, three systems are separated	Physical and institutional integration by design Linkages must be made between water supply, wastewater and stormwater, which require highly coordinated management
Collaboration = public relations Approach other agencies and public when approval or pre-chosen solution is required	Collaboration = engagement Enlist other agencies and public in search for effective solutions

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1.3 THE VISION OF WATER SENSITIVE CITIES

Water Sensitive Cities is an emerging tangible image of cities of the future, encompassing a plethora of terminology in the literature related to the sustainable use and management of water systems in the urban context. It has emerged in an Australian setting (Lincoln and Guba, 1985; Wong and Brown, 2008), but encapsulates internationally recognised shifts in focus of urban water praxis (Marsalek et al., 2001; Bettini et al., 2013). Such shifts include; from engineered paradigms of supply delivery, sewerage treatment and waste and flood water conveyance, to the principles of managing all facets of water's journey through an urban setting, with regard for its rural origins, coastal destinations (Vlachos and Braga, 2001); addressing its spiritual significances (Musacchio, 2009); management frameworks that recognise efficient use and re-use, to meet the needs of all water users (Gleick, 2003); and a concern for

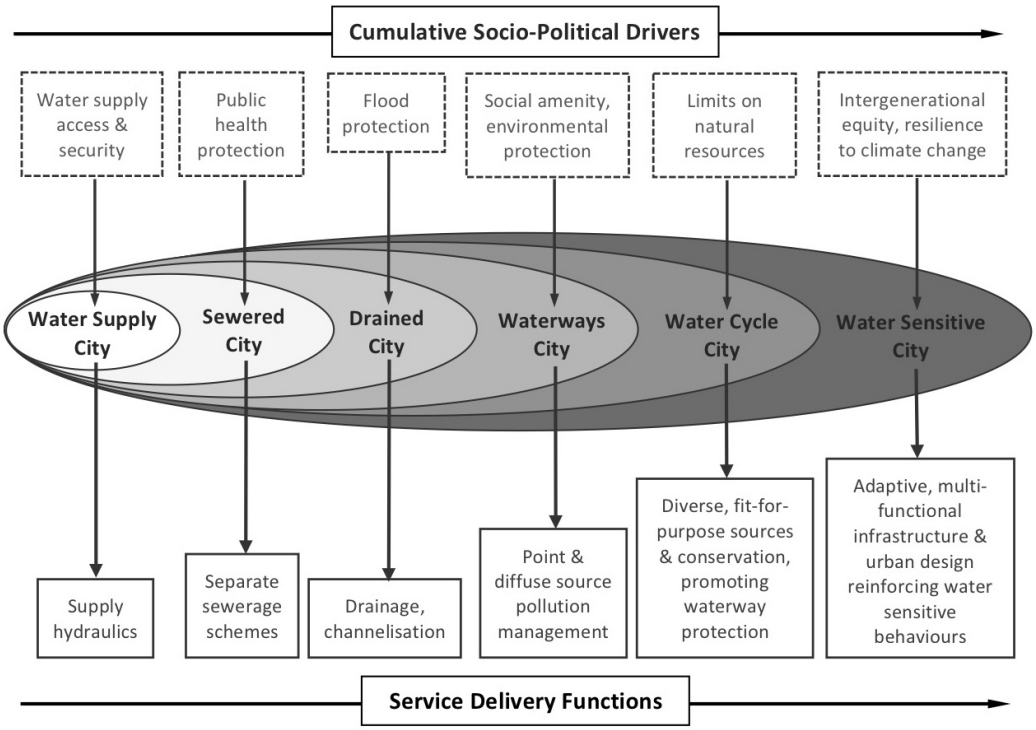
urban design aesthetics, where the visual display and use of water manifests these ideals for all to acknowledge, learn and appreciate (Wong and Brown, 2009). This holistic management paradigm is incorporated into many concepts with difference foci; Integrated Water Resources Management (Mitchell, 2005), Integrated Urban Water Management (Mitchell, 2006), Sustainable Urban Water Management (Brown and Farrelly, 2009), Integrated Catchment Management (Vlachos and Braga, 2001) and Adaptive Integrated Water Management (Pahl-Wostl et al., 2011). While some commentary points to a panacea-like focus on integration in these management approaches (Dovers, 2005a; Biswas, 2008), the discourse on urban water is linked to the broader issues of sustainable development.

There is a widespread call in the literature for urban water managers to view cities as human-created ecosystems. This necessitates managing resource extraction and outputs of waste in ways responsive to the needs of other organisms, ecosystems and communities. In this thesis, the term Sustainable Urban Water Management (SUWM) is used as the umbrella concept for all the underlying principles of the new urban water management paradigm, and the idea of a Water Sensitive City (WSC) is the vision this management praxis aspires to achieve.

With the modern experience of cities—with separated water supply, sewage and drainage systems designed, built and managed by water utilities; under the direction of governments and their agencies; and the use of water by individuals with little consideration for all of the above—there is much work to be done to achieve a Water Sensitive City. However, it is worth reflecting on the journey of modern cities, to see that these problems are not insurmountable. A transitions framework developed by Brown et al. (2009b) explored cities' relationships with water resources as they move through different phases of water system development (see Figure 1.1). Six categories of urban water management were characterised by the socio-political drivers of resource use, and their resulting physical infrastructure.

Many cities have tackled the issues of providing a reliable clean drinking water supply to its citizens (Water Supply Cities), and similar success has been achieved with sewering and draining cities to remove harmful water-borne wastes and damaging flood waters (Sewered and Drained cities). There has been some success at building in amenity provisions and environmental protection outcomes in modern urban water management systems to create the Waterways City. However, if we look beyond this category to the Water Cycle City, the infrastructure needed to deliver services such as fit-for-purpose water supply and waterway protection are significantly different to current reticulated systems. Thus, we begin to understand that urban water management has reached a significant hurdle, embedded in the physical artefacts that make up the city itself.

FIGURE 1.1 URBAN WATER TRANSITIONS FRAMEWORK



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While there is no example of a truly Water Sensitive City in the world, many cities are recognising this concept as a useful guiding vision for addressing social and environmental issues jointly to create more sustainable cities (Harding, 2006). However, there are some significant issues between socio-political drivers and their service delivery manifestations, which need to be overcome. This thesis sets out to explore the lack of success at solving these urban water management problems.

1.4 BARRIERS TO BETTER URBAN WATER MANAGEMENT

Why are urban water systems failing to address the changing water service needs of modern society? And why have new management paradigms such as SUWM failed to gain traction in practice (Rauch et al., 2005; Mitchell, 2006; Biswas, 2008), despite having emerged some two decades ago (Biswas, 2008; Wong and Brown, 2008). As a starting point to understand the origins of these urban water management challenges, the water management, technological innovation and diffusion and resource management literatures were reviewed. The focus of this review was to identify barriers to the uptake of new technology and management techniques, and a general commentary on urban water management issues and their causes. Three broad thematic areas were distilled and discussed in the following sections to provide a more systematic commentary of this complex problem.

1.4.1 Technological lock-in

In their historic review of perspectives on the built environment, Moffat & Kohler (2008) note that the later part of the 20th century was characterised by the belief that new technology would provide unforeseeable solutions to potential future resource

scarcity. This and the alternative view – curbing resource use is less risky than assuming technological efficacy gains will meet demand indefinitely – were made famous by the prominent public wager between cornucopian scientist Julian Simon and ecologist Paul Ehrlich in the 1980s. Both sides of this debate failed to account for the uptake process of new technology. As many technological innovation studies have revealed, the adoption of a new technology is dependent on many factors (Walker, 2000; Geels, 2002). Even if a particular piece of technology displays improved performance with cost effectiveness, it still must pass further tests of practitioner acceptance (through training), conform to industry standards, or may need changes to regulatory requirements before it can be mainstreamed. A new technology may also run the risk of being perceived as a failure through inappropriate application, design or maintenance (Collingridge, 1980).

Having overcome these hurdles, incumbent technologies are often the more attractive option in the short term due to their reduced transaction costs (Cowan and Hultén, 1996; De Vaus, 2001), regardless if it is a better fit for longer term needs (Walker, 2000; Elzen and Wieczorek, 2005). This is a particular issue for large technical systems such as urban water systems, where the capital and transaction costs of change are high (Walker, 2000; Monstadt, 2009). Thus the road to adoption of a new technology is not paved by its higher efficiency and cost effectiveness alone, but through competition with existing technology (Arthur, 1989). Scholars from the technological innovation field have labelled this phenomenon as technological entrapment or 'lock-in,' and identified it as a key blockage to the uptake of suitable technologies (Arthur, 1989; Cowan and Hultén, 1996; Walker, 2000; Monstadt, 2009). Unless a system is seriously underperforming it is unlikely that a new alternative will be sought or considered. Thus, the ability to accept and embrace innovation is also an important ingredient for the success of technological solutions (Foxon and Pearson, 2008). This leads to a broader perspective of barriers to more sustainable management of urban water; those embedded in the structure, operation and management of the water system itself.

1.4.2 Compartmentalisation of socio-technical systems

The historic separation of physical water supply, waste and in some cases drainage infrastructure, grew out of prevalent reductionist philosophies that sought efficiency by breaking the complex task of urban water management into logical service provision sectors. This has created infrastructure *and* administration legacies in the compartmentalised management systems set up to oversee the physical systems (Wong and Brown, 2009). There is general consensus in the resource management literature that the tactic for sustainable consumption is resource use efficiency (Gleick, 2003) and implicit in this aim is the integrated management of water extraction, consumption, reuse and disposal processes (Chocat et al., 2007; Barton et al., 2009). Thus, incumbent separated water services infrastructure, and their management regimes, are not conducive to more sustainable use and management of water.

This systemic compartmentalisation also makes the job of ensuring a successful alteration to any part of the water management system difficult. As Geels (2004) argues, large technical systems are intrinsically embedded in social values and

behaviours that indirectly affect their operation, i.e. they represent socio-technical systems of infrastructure. As much as the physical design, construction, operation and maintenance of the system itself, they are a product of their administrative, governance and regulatory arrangements, underlying philosophies and user preferences and behaviours. As a corollary to this, compartmentalised urban water systems will experience hurdles in ensuring change made in one part of the system aligns with other system components. Thus, not only is infrastructure unconducive to delivering contemporary water services, but also the institutional arrangements and management paradigms which administer and operate these water systems. This leads to the recognition that the water management regime is a barrier to better urban water management.

1.4.3 The water management regime as a barrier

The discussion of barriers has so far spanned issues of technology uptake, to the underlying matter of compartmentalisation of water management responsibility. These barriers are interrelated, but are also symptoms of a mismatch between current service delivery goals and the decision-making and governance arrangements in place to deliver those goals. Thus, the regime underpinning the management of these systems—the actors and institutions and the interdependencies and processes which connect them—need to be understood, as they ultimately determine change to urban water management practice (Holtz et al., 2008). This urban water regime includes the actors with a stake in the outcomes produced by the system, and consequently a broad set of organisations and their functional arrangements, roles and responsibilities with regard to urban water management. Most importantly, this regime is underpinned by an institutional setting that establishes and legitimises the authority and actions of these players.

It is within these governance arrangements that many scholars recognise the problem of institutional inertia when contemplating system change (Blomquist et al., 2004; Mitchell, 2005; Brown and Farrelly, 2009; Tortajada, 2010). Institutions evolve from the need for stability, providing structures of organisation to inject certainty into social life (Dovers, 2005b; Scott, 2008). Given this purpose, institutions have a tendency toward exclusivity; rejecting actions or ideas that contradict or outwardly challenge the rules of operation (Dovers, 2005b). Hence, the capacity to pursue 'better' urban water management depends on the ability for alternative approaches to be accepted by an incumbent regime. Given that change produces uncertainty, these regimes have a tendency to view alternatives suspiciously and as having undesirable costs, rather than as an investment in future certainty and stability through the development and preparation for new circumstances (Institutions will be further explored and explained in Chapter 2).

This journey through the various barriers to better urban water management has led to a growing area of scholarship that recognises that a root of the difficulties lie in the governance of urban water.

1.5 THE URBAN WATER GOVERNANCE PROBLEM

All these previously discussed barriers to implementation; the lock-in to traditional technology; the compartmentalisation of the act of urban water management; and the institutional inertia to address these problems; are symptoms of water governance where service delivery goals, physical infrastructure and administration and decision-making processes are entrenched and out-of-step with contemporary problems and solutions. The urban water sector[1] could be seen as reaching a threshold in its evolution. Modern society is moving from a 'contain and drain' philosophy to one that is recognising a need for greater sensitivity towards the multiple uses, values and benefits of water in the urban landscape.

The philosophical shift in the service delivery functions of urban water management is proving difficult to realise because of its radical departure from traditional management paradigms entrenched in existing governance arrangements. Solutions have been designed and demonstrated (Pawson, 2000; Mitchell, 2006). Policy from international (e.g. European Union Water Framework Directive), national (e.g. Australia's National Water Initiative) to local levels is outlining significant reforms to address the urban water problem (Holden et al., 2008). Yet researchers point to the problems persisting (Biswas and Tortajada, 2010; Pahl-Wostl et al., 2011), and practitioners express frustration that despite best efforts and intentions, continuation of the status quo prevails (Brown et al., 2009a).

The disconnection between policy, science and implementation has been well established in natural resources management and sustainable development literatures (Elzen and Wieczorek, 2005; Petrucci and Quinlan, 2007; Brown, 2009; Head, 2010). So while the service delivery functions expected of urban water management are currently beyond what the physical infrastructure can deliver, the governance arrangements and institutional processes of urban water management regimes entrap water managers. This thesis focuses on urban water governance as the core of the SUWM implementation problem (Biswas and Tortajada, 2010; Hukka et al., 2010).

1.6 THE RESEARCH PROBLEM

Urban water management problems can be framed as not only a problem of technology and its implementation, but as a decreased ability in the governance of that technology to adapt to new service requirements and operating contexts. The idea of a socio-technical system; where the physical infrastructure and technology is utilised as a function of social structures, norms and values (Geels, 2004), has begun to help unpack some of the systemic barriers in existing infrastructure systems to adjust

[1] The term 'urban water sector' is used throughout the thesis to capture the range of actors (from individuals, to groups, networks and organizations) who have a role to play in managing and/or governing water in the urban landscape; the physical infrastructure (used to supply, treat and drain water from the urban landscape) and underlying assumptions, cognitive frames and norms of professional practice these actors use in utilising this infrastructure.

to new objectives and expectations. Using this socio-technical frame, the urban water scholarship has begun to view the problem, not through a technological lens, but a social one.

Adaptive governance (Huitema et al., 2009), social learning (Keen et al., 2005), new institutionalism (Bartley et al., 2008), adaptive capacity (Engle, 2011), and coupling urban environments and socio-ecological systems (Moffatt and Kohler, 2008) are bringing new insight to the challenge of reconfiguring urban water systems through new forms of governance. If the solutions to urban water issues lie in significant changes to paradigms and management cultures, it is the fundamental 'rules of the game' (North, 1994) or institutional 'rules-in-use' (Ostrom, 1998) that need to be rethought (Blomquist et al., 2004). As previously highlighted, many scholars and practitioners from a variety of disciplinary backgrounds identify 'institutional inertia' as a major barrier to change (Imperial, 1999; van der Brugge and van Raak, 2007). While the work of some scholars (Becker and Ostrom, 1995; Crawford and Ostrom, 1995; Dovers, 2001; Huitema et al., 2009; Pahl-Wostl, 2009; Gupta et al., 2010) has gone some way towards exploring the role of institutions in the context of natural resources governance, there has been little empirical research that sheds light on how these systems of rules contribute to the policy-implementation disconnect. Thus the systemic inertia in water management institutions remains relatively undescribed in research, and unchallenged in practice.

Without a clearer understanding of institutional dynamics, or how they function to produce certain practices and outcomes, the embedded governance barriers to change cannot be identified and removed and/or managed to ensure water systems are responsive to changing operational conditions and societal needs. This research sets out to address this gap by beginning to look explicitly at urban water institutional settings, how they function to influence urban water management practice, and how they can adapt to new needs while maintaining their important stabilising role, thereby providing adaptive governance, and enabling more sustainable urban water management.

1.7 RESEARCH QUESTIONS

Given the real-world problem of urban water management, this research seeks to explain the process of regime transformation in the urban water field. Specifically, this research aims to look at the internal workings of the institutional setting behind management regimes, to identify ways that capacity to adapt to new circumstances can be developed in governance arrangements. The overall question guiding this research is: *How can urban water governance more effectively support institutional adaptive capacity, to enable and advance a shift toward sustainable urban water management?*

To address this question, three sequential aims were sought through the research process:

1. To empirically map the dynamic institutional context of urban water governance.

2. To generate recommendations on how institutional adaptive capacity can be built in governance processes.
3. To extend theoretical insights into adaptive capacity.

A series of research objectives were derived as a means of achieving these aims, and thereby address the research question. These objectives were to:

1. develop a conceptual understanding of how urban water institutions function;
2. empirically identify dynamic processes of change within cases of urban water institutional systems;
3. identify and describe the mechanisms of adaptive capacity within urban water institutional dynamics;
4. contrast and understand the mechanisms of adaptive capacity within urban water institutional dynamics, and
5. identify and analyse the role actors play in institutional adaptive capacity.

The research aims are further framed by the literature review presented in Chapter 2 (page 15), and the specific objectives distinguished and explained by the research approach outlined in Chapter 3 (page 35).

1.8 THESIS STRUCTURE

As a thesis-by-publication, this dissertation does not follow the traditional structure of a monograph. This introductory chapter has framed the study within the real-world problem of urban water management. Chapters 2 and 3 position the research in the literature and provide a discussion of the methodological approach to the study respectively. However some of this commentary is also provided by the publications, which for the most part make up the conventional results and discussion chapters of a traditional thesis. These sections are referred to where relevant in the chapter text.

Linking text is provided prior to the reproduction of each publication to assist the reader to navigate the text and provide the context within which each publication contributes to the overall work. Declarations of Authorship are also provided for each publication to indicate the percentages of the authors' involvement in the publication, in adherence to Monash University's thesis-by-publication requirements.

To maintain pagination throughout this thesis, the page numbers of publications have been altered. However, heading numbering has been retained within each publication. For language consistency, English spelling has been used throughout the thesis, and some publications may have been altered from their published versions in this regard.

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CHAPTER 2: THEORETICAL FRAMING

2.1 INTRODUCTION

Due to the exploratory nature of this research, this chapter is not structured as a traditional literature review. While it establishes the place of this study in current scholarship (and why it is exploratory), due to the emergent nature of the research design, the literature informed the study progressively. As such, some work reported in this section goes towards achieving some of the research objectives, and thus, could be considered results. However, in the interests of presenting a comprehensive commentary on the scholarly gap the research addresses, this work is included in this chapter. In a similar vein, some of the arguments presented here are contained in published papers, so the content has been reproduced and/or summarised from those sources for continuity.

2.2 GOVERNING, GOVERNANCE AND THE ROLE OF INSTITUTIONS

It is evident in the water management problem described in the previous chapter, that while human society's ability to develop through technology is well advanced, understanding how governance processes fulfil societal needs has not kept pace (Folke et al., 2005; Biswas and Tortajada, 2010; van de Meene et al., 2011; Westley et al., 2011). The complexity of sustainability problems (Dovers, 2005) raise fundamental questions surrounding the relationship between state, society and the natural environment. In the mêlée of interests and expectations that result, governments are struggling to govern, using the authority structures and processes of management available to them (Tiihonen, 2004; Meuleman, 2008; Teisman et al., 2009). Consequently, within the sustainability sciences, the study of many environmental problems has moved to questions of governance (Adger and Jordan, 2009); the structures and processes by which collective decisions are made to organise societal affairs and meet societal needs (Folke et al., 2005). Urban water management problems represent, not a failure of governments, but a failure of governance (Tiihonen, 2004; Pahl-Wostl, 2009).

The idea of governance has regained popularity in recent years as a means for researchers to explain the 'deeper structures of economy and society' (Tiihonen, 2004:43). In particular, to describe the contemporary shift away from 'top-down' control from governments, to more cooperative and inclusive forms of societal decision-making (Mayntz, 2003).The term has been discussed and defined in a wide range of ways (Mayntz, 2003; Tiihonen, 2004). Here, it is employed as an overarching concept to describe the political and administrative field of urban water management. As Pahl-Wostl (2009) observed, it has gained popularity with environmental scholars, providing a bridge to the social sciences for exploring the human dimension of sustainability science.

A prevalent means of characterising governance in the resources management literature has been as three distinctive modes; hierarchical, market and network or polycentric (Meuleman, 2008). These modes are distinguished by where decision-making authority is found; centralised bodies vested with power through formal laws

and accountability mechanisms (hierarchical); delegated roles and responsibilities with regulatory mechanisms to ensure compliance (market); and disperse nodes of power and influence connected through networks and based on principles of participation and consensus (network) (Meuleman, 2008; van de Meene et al., 2011). This typology has generated understanding and discussion of decision-making processes and accountability issues at the heart of resource allocation and management problems (Lemos and Agrawal, 2006; Biswas and Tortajada, 2010). However, they represent ideal forms of governance (Treib et al., 2007; Meuleman, 2008). In reality a hybrid mix of different features and instruments from all three modes are likely to appear, and be required to solve different types of issues in different contexts (van de Meene et al., 2011).

Another perspective on governance comes from the typology developed by Treib and colleagues (2007), which distinguishes governance through the mechanism by which governing occurs. A focus on actor networks and power dynamics is typified as politics, steering through different discourses and instruments as policy, and systems of rules that structure the actions of actors as polity. This later perspective of governance is adopted by this research, as it enables an understanding of broader processes of change, rather than focusing on power and agency in the political dimension, or on the specific outcomes of policy processes. Using this polity perspective, a greater understanding of the components of governance; actors, processes, structures and influences (van der Brugge, 2009); can be developed in concert, to make sense of the complexity of urban water governance.

A review of governance in the sustainability literature shows there has been much advocacy for the network mode of governance. This idea of broader involvement in governance processes has been incorporated into the concept of Adaptive Governance (Folke et al., 2005; Huitema et al., 2009). With heritage in natural resources management (Chapin et al., 2010), this concept has arisen from the idea that more inclusive and participatory decision-making is required, to address the multi-scale, cross-jurisdictional and temporal dimensions of sustainability issues (Lee, 1999; Olsson et al., 2006). It emphasises the need to build a societal basis for resilient and adaptive socio-ecological systems (Pahl-Wostl et al., 2007; Biggs et al., 2010; Chapin et al., 2010). For this reason, the focus is on diverse knowledge and perspectives, to foster social learning processes. In this way, system feedbacks are recognised and generate new knowledge and experience to inform management practices (Lee, 1999; Folke et al., 2005; Keen et al., 2005).

There is a growing number of new governance arrangements that build on this adaptive governance lineage, such as co-management (Huitema et al., 2009), private-social partnerships (Lemos and Agrawal, 2006), transitions management (Loorbach, 2010) and social innovation and entrepreneurialism (Huitema and Meijerink, 2009; Biggs et al., 2010; Westley et al., 2011). Advocates for these alternative forms of governance argue that the adaptive and reflexive qualities inherent in them enable more responsive institutional systems and management practices (Folke et al., 2005; Olsson et al., 2006; Teisman et al., 2009; Rotmans and Loorbach, 2010; Westley et al., 2011). However, other scholars argue that successful implementation of these forms of governance has not yet been realised (Huitema et al., 2009; Rijke et al., 2013). Others query the emphasis on social learning (Reed et al., 2010), arguing this neglects other key governance processes such as decision-making, action taking, and

consideration for where authority and power for these activities lies (Huitema et al., 2009; Sandström, 2009).

Regardless of how governance is understood, underlying all these discussions is the question of what role institutions have to play in the act of governing (Young et al., 2008; Tortajada, 2010). How do formal and informal institutions coordinate and steer collective decisions and actions? The concept of institutions includes formal rules such as laws, legislation, policies and documented procedures; and informal rules such as relationships, power structures, procedures and norms that are followed in everyday working life (Pierre and Peters, 2000). A more detailed discussion of this key concept is provided in Section 2.4, but it needs to be noted here that governance scholars argue that institutions have not kept up with the layers of complexity being added to the act of governing (Tiihonen, 2004; Huitema et al., 2009). Conversely, they are also seen as key resources for addressing governance problems (Dovers, 2001; Blomquist et al., 2004; Young et al., 2008). The use of institutions in the literature, as both the problem and solution, highlights an underdeveloped understanding of institutions at an empirical level. What are the institutional barriers and opportunities? How can they be removed and/or utilised? This paucity in the scholarship to both explain and create appropriate governance is the crux of this thesis – to understand governance issues through the lens of institutional change.

How can we begin to conceptualise this idea that institutions provide the underlying structures and processes of governance? The chapter now begins to diverge from a traditional literature review to address Research Objective 1; *to develop a conceptual understanding of how urban water institutions function.* However, elements of the discussion will continue to place this research in its scholarly context.

2.3 COMPLEX ADAPTIVE SYSTEMS

To begin to explore the governance issues behind urban water management, first an understanding of what it is to be explored must be found. The use of systems theory to aid in the study of social and ecological phenomenon has permeated many different disciplines and fields (Forrester, 1994; Simon, 2008). Many of the scholarly communities working on the urban water management problem are implicitly employing complex systems theory (Rijke et al., 2013). To align with its academic community, this research will also draw on this theoretical background to understand the subject of this study – the institutional settings underpinning urban water governance.

Complex adaptive systems theory recognises that systems comprise of components, interconnecting and interacting to produce emergent properties (Forrester, 1994). Whilst complex systems theory developed from diverse disciplinary backgrounds (Ison, 2010), this included sociological origins. As such, this idea of emergence can be aligned to the theory of structuration in social systems (Giddens, 1984). In his classic theory on societal functioning, Giddens (1984) argued that all human action occurs within the bounds of social structures, and that human agency contains the ability to alter these structures. With their capacity for reflexivity and abstract thought, humans can anticipate, plan, and forecast their actions in response to stimuli. This provides an ability to act as agents of change, to reorganise the system in which they operate (Teisman *et al.*, 2009, Loorbach, 2010). Hence society is self-organised, through a

continual dynamic interplay between the system's components or structures, and the activities of actors.

Self-organisation is one key property which emerges in complex adaptive systems (de Haan, 2006), and is an important theoretical underpinning to this thesis. For, in recognising urban water institutional settings as complex adaptive systems, they have the ability to change structurally and functionally, as a result of actors' activities. Identifying and understanding the mechanisms of agency behind system changes may provide an ability to become more proactive in guiding adjustments, and hence expedite shifts to more sustainable urban water management. There is, however, some controversy over whether harnessing the self-organising capacity of complex adaptive systems is possible (Walker and Shove, 2008; Teisman et al., 2009), given the unpredictable nature of these emergent properties (Hjorth and Bagheri, 2006). Some argue for a co-evolutionary approach, where system change is a reciprocal process of organic experimentation between system actors and components (Gerrits, 2008).

This thesis views these two approaches, co-evolution and active intervention, as non-mutually exclusive. Both aim to influence system change, though co-evolution takes a more passive, conservative standpoint. This research takes a somewhat normative but pragmatic view. Given the increasing concerns that urban water systems are not meeting new water management objectives and climate conditions, a more a proactive role in systemic change needs to be explored. Therefore, in this thesis, complex adaptive systems provide the ontological basis for framing urban water governance problems; as systems of components connected by processes of agency, which interact in complex independencies to shape the nature of the system itself. What the components and agency comprise of is now explored.

2.4 INSTITUTIONS AS SYSTEMS AND THE ROLE OF AGENCY

An institutional perspective has been recognised as a useful lens for exploring a range of sustainability issues (Dovers, 2001; Rotmans, 2005; Bartley et al., 2008; Huitema et al., 2009; Sandström, 2009; Young, 2009; Fuller, 2010; Engle, 2012). However, the use of the term institution is diverse (Hodgson, 2006). This section is devoted to clarifying its use within this particular study.

Institutional analysts have identified three dominant streams of institutional theory, with differing epistemological emphases (Hall and Taylor, 1996; Campbell, 2004; Scott, 2008). These are described in detail by (Hall and Taylor, 1996), and are summarily reduced here to; Rational Choice Institutionalism, which focuses on systems of rules and the sanctions and rewards needed to ensure the system functions well; Historical Institutionalism, which is concerned with understanding questions of legitimacy in the origin and evolution of contemporary institutions; and Sociological Institutionalism, which is interested with the nature of society and how it functions through examination of institutions. It is this latter stream that suits the purpose of this thesis, as it allows emphasis to be placed on the actors in the system and what they do, rather than on the way institutions constrain them. A most eloquent and suitable definition of institutions using this sociological slant is given by Campbell (2004):

'Institutions are the foundation of social life. They consist of formal and informal rules, monitoring and enforcement mechanisms, and systems of meaning that define the context within which individuals...nation-states, and other organisations operate and

interact with each other. Institutions are settlements from struggle and bargaining. They reflect the resources and power of those who made them and, in turn, affect the distribution of resources and power in society. Once created, institutions are powerful external forces that help determine how people make sense of their world and act in it. They channel and regulate conflict and thus ensure stability in society.' (Campbell, 2004).

The only addition to this description pertinent to this thesis is that, beyond mediating conflict, institutions also shape and guide actors behaviours, enabling collective action (Eisenack and Stecker, 2012). Sometimes, this may be aimed at changing the institutions themselves. This thesis employs the idea of 'rules-in-use' (Ostrom, 1998) to encompass the variety of documented laws, social norms, and cognitive frames that make up the institutional setting. This concept allows an emphasis on the more informal institutions, such as shared meanings, norms and other social constructs.

As they are more tacitly known, these informal institutions are not so apparent in definitions such as the 'rules of the game' (North, 1994). However, they are particularly important, as they are often the means by which formal institutions are created, shared and legitimised. As Helmke and Levitsky (2004) point out, neglecting these informal rules-in-use risks missing crucial mechanisms for understanding institutional change. Following this observation, the interplay between formal institutions and the informal institutions guiding actor's interpretations, choices and enactment of formalised rules, are the processes by which institutions are changed (Hall and Taylor, 1996). While having a reputation as being inert, institutions do change, albeit slowly (Dovers, 2001; Campbell, 2004; Garmestani et al., 2009). Rather than viewing these structures of governance as barriers, this thesis is underscored by the assumption that institutions could enable change, if identified and harnessed in appropriate ways.

This raises the question of power in institutional systems (Sandström, 2009). This thesis deals with this issue by using an actor-orientated analysis of the urban water institutional setting. By focusing on agency, an understanding of where power is vested in the system can be generated. While this research did not explicitly explore questions of power, the information the study generated could empower actors with an appreciation of power dynamics within their operating context, and new knowledge of their own capacity to act as change agents. Therefore, this research contributes to questions of power, by inputting understandings of power dynamics into the applied governance approach provided by Transitions Management. This is explored in Publication Three. The extent of action research in this study design is discussed in Chapter 3. While questions of power are important, this work has sought to develop an overall picture of institutional change as a starting point for understanding adaptive governance, thereby offering a means of exploring the power dynamics therein.

The above discussion has gone some way to clarify the subject of this research and the scholarly heritage it draws on. However, to pursue the research objective to understand institutional change, intellectual tools for understanding system change are needed.

2.5 EXPLORING SYSTEM CHANGE

To understand how institutional systems change, an understanding of how self-organising properties emerge, and how they help actors to navigate dynamic change processes are called for. Research examining how human society interacts with ecosystems and technological systems provide intellectual and analytical tools for understanding these change processes and the role actors play in them.

2.5.1 Transitions

A prominent scholarship emerging from science and technical studies is that of transitions. A transition is defined as a fundamental change in the way society operates, which occurs over a generation or more (Rotmans, 2001). There is a strong body of theoretical developments in transitions. For example, the multi-level perspective (Rip and Kemp, 1998; Geels and Schot, 2007) is used to distinguish between macro (landscape), meso (regime) and micro (niche) levels of societal change. Also, the diffusion of innovation S curve delimitates pre-development, take-off, acceleration and stabilization phases of transitions (Rogers, 1962; Rotmans, 2001).

Transitions theorists are now beginning to unpack change dynamics, identifying different drivers that create interplay between macro, meso and micro levels and result in different pathways and patterns of change (Geels and Schot, 2007; van der Brugge, 2009; de Haan and Rotmans, 2011). This work is beginning to unravel the processes behind transitions, however, the scholarship is still developing, and as Berkhout et al. (2003) note, there has been limited empirical testing of these theoretical developments. Nevertheless, transition theorists have taken these theoretical understandings a step further, by developing a framework to operationalise the theory. Transitions Management offers a theoretically grounded process to guide transitions (Loorbach and Rotmans, 2010), drawing on foresight and scenario techniques for problem framing, visioning and planning (Sondeijker et al., 2006), using participatory techniques and social learning as central tenets for developing alternative governance solutions to sustainability issues (Rotmans and Loorbach, 2010).

Transitions theories have been criticized largely for their assumption that managing emergent properties in complex systems can be achieved (Walker and Shove, 2008), and for not yet providing detail on the dynamic change processes behind a transition (Farla et al., 2012; Markard et al., 2012; Park et al., 2012). A discussion of these criticisms can be found in Publication Three. As a relatively young scholarship, Transitions theories have been advanced to contribute broad conceptualisations for understanding societal change, while Transitions Management has been developed through iterative theory development/empirical application processes to provide a pragmatic method for influencing institutional change. However, neither provides the analytical tools applicable to the research aims and questions of this study. To quote the prominent transitions scholar, Jan Rotmans:

'We know too little about the social and institutional aspects of transitions and the extent to which institutions change and are changed by them. The process side of transition management lacks a satisfactory knowledge base.' (Rotmans, 2001:29).

While lacking the institutional perspective this study seeks to apply, Transitions Management nevertheless offers a potential governance framework for operationalising knowledge about institutional settings and their change processes. This point is revisited and discussed in depth in Publication Three.

2.5.2 Resilience, transformation and adaptive capacity

The ability to continually evolve new ways of doing and being provide systems with an 'adaptive capacity.' This concept has entered the sustainability sciences nomenclature from systems ecology (Georgiou, 2003; Hjorth and Bagheri, 2006). It is used as an umbrella concept to capture the variety of potential mechanisms behind change processes in social-ecological systems. A number of concepts describe the types of system change that result from adaptive capacity. Resilience is created when the system can adapt to absorb shocks, while transformation occurs when the system reconfigures to operate in a new way (Walker et al., 2004; Garmestani et al., 2009). Theoretical debates exist in the literature surrounding these two forms of change (resilient and transformative) and there is no clear consensus on what they encompass, which form of change is needed and when, or whether they are complimentary or competitive (Rotmans, 2001; Geels, 2004; Walker and Shove, 2008; Teisman et al., 2009). Publication Four provides a fuller discussion of these issues.

Despite the debate, scholars have adopted the concept of adaptive capacity to encompass the potential mechanisms for both resilience and transformation (Walker et al, 2004). It has been employed in a variety of scholarships including natural resources management (Lee, 1999), environmental governance (Huitema et al., 2009; Pahl-Wostl, 2009), and transitions management (Berkhout et al., 2003; Pahl-Wostl, 2007; Loorbach, 2010). This intellectual convergence, between socio-technical and socio-ecological scholarships, has generated some promising cross-pollination of ideas to deal with the human dimension of sustainability issues (van der Brugge and van Raak, 2007; Westley et al., 2011). However, further theoretical development of adaptive capacity is needed to clarify its usage and usefulness in explaining system change (Newell et al., 2005; Engle, 2011).

While more work is required to develop shared understandings and empirical rigour behind adaptive capacity, it does provide a useful focal point for organising knowledge of system change. How is adaptive capacity formed in the dynamic interplay of the institutional setting? What role do actors play in generating and/or utilising adaptive capacity? Publication Four provides a detailed discussion of how adaptive capacity is used to examine the urban water governance problem in this study.

At this juncture it is worth emphasising that adaptive capacity provides the underlying concept this research seeks to shed light on. Here, it is understood as a combination of the abilities of the actors and attributes of the institutional setting to change the structure or function of the system. Adaptive capacity provides the concept to capture the inherent ability of institutions to enable system change. It is, therefore, proposed that exploring institutions as complex systems, and identifying adaptive capacities in their emergent properties, presents a significant opportunity to learn how to utilise institutional dynamics for governance change. Further, to understand how institutions change over time, identifying the adaptive capacity created as actors navigate their institutional settings while expressing their agency is required. Without this understanding of how institutional settings function to shape and order society, new more flexible modes of urban water governance will remain elusive.

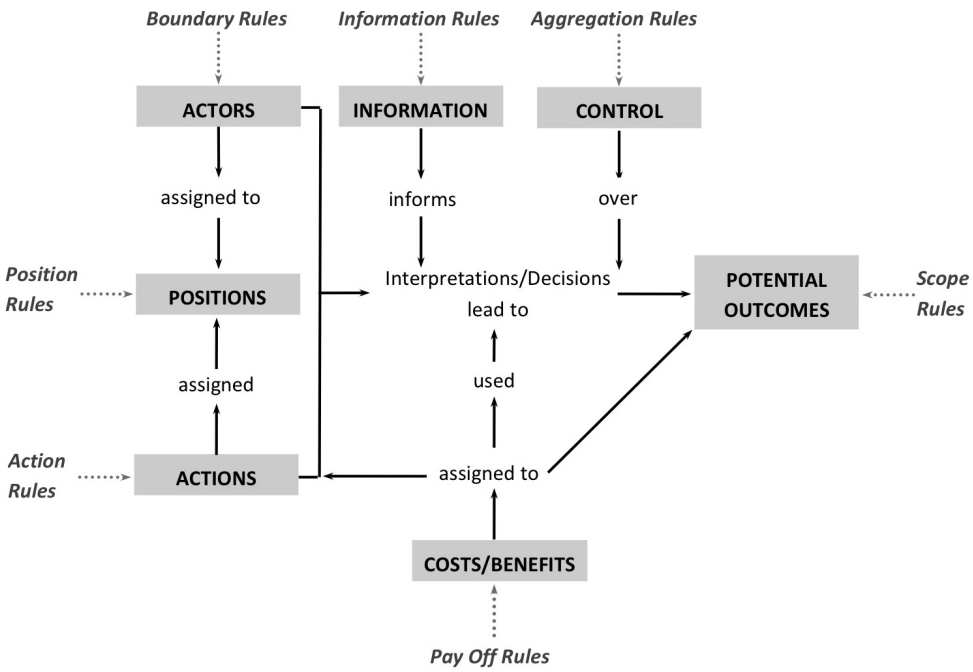
2.6 DYNAMIC INSTITUTIONAL SETTINGS

Socio-ecological theory provides a useful general theory of change in the connection between adaptive capacity and system resilience or transformation. On the other hand, Transitions Management contributes a pragmatic framework to go about organising adaptive capacity to achieve system change. However, there remains a large gap in identifying adaptive capacity in system dynamics and the role it can play in enabling change. Drawing on the socio-ecological and institutional literatures discussed above, a dynamic conceptualisation of institutional settings has been developed to explore this gap in knowledge throughout this research. This conceptual framework is presented in detail in Publications One and Three. However, the theoretical background is provided here, before a brief reproduction of the Framework is provided.

2.6.1 Institutional Analysis and Development Framework

The Institutional Analysis and Development (IAD) Framework produced by Ostrom and others (1998; 2005) has been developed to understand the governance of common pool resources. The Framework has since been tested and applied in a wide range of empirical contexts and fields of study (Ostrom, 2005; Ostrom and Cox, 2010), and is a widely recognised tool to identify and explore the intricacies of institutional settings behind resource governance problems (Imperial, 1999; Madison et al., 2010; Pahl-Wostl et al., 2010). A component of the IAD Framework, the Action Situation, is a generic description of the problem-solving process inherent to the act of governing (see Figure 2.1).

FIGURE 2.1 ACTION SITUATION OF THE IAD FRAMEWORK



ADAPTED FROM OSTROM (2005)

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This process is broken down into a number of components (capitalised in Figure 2.1), and the relationships between them are described, showing how a problem is solved by producing potential outcomes. To understand how these components interact in

different contexts, the rules-in-use that determine the nature of the components are identified (italicised in Figure 2.1). These rules-in-use describe the constraints and enablers influencing the components. So by understanding their influence, an appreciation of the subsequent dynamic interactions of the components in the Action Situation can be gained. The rules-in-use that describe these dynamics are listed in Table 2.1.

TABLE 2.1 IAD FRAMEWORK RULES-IN-USE

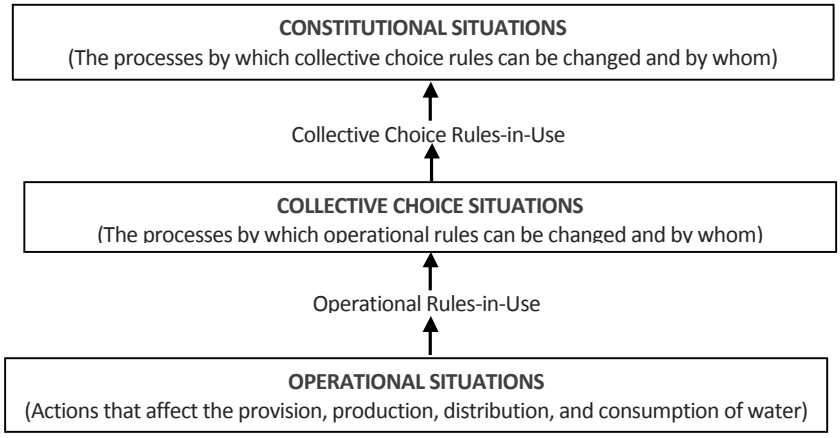
Action Situation Component	Corresponding Rule	Influence of Rule on Action Situation Component
ACTORS	*Boundary*	Define actor's eligibility and selection/departure process to/from positions
POSITIONS	*Position*	Set the 'slots' that can be inhabited by actors and 'hold' roles and responsibilities and actions that can be taken to fulfil these
ACTIONS	*Choice*	Determine the range of actions (must, may, must not) and what should inform their selection
INFORMATION	*Information*	Set level of information available to inform participants choice of actions
CONTROL	*Aggregation*	Determine level of control of the action situation by setting which positions can be involved in certain actions by other positions
COST/BENEFITS	*Pay-off*	Assign rewards and sanctions for particular actions
OUTCOME	*Scope*	Set what the desirable and non-desirable outcomes are

SUMMARISED FROM OSTROM (2005)

To illustrate, a water manager (Actor) has the task of managing the water in a dam (Position). The actions he/she takes to achieve this task are prescribed in the dam's operational manual (Actions). However, to decide on the appropriate actions needed, for example whether to release water after a rainfall event, he/she must interpret the amount of run-off, likelihood of another rainfall event etc. (Information), and weigh up the possible positive and negative consequences (Costs/Benefits). He/she may also have to contend with outside influences, such as politicians or communities wanting to hold floodwaters back (Control). Thus, the outcome of this Action Situation can be understood by the relative influence of these rules-in-use, constraining and enabling the actor, and generating influence over him/her through other components.

The IAD Framework also offers another dimension with which to understand system dynamics, by recognising multiple levels of activity. Rules-in-use are nested in a hierarchical series of Action Situations, described by their own sets of rules-in-use. Action Situations higher up the hierarchy determine how lower level rule sets can be changed, and who can be involved in this process (see Figure 2.2).

FIGURE 2.2 LEVELS OF ANALYSIS OF IAD FRAMEWORK



ADAPTED FROM OSTROM (2005)

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To illustrate this hierarchy, the decision-making process to release water from a dam may be described by a set of operational rules-in-use, such as the dam operational manual. The process for changing this manual (hence operational rules-in-use) would be described by a collective choice Action Situation, with its own set of rules-in-use, stipulating the review process and the stakeholders who should be involved. The constitutional level Action Situation would decide who is involved in the dam's management in the first place, i.e. who owns the water? Who owns the infrastructure? As the real-world subject of this research is the dynamic between infrastructure systems and their management, the research focuses on the operational and collective choice levels, and not the more fundamental constitutional level of the institutional setting.

The IAD Framework provides a robust way to describe and analyse institutional settings, by providing a generic model of decision-making (Action Situation), with analytical power to explain the dynamics within this setting (rules-in-use and nested Action Situations).

2.6.2 Institutional Work

As has been discussed, traditionally institutions have been perceived as barriers to the systemic change needed to solve complex sustainability problems. This is perhaps as institutional theory has neglected the role of actors in institutional change (Lawrence et al., 2011). Institutional studies have tended to look to explain macro-change processes such as social movements and technological innovation, overlooking the everyday activities and experiences of actors;

'the efforts of individuals and collective actors to cope with, keep up with, shore up, tear down, tinker with, transform, or create anew the institutional structures within which they live, work and play, and which give them their roles, relationships, resources and routines.' (Lawrence et al., 2011:53).

Institutional Work is a developing branch of institutional theory, seeking to address this gap. It focuses on the ways actors express their agency, and the effects of this activity on the institutional setting (Lawrence et al., 2009). It is based on the premise that there are three forms of institutional activity or 'work' that actors conduct, defined by the impact they have on the institutional setting. Maintaining Institutional

Work are activities that uphold current institutions (rules-in-use). This can create barriers to changing inappropriate institutions by protecting their legitimacy. Although, these activities can also serve to incorporate changes into pre-existing routines and patterns, and to socialise new actors into the institutional setting. Creative Institutional Work is about establishing new rules and incentives to follow them. Disruptive Institutional Work involves undermining the social controls that lead members to associate and comply with institutions. It may involve directly attacking compliance mechanisms or covertly redefining, manipulating or problematizing institutions. These creative and disruptive activities challenge the relevance of current institutions, and open them up to review and reconfiguration. Together, these three forms of institutional work represent the agency of actors to uphold, adjust or dismiss the institutions that bound them, through their day-to-day interactions and activities. These concepts, therefore, provide a way of describing the dynamic processes that change, or sustain, rules-in-use, and hence how institutions might be altered over time.

In addition to using Institutional Work theory to dynamically describe processes of change through the agency of actors, Scott's conceptualisation of New Institutionalism (2008) provides further analytical depth. In his extensive review of institutional studies, Scott identified three main pillars on which institutions stand. Regulative institutions are perhaps the most commonly known, relying on some form of sanctioning or enforcement to induce certain behaviours and actions. Normative institutions on the other hand, compel actors to follow social norms or ideas of what is the *right* course of action. And finally, compliance with Cognitive institutions occurs because actors conceive them as the right course of action; they are simply taken-for-granted as the way to act.

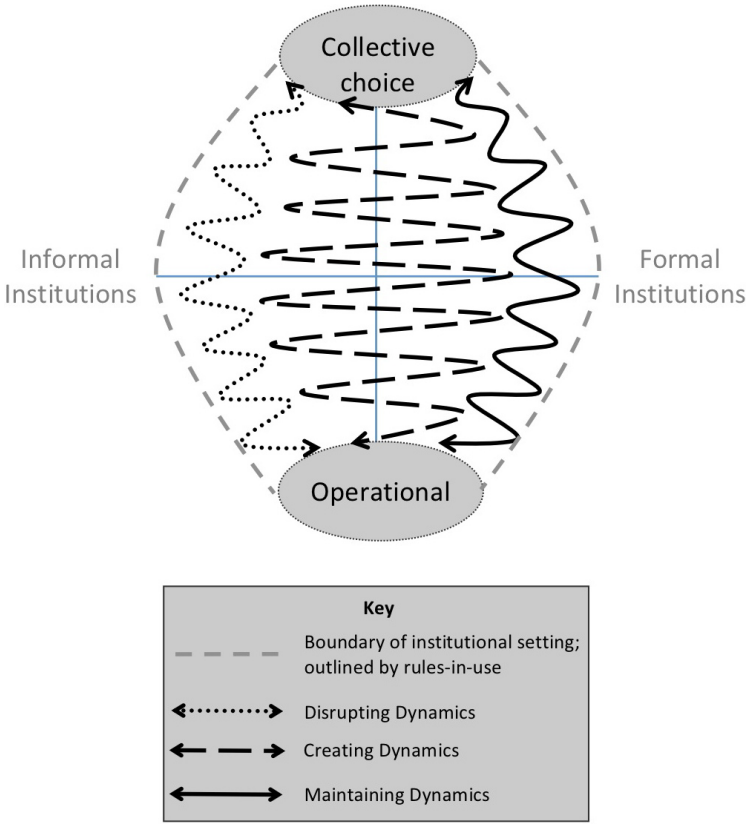
Recognising Scott's three pillars, Lawrence and Suddaby (2006) identified that certain types of Institutional Work are aligned to certain pillars. This connection offers greater analytical depth to explore what impact institutional activities are having on the institutional setting, by explaining how institutional dynamics are created (through Institutional Work) and why and how they lead to change (pillars). The regulative, normative or cognitive pillars connected to specific types of institutional work are listed in Table 1 of Publication Four.

Using these concepts from the IAD Framework and Institutional Work theory, an understanding of the dynamic processes of change within urban water institutional settings can be identified and described. The resulting conceptual framework has been described in Publications Two and Three, but is reproduced briefly below.

2.6.3 Conceptual framing of dynamic institutional settings

To visualise the institutional setting, key concepts of the scholarships described in the previous section have been drawn together to represent a dynamic understanding of the processes of agency and change. These key concepts are illustrated as a conceptual model of the urban water institutional setting in Figure 2.3.

FIGURE 2.3 CONCEPTUAL MODEL OF INSTITUTIONAL DYNAMICS



The different scales of institutional activities (operational and collective choice) are presented on the vertical axis, bounded by the rules-in-use on a continuum from formal to informal institutions (horizontal axis). The three different forms of institutional work (maintaining, creating, disrupting) mediate between these levels, generating interplay between operational and collective choice levels, and altering rules-in-use through regulative, normative and cognitive means (not illustrated). Maintaining activities enforce and conform to formal rules-in-use, and so tend to rely on these formal mechanisms. In contrast, disrupting activities seek to challenge and undermine formal institutions, and so rely on informal rules-in-use, beyond the sanctions imposed by formal rules. Creating activities mediate between the two, questioning formal rules with insights from disruptive activities, but, rather than challenging these directly, using passive strategies to 'bend' the formal rules to accommodate and eventually legitimise these new ideas.

This model conceptualises the dynamic processes within institutional settings, resulting from actor's agency. But where might adaptive capacity lay within these dynamics? The next task for this research is to identify tools in the adaptive capacity literature to identify and describe adaptive capacity within this framework of institutional dynamics.

2.7 ASSESSING ADAPTIVE CAPACITY

To find suitable assessment tools and frameworks for understanding adaptive capacity, a meta-analysis of global change literature was conducted. Studies that presented a tool or framework with adaptive capacity as an explicit element, and a method or empirical example of application, were reviewed in depth. The results of this meta-analysis are presented briefly below.

2.7.1 Available tools

The sustainability sciences scholarship using an institutional lens has provided frameworks for benchmarking system conditions (Ostrom, 1998; Brown et al., 2009; Pahl-Wostl, 2009) and identifying fundamental design principles for better functioning institutions (Dovers, 2001; Olsson et al., 2006; Biggs et al., 2010; Pahl-Wostl et al., 2010). However, these frameworks do not provide analytical capacity to examine the dynamics, or activities and strategies, which create adaptive capacity. A number of recent studies used an institutional lens to examine adaptive capacity in decision-making processes (Park et al., 2012), institutional design (Gupta et al., 2010; Pahl-Wostl et al., 2010), actor-orientated studies (Eisenack and Stecker, 2012), and frameworks to manage barriers to change processes (Moser and Ekstrom, 2010). These published studies offered potential to explore dynamics processes and/or actor's roles in them. Their tools and frameworks were reviewed with regard to their treatment of adaptive capacity and institutional dynamics. The results of this review are presented in Table 2.2

Most of these tools provide insight on adaptive capacity determinants, and have clear individual merits in their specific foci. However, only the Adaptive Action Cycles tool specifically looks at how a proactive decision to adapt might occur and how that decision is acted upon i.e. how adaptive capacity might be identified and used. However, this tool is geared towards operational application, and its analytical power is limited. It proposes a series of key questions to understand the contextual conditions and dynamics in cases of adaptation. The framework provides no means to aggregate and generalise the answers to these questions, in order to generate insight on adaptive capacity beyond a particular case. From this review, none of the tools identified offer the analytical power to explore dynamic processes of change and agency, at a systems scale.

TABLE 2.2 ADAPTIVE CAPACITY ASSESSMENT TOOLS

Frameworks/ Tools	Adaptive Capacity Wheel	Management and Transitions	Adaptation as Actions Framework	Planned Adaptation Framework	Adaptation Action Cycles
Key sources	Gupta, 2010	Pahl-Wostl, 2009; Pahl-Wostl et al, 2010	Eisenack & Stecker, 2012	Moser and Ekstrom, 2010	Park et al, 2012
Intellectual traditions	Governance/institutional theory, management literature, vulnerability	Adaptive management, social learning, transitions, social-ecological systems	Vulnerability, social-ecological systems, sociology	Social-ecological systems, political science, management literature	Transitions management, management literature
Purpose	A methodological framework to assess adaptive capacity vested in institutions	Conceptual framework for understanding how system properties interact to determine policy outcomes and regime change. Includes methodological approach for implementing such change processes	A systematic analysis of actor-orientated relations and the barriers they come across in adaptation processes	A systematic framework to diagnose barriers in the process of adaptation	A framework for understanding decision-making in relation to incremental and transformative change
Focus	Institutions	Generalized relationships between system components	Comparing outcomes of different actions through an actor-oriented perspective	Planned adaptation processes	Decision-making
Key component(s)	6 determinants of institutions that can promote adaptive capacity defined by a set of criteria	Structural system diagram and activity diagram showing flows of influence and sequences of activities	Process model of actions to describe 'means-ends chains' that lead to adaptation	Idealised adaptation decision-making process recognising three main phases (understanding, planning, managing) a series of diagnostic questions to identify barriers in each phase, and a matrix for determining the scale and potential to influence barriers	Decision-making cycle depicting two interrelated scales (incremental and transformational), with series of questions to probe the decision-making process and its outcomes
Scope	System-scale	Multi-scale Focused on water management systems, but could be adapted to other resource regimes	Decision-making processes	Management processes	Decision-making in the context of management processes

As '*adaptive capacity is generated by the interaction of determinants which vary in space and time'* (Smit and Wandel, 2006:288), there is clearly a need for an analytical tool capable of capturing how institutional determinants of adaptive capacity interact and/or are harnessed by actors, to realise change. Indeed Gallopin (2006) suggested adaptation studies move toward development of general theories of change, in order to understand adaptive capacity in the context of internal system dynamics (including self-organisation),and in the interaction of the system with its environment (i.e. responding to external feedback). Recent reviews have observed that the scholarship has not yet moved to this level, focusing instead on questions of measurement and indicators to statically assess adaptive capacity (Engle, 2011; Hinkel, 2011).

These gaps in scholarship support broader calls for a more diagnostic approach to analysing sustainability problems (Young, 2008; Moser and Ekstrom, 2010; Ostrom and Cox, 2010; Pahl-Wostl et al., 2010). The argument for diagnostic methods is that they will: i) disaggregate issues and help understand interdependencies in complex adaptive systems; ii) provide a way to focus on underlying nature and cause; and iii) develop knowledge to target solutions at leverage points in the system to maximise success rates. This points to a growing need to study relationships between the determinants of adaptive capacity, within the context of system change, to explain how 'capacities' combine to generate different forms of adaptation.

Given the state of scholarly understanding and available tools, an exploratory approach was taken in this research. The goal of the study was to bridge the gaps in knowledge on institutional dynamics and adaptive capacity outlined in this chapter through three sequential aims:

1. To empirically map the dynamic institutional context of urban water governance.
2. To generate recommendations on how institutional adaptive capacity could be built in governance processes.
3. To extend theoretical insights into adaptive capacity.

This approach would provide pragmatic knowledge on how to enable the governance of urban water to change, implementable through new governance approaches such as Transitions Management, while also informing further scholarly work. The next Chapter outlines the emergent research design employed to achieve these aims, outlining the specific research objectives and how they were met.

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CHAPTER 3: RESEARCH DESIGN

3.1 INTRODUCTION

The landscape of institutions in the sustainability field has been largely unexplored. Much like tourists admiring the Grand Canyon, scholars have appreciated their scale, complexity and significance, but not many have ventured out to identify the nooks and crannies, or map how these pieces fit in and contribute to the overall spectacle of the whole. This research sets out to make some tentative steps towards this exploration. However, with few maps or tracks through the institutional terrain, the research design (or overall plan for the expedition) must be somewhat emergent, leaving flexibility to explore certain pathways, and much stopping to map the path for others along the way. As Creswell (2009) argues, such an emergent approach allows for new insights to be accounted for, tested and refined through the course of the research. Lincoln and Guba (1985b) argue an emergent nature is characteristic of all social research, as research outcomes are generated through a process of negotiation and interpretation of meanings with human data sources. While Blaikie (2009) agrees with this distinguishing feature of social research, he also advocates the need for a plan by which to conduct the research, to keep the process on track with the original intent.

To provide both guidance and flexibility, this research turned to Yin's distinction between the logic behind research (design) and the logistics of research (method) (Yin, 2009).The first part of this chapter sets out a clear logic to the research design, positioning the research in ontological and epistemological standpoints, and establishing a line of inquiry to guide the application of a research strategy. This provides an overall interpretation of the research task (Bechhofer and Paterson, 2000), which then guides a flexible application of methods toward this end. Because of this emergent design and the layout of the thesis-by-publication, the second section of this Chapter provides a summary of the research methods and how they were employed to answer the research questions. The actual methods developed through the course of the research can be followed through the published papers. Publication One illustrates the initial data analysis method employing the IAD Framework, while Publication Two introduces a combination of this and Institutional Work theory. The final method is described in part in Publications Three and Four.

3.2 RESEARCH LOGIC

This section describes the 'interpretive framework' used for the study (Denzin and Lincoln, 2008: 31). It makes explicit the understanding of reality (ontology) and the creation of knowledge (epistemology) underlying the research. This clarifies the foundational assumptions of the approach to guide the reader's interpretation of the research. Blaikie (2007) also notes two other important choices a researcher faces in addition to these paradigmatic ones; the strategy or logic used to answer the research questions, and the position the researcher adopts toward the researched. This foundational matter is covered in this section to provide the reader with an

understanding of the 'logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions' (Yin, 2009:26). To briefly revisit the pragmatic problem behind the research and the aims to help situate it in the methodological discussions which follow:

- the research problem is that urban water systems are locked into old and potentially unsustainable, unsuitable practices, by the institutions that govern them;
- the research topic is institutional systems whose dynamics produce forms of adaptive capacity that lead to societal resilience and/or transformability;
- the overall research question is; *How can urban water governance more effectively support institutional adaptive capacity to enable and advance a shift toward sustainable urban water management?* and
- the overall aims of the research are to:
    1. *Empirically map the dynamic institutional context of urban water governance.*
    2. *Generate recommendations on how institutional adaptive capacity can be built in governance processes.*
    3. *Extend theoretical insights into adaptive capacity.*

To the above ends, the objectives of the research are to:

1. develop a conceptual understanding of how urban water institutions function;
2. empirically identify dynamic processes of change within cases of urban water institutional systems;
3. identify and describe the mechanisms of adaptive capacity within urban water institutional dynamics;
4. contrast and understand the mechanisms of adaptive capacity within urban water institutional dynamics; and
5. identify and analyse the role actors play in institutional adaptive capacity.

Given the research problem, question, aims and objectives, the remainder of this Chapter explores the question, 'What type of evidence is needed to answer the [research] question in a convincing way?' (De Vaus, 2001:9).

3.2.1 Research paradigm

In making the researcher's understandings of reality and creation of knowledge explicit, the research paradigm defines an 'intellectual context' for the research (Blaikie, 2009: 97). Described by Guba (1990) as the research paradigm and comprising a set of ontological and epistemological beliefs, this position guides the researcher in their methodological choices. This section provides the foundational assumptions behind this study.

This research applies a social realist perspective, seeing reality as the result of underlying social structures and mechanisms that produce both observed experience and unobserved phenomena (Blaikie, 2007). The observed experiences can reveal the nature of some of these underlying structures and mechanisms, and are accessible through the experiences of the social actors themselves. Thus, the epistemological standpoint of this research is that understanding reality relies on capturing and understanding the perspectives and meanings of the social actors who experience it

(Lincoln and Guba, 1985b). In this, it aligns with the constructivist branch of social realism (Blaikie, 2007), or the constructivist paradigm described by Guba and others(Guba, 1990; Denzin and Lincoln, 2008).

A further ontological assumption of this research is one which Blaikie (2007) describes as the depth realist, and follows Bhaskar's argument that reality exists in a number of domains; what can be observed (empirical domain), what exists independent of the observer (actual domain), both of which are based on an underlying meta-infrastructure of structures and mechanisms (real domain) (Bhaskar, 2008). This ontological construction aligns with Guba's ideas of *relativitisim* as a constructivist alternative to positivist and post-positivist realism (Guba, 1990). The main criticisms of depth realism are that it assumes there is no truth to be discovered through research, and that social actors may not recognise the make-up of the real domain (Crotty, 2003; Smith and Hodkinson, 2008). Despites this criticism, this research is based on the premise that compiling social actors perspectives will provide a more comprehendible (though not comprehensive) idea of how urban water institutions function. As such, the research approach will provide insight into the empirical domain, and build an understanding of the make-up of the real domain.

To link these perspectives back to the use of theory discussed in Chapter 2, the research uses structuration theory as a way to understand the mechanisms and processes that underlie the real domain. Institutions are used as an epistemological device to understand the constructed reality of urban water practitioners, and how their meanings combine to produce the empirical domain of the urban water institutional setting.

3.2.2 Logic of inquiry

Given the ontological and epistemological assumptions behind this research, traditional inductive and deductive logics that require the researcher to operate as a detached observer, are ill suited to the needs of this research. As the subject matter of this research exists in the tacit knowledge of actors, and the formation of knowledge relies on accessing these understandings, an inductive logic based on observations and interpretations of an 'objective' researcher is unlikely to reveal meaningful results. Likewise deductive logic does not prove useful, as it relies heavily on the presence of a theory or hypothesis to explain observed phenomena and then follows a procedure to test this. The phenomenon of institutional functioning is largely unexamined. Hence few theories explaining dynamic process within the institutional setting exist to test.

This research takes a first step towards exploring this institutional subject matter empirically, and does not seek to make the substantive jump to causal relationships; rendering deductive logic an unsuitable approach. As Blaikie (2007) notes, the traditional inductive/deductive logics represent linear processes of research, and the nature of some social research are not conducive to such treatment, due to their emergent subject matter. Two alternative research logics, abduction and retroduction, both provide useful alternative reasoning for this research design.

Knowledge built on an abductive logic seeks 'educated reasoning' by delving deep into the tacit knowledge of social actors: shared meanings and rules, interpretations,

intentions, and motives, which provide the orientations for [social actor's] actions (Blaikie, 2009). Using abductive logic, the researcher seeks to create a best fit between actor's understandings and the researcher's interpretations of these in collecting, organising, analysing, explaining and representing the data through the research process. This research employs an abductive logic to interpret data from practitioners about urban water institutions in practice and their contextual setting.

To manage the need to understand multiple perspectives, and provide generalisable and transferable findings, the research used retroductive logic as the overall reasoning behind the study. This approach seeks to devise a model of the structures and mechanisms of the 'real' domain of reality. This strategy has been advanced largely through the work of Roy Bhaskar in his development of critical realist perspectives on science (Denzin and Lincoln, 2008; as cited in Blaikie, 2009), as an alternative to overcome some of these problems of inductive and deductive strategies.

The retroductive strategy is close to deductive research in its aim to uncover causal explanations by connecting hypothesised relationships to what is observed in reality. However, retroductive logic differs in its epistemological approach to achieving this aim (Blaikie, 2009). Rather than relying on deductive argument, retroductive research turns to the real domain of structures and mechanisms. A hypothetical model of these structures and mechanisms is constructed, drawing on theoretical sources, to hypothesise how events, regularities or patterns observed in the empirical domain, are produced by this real domain. As Blaikie summarises 'the retroductive approach seeks to try to establish the existence of a particular generative mechanism' (Blaikie, 2009: 113). The model generated by retroductive approaches is not designed to provide definitive causal descriptions, but rather reveal these structures and mechanisms and contribute a greater understanding of actors in their context, thus providing some explanatory power. The general approach to research following the retroductive and abductive logics are contrasted with the traditional inductive and deductive logics in Table 3.1.

TABLE 3.1 FEATURES OF FOUR RESEARCH LOGICS

	Retroductive	Abductive	Inductive	Deductive
Aim	To discover underlying mechanisms to explain observed regularities	To describe and understand social life in terms of social actors' motives and understandings	To establish descriptions of characteristics and patterns	To test theories, to eliminate false ones and corroborate the survivor
Starting point	Document and model a regularity Describe the context and possible mechanism	Discover everyday lay concepts, meanings and motives Produce a technical account from lay accounts	Collect data on characteristics and/or patterns Produce Descriptions	To identify a regularity to be explained Construct a theory and deduce hypotheses
Finishing point	Establish which mechanism(s) provide (s) the best explanation in that context	Develop a theory and elaborate it iteratively	Relate these to the research questions	Test the hypothesis by matching them with data

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This combination of retroductive and abductive research strategies is appropriate for this particular research project, because it allows both institutions (structures) and actors' interpretations and actions (agency) to be examined. While there is an element of structuralism – by seeing institutional change as generated by structures and mechanisms – the study recognises constructivist traditions in actors' abilities to construct their reality by recognising institutions and utilising them. In using this approach, the research acknowledges the complexity human behaviour brings to systems they interact with (Hjorth and Bagheri, 2006). Indeed, it is the premise of this study that the structural nature of institutions is well known, but the real operation or construction of the institutional setting resulting from the behaviour and interaction of the actors is not.

3.2.3 The use of theory

Using the research logic discussed in the previous section, this study seeks to build on theoretical understandings of institutional adaptive capacity, for practical application by urban water managers, thus taking the form of theory-driven empirical research (Pawson, 2000). However, the research also sought to contribute to future theory developed by producing generalised propositions on institutional adaptive capacity for further expansion and testing in other sectors and contexts. The study, therefore, aligns to Merton's concept of middle range theory (1967). This approach to theory development seeks to connect generalised conceptual schemes (theory) closer to real-world application, by starting with the empirical phenomena under study, and abstracting from this more tangible position to create propositions for testing.

This use of theory in the study contrasts with more definitive traditions of theory building (for example the early method of grounded theory proposed by Glaser and Strauss, 1967) and theory testing (for example see Wallace, 1971). The logic behind these traditional approaches rests on inductive reasoning (theory building) or deductive arguments (theory testing) (De Vaus, 2001). As an alternative, this study follows Layder's (1998) idea of adaptive theory, in that prior theoretical inroads are used to organise empirical data, while simultaneously adjusting these theories to reflect the patterns emerging from the data (Layder, 1998: 27). Thus, in this study, retroductive logic provides a way to match prior theory with empirical data, while abductive logic provides the data to populate the model subsequently developed. In doing so, this research design allows the empirical testing and refinement of existing theories/concepts/models.

As has been discussed in Chapter 2, there is a wealth of available frameworks and concepts attempting to examine and explain the problems experienced in urban water systems. What is needed is the operationalisation of these into theories that can help diagnose problems and develop solutions in real-world contexts. By taking a middle range theory approach, this study aims to produce operationalisable results, while also providing understanding and explanation in generalised and transferable forms.

3.2.4 Research strategy

Given the questions this research aims to answer, a strategy was required to examine the mechanisms and dynamics of institutional change in an empirical urban water

institutional context. The case study research strategy addresses this need by providing an approach to examine a particular phenomenon in detail and in situ. As defined by Yin (2009: 18) case studies are an appropriate choice of empirical inquiry when; a contemporary phenomenon is to be studied, and its contextual conditions are pertinent to its understanding, and; the boundaries are not clearly evident. Situating the case in its context is important for this research, as the complexity of urban water institutions and how they function results from non-linear dynamics, emergence and co-evolution with other systems at various scales (Teisman et al., 2009).

While a case study strategy requires boundaries to be drawn around the case, it also allows some flexibility in these boundaries in order to identify and include significant external factors in the analysis. Further, the underlying queries of the research questions are 'what' and 'why' questions. As Blaikie (2009) explains, the purposes behind these types of research questions are to explore, describe, understand and explain[1]. Given these purposes of the research, and the strength of case studies as an exploratory research method, this research strategy is an appropriate fit to the aims and subject matter of this research.

To add breadth and robustness to the results, and the ability to transfer the findings beyond the specific case, a number of comparable cases can be examined (Herriott and Firestone, 1983). For these reasons, a multiple case study design has been chosen in order to understand some of the complexities of institutional change, by looking at these processes in comparable settings and seeking similarities and differences in the mechanisms and dynamics observed. According to Yin (2009), the selection of cases in a multiple design must follow some replication logic (as opposed to a sampling logic, see Creswell, 2009) so that cases represent conditions where the phenomenon of the study can be expected to be found, and cases are also comparable.

The recent Australian experience of extended drought provided this comparative context to examine institutional change in the urban water setting. Most Australian state capital cities had been subject to drought conditions since the early 2000's and experienced water supply shortages. Cities responded to water scarcity using technological solutions to augment and optimise current centralised systems. A number of novel solutions such as managed aquifer recharge, stormwater harvesting and waste water recycling were also explored and implemented to varying extents. Implementing these alternative solutions to water supply required significantly different management requirements compared to traditional central reticulated supply. The subsequent management practices were thus, not expected to align comfortably with current urban water institutions. Therefore, a process of adjustment

[1] Following Blaikie and others (see Blaikie, 2009:59), this research distinguishes between understanding and explanation; the former is achieved through reasons given or derived from social actors' accounts, while the later looks for causal explanation. As institutions are understood and interpreted by actors, the 'insider' view achieved by abduction provides an understanding of institutional change. To address the criticism that such context specific understandings cannot be relied upon in other contexts, the research attempts to aggregate the findings to an 'outsider' perspective by using the retroductive strategy, and thus produce explanations. Due to the exploratory scope of the study, the extent to which this later aim is achieved is limited, but nevertheless contributes to the development of middle theory on the subject.

was likely to be underway within the institutional setting, to create congruence between cognitive and normative institutional underpinnings of these alternatives, and new regulative institutions. The following criteria were developed to select potential cases for study:

- They were undergoing or had undergone significant formal institutional reform processes (for example the creation of new departments, water utilities or other government agencies).
- They were trialling or had implemented some form of alternative to centralised supply augmentation.
- A number of actors or a key network of actors could be identified who were advocating a rethink of the traditional approach to water supply, either internally within their own organisation, through the broader water sector, or publicly.

The first two characteristics were considered indicators that some form of institutional adjustment was underway, while the last ensured there would be access to actors who would have some experiential knowledge of these change processes. Following these criteria, the cities of Perth, Adelaide, Sydney and Brisbane were initially selected as potential cases. Operating under a common system of government, but with specific institutional arrangements and varying responses to water scarcity, these cities offered potential to provide rich comparative data. Following initial scoping interviews with practitioners, the cities of Perth and Adelaide were selected for in-depth exploration. These two cities had similar contextual conditions, yet showed different responses to water scarcity. This provided theoretical replication (Yin, 2009) in the cases, where differences in their institutional dynamics were expected to produce different forms of adaptive capacity, as expressed in their differing responses to water scarcity. For a detailed account of the selection of cases, see section 2.1 of Publication Three (p. 92) and section 4.2 of Publication Four (p.113).

3.2.5 Research quality

There is a long standing debate between scholars from various social research paradigms on how the quality of quantitative research should be judged (see Smith and Hodkinson, 2008 for a discussion on this topic). As outlined in Section 3.2.1, this research sits within the constructivist paradigm, described by Denzin and Lincoln as:

'…assuming a relativist ontology (there are multiple realities), a subjectivist epistemology (knower and respondent co-create understandings), and a naturalistic (in the natural world) set of methodological procedures.' (Denzin and Lincoln, 2008:33)

Lincoln and Guba (1985a) have argued that the quality criteria of validity, reliability and objectivity are not appropriate for research under this paradigm, as they assume *naive realism*; that one reality exists to benchmark and test the results of research against (Lincoln and Guba, 1985a). As alternatives, these authors have developed the criteria of credibility, transferability, dependability and confirmability as surrogates for internal and external validity, reliability and objectivity, in order to show the 'trustworthiness' of research outcomes (Lincoln and Guba, 1985a). It is not within the scope of this thesis to argue for different sets of quality criteria, and other authors have already covered this ground extensively (Lincoln and Guba, 1985a; Smith and

Hodkinson, 2008). As the techniques for maintaining trustworthiness of the research results can be applied to both sets of quality criteria, this thesis subscribes to the use of validity and reliability. These are defined by Creswell (2009) as; accuracy of the findings and consistency of the approach, and the ability to be reproduced, respectively. Yin (2009) goes further to identify the different forms of validity (construct, internal and external), which are common to empirical social research. The techniques used to address these criteria are presented in Table 3.2. The various strategies employed to ensure these quality criteria have been met have been drawn from the texts of Yin (2009) and Stake (1995) on how to conduct case study research.

TABLE 3.2 STRATEGIES TO MAINTAIN RESEARCH QUALITY

Quality Criterion	Techniques Employed
Construct Validity	Multiple sources of evidence (interview data, documents, focus group outputs, observations) Chain of evidence recorded in NVivo software package Member checking Peer review
Internal Validity	Pattern matching Procedural challenges to explanations Addressing rival explanations
External Validity	Theoretical replication logic
Reliability	Data collection and analysis protocols documented (see Appendix B) Case study database contained in NVivo software package

3.2.6 Researcher's stance

The ability to maintain objectivity in any academic inquiry is a classic methodological debate. When positioned in a social realise paradigm, recognising multiple constructions of reality, the debate is more concerned with how to manage subjectivity than trying to persist with the notion that objectivity can be maintained. Researchers can only present their own explanation of social phenomena, tempered by their own perceptions and constructions of reality. This can, however, provide useful and transferable knowledge, if certain techniques are used throughout the research process to query new understandings, how they are represented and reported (Creswell, 2009). The conventions followed to these ends have been described in Table 3.2. Overall these 'trustworthiness' techniques ensured the representations of the data were subject to review and comments from research participants and peers. The researcher thus played a role described by Blaikie as reflexive partner (Blaikie, 2009), facilitating deeper reflection and thought, and incorporating a range of perspectives and expert knowledge, to develop shared understandings, interpretations and new meanings for urban water practitioners involved in the research.

Another key issue when recognising the influence of human agency on social structures and vice versa, is that the very process of being subject to research enquiry may alter the subjects under study. As the ultimate aim of this research is to offer insight into urban water institutional adaptation mechanisms, if the research process itself leads to some change in the system through interaction with actors, then this is a

result to be recorded. It is worth anticipating the extent to which this may have occurred during the phases of the research[2] (Coghlan and Shani, 2005).

As Phase 1 of the research consisted of a literature review, there was unlikely to be any influence on the research subject (institutional setting and the actors within it). Similarly, Phase 4 consisted of data analysis from the previous phases, with no interaction with the case study. Phases 2 and 3 sought to identify and describe adaptive processes, making these explicit to actors during the interviews and workshops. While the process of trying to reconstruct past reality in the present may have altered these participant's views of reality, two techniques were employed to overcome this issue.

Firstly, the workshops and analysis method were designed to elicit and represent multiple perspectives, not to create consensus on past realities. As such, participants were encouraged to present their own views, and these were considered in the analysis. Secondly, the results of these research activities were validated through member checking with participants who had not been involved in the initial workshops and interviews. This enabled them to comment on whether the results presented an accurate account of past reality based on their own recollections, not those tempered by the research process.

Phase 3 of the research contained an exercise in action research – where the results of the study were communicated to study participants and applied to the real life research problem (Coghlan and Shani, 2005). Urban water practitioners participated in a focus group aimed at testing the utility of the research findings to strategise institutional change and produce policy recommendations. This activity did not impact on the research findings, as the study was no longer attempting to identify, describe or analyse the institutional setting. This may have empowered actors with new knowledge to think and act differently, thereby changing the research subject (institutional settings and actors actions), post-research. As Jäger (2009) notes, research needs to move beyond simply identifying and explaining problems in the sustainability sciences, to actively exploring solutions to them. Thus, the final activities of this research design sought an action research element to achieve these ends.

3.3 RESEARCH LOGISTICS

This section outlines the methodological format the research followed. As noted earlier, the exploration of various data collection, organisation and analysis approaches were used, and this variety is reflected in the publications. This section describes the final methods settled on to address the Research Objectives, which were to:

1. develop a conceptual understanding of how urban water institutions function;
2. empirically identify dynamic processes of change within cases of urban water institutional systems;

[2] The phases of the research are described in Section 3.3.2 on page 46.

3. identify and describe the mechanisms of adaptive capacity within urban water institutional dynamics;
4. contrast and understand the mechanisms of adaptive capacity within urban water institutional dynamics; and
5. identify and analyse the role actors play in institutional adaptive capacity.

3.3.1 Research plan

The study was designed over four phases. As an initial starting point, in Phase 1 an understanding of adaptive capacity was generated from the literature review in the form of a conceptual framework (the model for the retroductive strategy), referred to as the Conceptualise phase. This was empirically refined in Phase 2 through application to the case studies to inject contextual conditions into the framework, making it tangible to the urban water setting (Contextualise phase). Phase 3 populated this framework by adding the complex dynamic dimension in describing and characterising the interplay between different adaptive processes in the cases (Characterise phase). Phase 4 compared the case studies and examined the roles the urban water actors played in the dynamics of adaptive capacity (Compare phase). This new understanding of the role urban water manager's play in shaping change in the system was tested using a focus group from a single case study as a final validation of the research results.

Each phase of the research drew on the understandings generated from the previous phase, and an iterative approach was used in the analysis and interpretation as the research progressed. However, care was taken to ensure the methods for data collection and organisation were applied consistently to both cases to ensure comparability of data (See Appendix B, page 157, for data collection and analysis protocols). The research phases were treated in varying ways within the Publications of this thesis, due to the framing of individual papers and the emergent nature of the research method. The first phase of model development (Conceptualise phase) was often aggregated into the introduction/literature review section of these publications (as has been done in this thesis, see Sections 2.4-2.7, pages 18-28). Some publications also combine the research tasks into phases in different ways, to suit the structure and argument of individual papers. The four-phase structure is presented here to connect the research activities to the objectives in a clear and logical manner. A schematic of the research process is provided in Figure 3.1, while more detail of the methods for each phase are provided in the following sections.

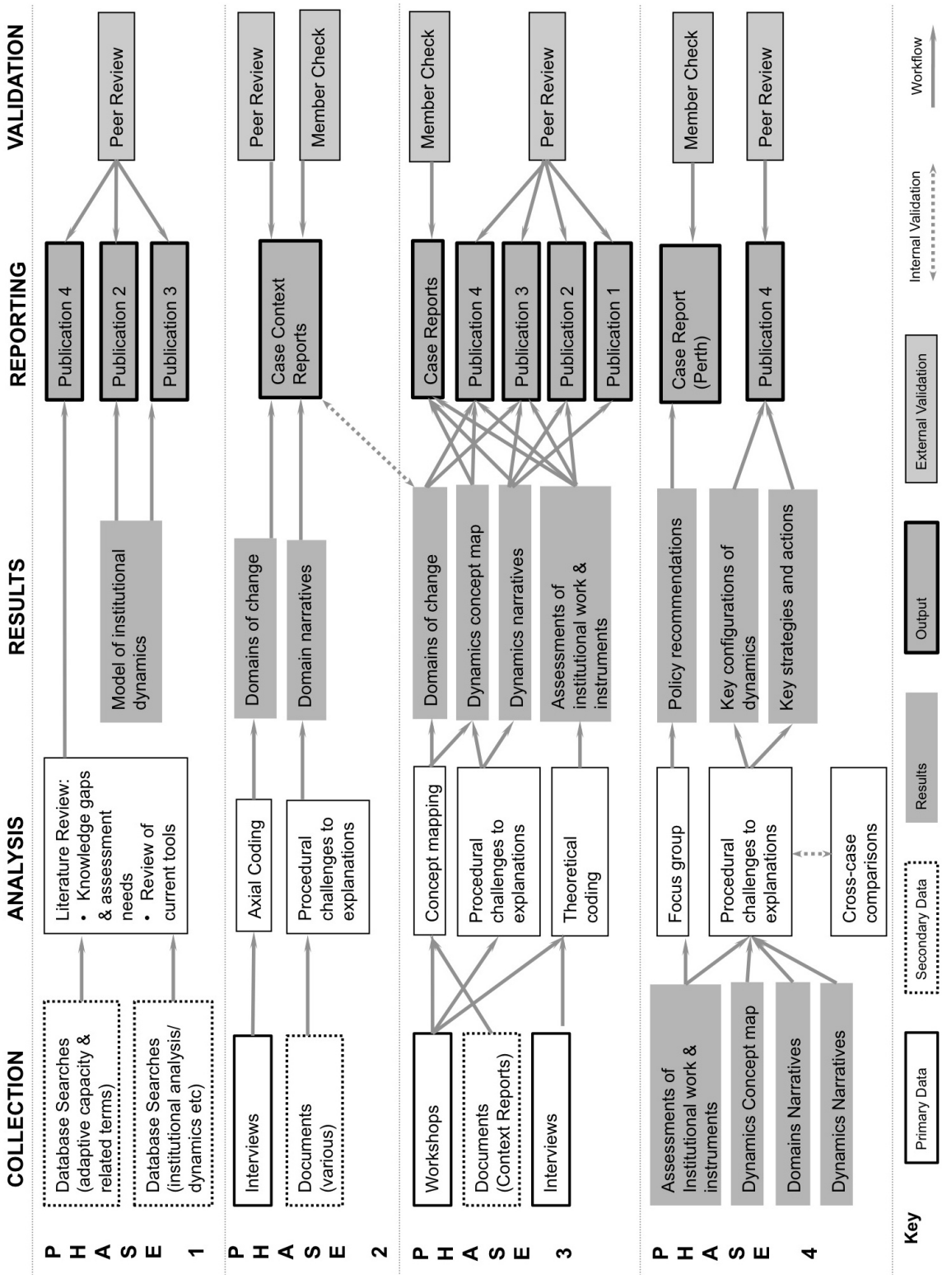

FIGURE 3.1 SCHEMATIC OF RESEARCH PROCESS

3.3.2 Phase 1: Conceptualise

This phase sought to develop a conceptual understanding of how urban water institutions function (Objective 1). A review of global change literature was conducted to develop this understanding, guided by the following questions:

- What constitutes the urban water institutional setting?
- How can the functional features/dynamic processes of urban water institutional settings be described?

Using Web of Knowledge and Scopus databases, governance and institutional literature searches were conducted using combinations of key terms such as institutional analysis, adaptive capacity, resilience, transformation, transition, systemic change, and complex adaptive systems. Studies that presented a tool or framework with adaptive capacity as an element, and a method or empirical example of application, were reviewed in depth for their ability to be applied to an institutional analysis. Drawing on this review of the literature, a conceptual model of institutional systems was devised, with capability to describe dynamic processes and the conditions and actions that create them. This model is described in Chapter 2 (Section 2.6.3, page 25).

3.3.3 Phase 2: Contextualise

The objective of this phase was to empirically identify dynamic processes of change within cases of urban water institutional systems (Objective 2). It sought to generate a detailed account of the broad context and institutional conditions within each case, to provide a basis for explaining the analysis results from subsequent phases (Stake, 1995).

Data collection

A desktop analysis of current water policy documents was conducted to understand the formal institutional setting of water management in each city. Semi-structured phone interviews with people in key management positions in a broad range of organisations were conducted and audio recorded (Perth: n = 10; Adelaide: n = 6) to understand something of the informal institutional setting. A number of interviews with practitioners from key national water sector roles (n = 4) were also conducted. This provided a perspective on the Australian water sector as a whole, and an understanding of the position of each case city in a national context.

These interviews sought to collect participant narratives as a way of representing their experiences working in the urban water sector (Chase, 2008). Interviews focused on exploring: i) the response of the water sector in their city to the drying conditions, ii) their thoughts on what some of the major changes had been, iii) what had influenced that change and how it had come about, iv) how the sector was performing to deal with the lack of water, and v) what the future challenges might be. Following the abductive research logic described earlier, a semi-structured interview technique was considered most appropriate for collecting these narratives, as it enables a conversational flow to develop and allows the interviewee to surface thoughts and memories and express them without the limitations of structured questions (Neuman, 2005). The semi-structured technique also provides the interviewer with some scope

for prompting questions, to ensure the desired information is obtained. An interview protocol provided a set of key questions with which to prompt interviewees onto the topic of interest. Two levels of questions were used, the first level being the questions asked of participants, and second level questions aiding the researcher with the line of enquiry by indicating the information the first level question sought to draw out (Yin, 2009). This ensured the researcher could steer the interview to obtain the desired data, while allowing the participants own narrative to be captured. This protocol is included in Appendix B (page 157).

Data analysis, validation and reporting

The *ad verbatim* transcripts from these interviews were selectively coded to identify contextual drivers or influences and the water supply solutions and management practices employed in each city. The contextual drivers were refined through a modified version of axial coding (see Strauss and Corbin, 1998), which sought to make connections between contextual drivers to gather these diverse influences under a number of major themes. These themes represented areas or domains within the institutional system where key change dynamics were present.

Narratives of the conditions and drivers under these themes were then constructed from the interview data. These narratives were procedurally challenged during their construction, by seeking corroborating and/or contradicting evidence or accounts from the interview data, and through a document analysis. Draft case context reports were sent to interviewees who had indicated an interest in providing feedback, in order to validate this account of the contextual setting through a member checking process (Lincoln and Guba, 1985b). These case context reports are included in Appendix C (page 169).

3.3.4 Phase 3: Characterise

This research phase sought to apply the conceptual framework to begin to identify, map and describe the institutional mechanisms behind adaptive processes occurring within the empirical cases (Objective 3).

Data collection

To populate the conceptual framework with empirical data, the research needed to access the tacit knowledge of practitioners. While this is recognised as problematic, due to the implicit nature of this type of knowledge, it can be identified using various techniques (Zappavigna and Patrick, 2010). As tacit knowledge is fundamentally procedural knowledge, Ambrosini and Bowman (2001) suggest the best method of accessing this knowledge is through reflective exercises in group settings, where practitioners can use a tangible tasks and each other's shared experiences to help identify and draw out their implicit understandings about 'how they do what they do'.

A workshop was designed to draw out this tacit knowledge through three exercises; individual reflection, focus group activity, and group concept mapping. Practitioners from water utilities, local government, State government water, environment and health departments, regulatory agencies, environmental management agencies, and consultants attended the workshops through an open invitation process (Perth, n = 21;

Adelaide, n = 12). At each workshop practitioners first reflected individually on the factors or conditions hindering or enabling their work practice, documenting these influences individually. A focus group approach was then used to target discussion (Kamberelis and Dimitriadis, 2008) and draw out the norms, behavioural scripts, underlying beliefs, assumptions and cognitive frames, and some of the formal institutional constraints guiding practitioners in their day-to-day tasks. These discussions did not seek to generate a consensus on what the informal rules-in-use behind their practice were, but to elaborate, or present contrasting accounts of these influences. Finally, these influences were mapped on a whiteboard, drawing connections between influences and beginning to identify the impact of these on the urban water system and the management responses that had been observed during the drought. Workshop discussions were audio recorded to aid interpretation and analysis of the written data. Initial data analysis was discussed in semi-structured interviews with a different set of practitioners to validate, refine and add to the results (Perth, n = 9; Adelaide, n = 4), as per the member checking technique described by Lincoln and Guba (1985b).

Data analysis, validation and reporting

Data analysis in this phase was twofold. Firstly, qualitative concept mapping techniques (Ambrosini and Bowman, 2001) were applied to the workshop data to identify and organise the key concepts illustrated in the maps, show the relationships between them. Not only did this technique provide a way to organise and represent the complex interactions occurring within the institutional system, it also provided a visual account of the institutional context which could be used to communicate the results of the research in subsequent validation and reporting (Sutherland and Katz, 2005). A consolidated concept map of the dynamic connections and interactions occurring between domains within the institutional system of each city was produced (illustrated in Publication Four on pages 119 and 120). Secondly, workshop data were coded using Institutional Work (maintain, disrupting, creating) and institutional pillars (cognitive, normative, regulative) as coding categories. This enabled the institutional domains identified in Phase 2 to be explored in greater depth, generating an understanding of the institutional activities and instruments behind the dynamics that had been documented in Phase 2.

These domains and institutional activities/instruments were then tabulated, and drawing on all the available data, a qualitative assessment on the extent of influence the three forms of institutional work were having on the institutional system was conducted. This produced a traffic light style snapshot of whether, for example, maintaining dynamics were having a significant, limited, or insignificant influence on the overall system. These assessments are documented in Publication Three (page 97).

Drawing on the available data, narratives were constructed to describe some of the detailed processes behind these assessments. These detailed results are documented in the Case Study Reports in Appendix D (page 213). These reports were sent for member checking with key informants in each city (Perth: n = 9; Adelaide: n = 4), and a validation workshop was also conducted on the results for the Perth case, with 16 participants from state and local government and government agencies attending.

3.3.5 Phase 4: Compare

This phase aimed to compare configurations of dynamics between the cases, and draw on the assessments of institutional dynamics, concept maps and narratives to propose an explanation of these results (Objective 4). It also sought to examine specific forms of institutional work underlying these configurations, to generate an understanding of what role actors played in these processes (Objective 5).

Data analysis and reporting

The data analysis in this phase followed a three-step process to find patterns in the data, explore these patterns, then build an understanding of their origins by comparing and contrasting possible explanations and addressing rival explanations (Yin, 2009). Firstly, the institutional assessments of the cases were compared to identify similarities and differences in the dynamics within domains of the institutional systems. Secondly, the concept maps and narratives from Phase 3 were used to qualitatively explain these points of similarity and difference, by investigating patterns of connections (configurations) between domains, dynamics (maintaining, creating, disrupting), and institutional instruments (cognitive, normative and regulative). Thirdly, further narratives describing how these configurations connected to the management practices, governance changes and other manifestations of system change observed in each case were documented, drawing on all the available research data. These results are documented in Publication Four (page 107).

Finally, to use the results of the research to put forward some propositions on adaptive capacity, the cases were positioned on the Adaptive Cycle as cases of Lock-in and Reorganisation, and the institutional work activities and instruments underlying these cases identified in the previous analyses were tabulated. Propositions were extrapolated from these results to describe the possible institutional conditions and dynamics within the Crisis and Stabilisation phases. These propositions can be found in Publication Four (page 131).

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CHAPTER 4: CASE RESULTS AND REFLECTIONS

4.1 INTRODUCTION

This section consists of two publications:

- Bettini, Y., Rijke, J., Farrelly, M. and Brown, R.R. (2013). Connecting levels and disciplines: Connective Capacity of Institutions and Actors Explored. Chapter 7 in Edelenbos, J., Bressers, N. and Scholten, P. (eds) *Connective Capacity in Water Governance.* Ashgate Publishing, Farnham, U.K. Used by permission of the publishers. Copyright © 2013 Ashgate Publishing. http://www.ashgate.com/isbn/9781409447467
- Bettini, Y., Brown, R.R. and de Haan, F.J. (in press). Water scarcity and institutional change: lessons in adaptive governance from the drought experience of Perth, Western Australia. *Water Science and Technology.* Used by permission of the publishers. Copyright © 2013 IWA Publishing.

These publications provide summaries of the case studies, and so present the results of Phase 1 (Contextualise) and Phase 2 (Characterise) of the research. In doing so, these publications achieve the first aim of the research – *to empirically map the dynamic institutional context of urban water governance.*

These publications have been framed according to the foci of their respective book/journal, and as such, emphasise the results in different ways. However, the detailed analysis and full results for each case can be found in the Case Context Reports (Appendix C) and Case Study Reports (Appendix D).

Each publication also varies in its reporting of methods, to adhere to the requirements of the publisher, the way they have been framed, and as a consequence of the emergent research design. These differences are explained in the linking text before each publication.

4.2 PUBLICATION ONE: CONNECTING LEVELS AND DISCIPLINES: CONNECTIVE CAPACITY OF INSTITUTIONS AND ACTORS EXPLORED

This publication provides a snapshot of the Adelaide case study, focusing on the uptake of stormwater harvesting to illustrate the main findings. Its major role in the thesis is to report the Adelaide case study results for Phase 1 and 2 of the research design, thereby presenting the results for Objective 2 – *to empirically identify processes of change* – and Objective 3 – *to identify and describe mechanisms of adaptive capacity.* The publication also illustrates an early iteration of the method of analysis used in the research. These contributions are outlined below:

4.2.1 Method

This publication describes an early approach to the analysis, using the IAD Framework. This analysis produced a detailed description of the rules-in-use forming Adelaide's urban water institutional system. However, it was found that the results produced did not translate easily for practitioners to validate. Also, this analysis did not enable an examination of how rules-in-use were changed, as the IAD Framework could only recognise the level of the institutional system where this process occurred, not the mechanisms or instruments by which it occurred. As such, the analysis method was unable to achieve Objectives 4 and 5, which sought to identify these mechanisms and the roles actors played in them. The analysis method was revised to include this capability, by drawing from Institutional Work and New Institutionalism theories. A visual representation of the rules-in-use was also provided through concept mapping techniques, providing a way to communicate the research findings more successfully. This new method is documented in detail throughout the thesis.

4.2.2 Results

Phase 2: Contextualise. This publication illustrates the achievement of Objective 2 by:

- providing a commentary on the driver of water scarcity and water management responses across Australia, and specific to the Adelaide case; and
- empirically applying the IAD Framework to identify and examine the rules-in-use that enabled stormwater harvesting to become an acceptable alternative water supply solution in Adelaide.

Phase 3: Characterise. The publication achieved Research Objective 3 by:

- determining the key rules-in-use that enabled the widespread uptake of stormwater harvesting; and
- describing the interplay within configurations of these rules-in-use to examine the processes that led to this uptake.

In summary, the publication reports how Adelaide's urban water sector was characterised by certain institutional configurations that produced:

- reflexive consideration of urban water management practice;
- a culture of collaboration to consider issues and ideas, and to be innovative in practice;
- a strong network of champions to develop and disseminate messages through discourse, serving to elevate issues and solutions to the policy level (collective choice); and
- a legacy of socio-political capital developed through community engagement.

4.2.3 Contributions

This publication provides a detailed commentary on some of the empirical insights into adaptive processes that the Adelaide case revealed. These insights informed the development of governance recommendations, and so contribute to the achievement of the aim – *to generate recommendations on how institutional adaptive capacity can be built in governance processes.*

Through the application of the analysis method and the subsequent refinement of the approach, the publication also contributes to the aim *to – empirically map the dynamic institutional context of urban water governance*.

DECLARATION FOR THESIS CHAPTER 4.2

Declaration by candidate

In the case of Chapter 4.2, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Formulation of the research problem; position of the research in the literature; data collection, analysis and interpretation; framing the research results and writing	70%

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Rijke, J.	Formulation of the research problem; data collection, analysis and interpretation; framing the research results and writing	n/a
Farrelly, M.	Interpretation of results and revision of writing	n/a
Brown, R.R.	Formulation of the research problem and research design	n/a

Candidate's Signature		**Date:**

Declaration by co-authors

The undersigned hereby certify that:

1. the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors;
2. they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
3. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
4. there are no other authors of the publication according to these criteria;
5. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
6. the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	School of Geography and Environmental Science, Monash University

Signature 1 **Date:**

Signature 2 **Date:**

Signature 3 **Date:**

Connecting levels and disciplines: Connective Capacity of Institutions and Actors Explored

Yvette Bettini, Jeroen Rijke, Megan Farrelly and
Rebekah Brown

Introduction

Water is an ideal resource to illustrate the theme of this book. Its role in sustaining life makes it a fundamental connector between all organisms and substances on this planet. However, the arrangements that govern its management far from account for these diverse functions, protect its sources and receiving environments or distribute it equitably. With highly modified landscapes, dense populations and diverse consumptive needs, the urban environment adds to the complexity of water management. Within this complex setting, the chapter explores features of connective capacity, drawing together contemporary urban water governance research from Australia. The water scarcity experience of Adelaide, the capital city of South Australia, is explored to reveal how connective capacity can enable changes to water governance in response to a significant environmental driver. Through this case, two carriers of connective capacity are examined; urban water institutions and actors. Whilst the nature and interplay of these carriers is explored within an urban water supply context, the case also considers broader sectors and disciplines including water service provision, drainage management, waterway health, spatial planning and public health. Interactions between these different disciplines reveal connective capacity in the interplay within the urban water institutional settings and through processes of agency. We describe how institutions enable and bound connective capacity across different government levels and disciplines of the urban water sector, whilst actors set the magnitude and potential impact of connective capacity through interaction and leadership processes. We conclude with some key implications of connective capacity for adaptive governance.

The Australian water scarcity story

Following nearly a decade of drought across the south of the Australian continent through the early 2000's, many Australian state capital cities were driven to reassess their centralised, reticulated systems of water supply. These systems came close to failing to provide enough water after prolonged low in-flows to major reservoirs, despite a higher than average storage capacity and successful demand management campaigns. A new politically driven discourse emerged around 'drought proofing' cities for similar conditions in the future (Head, 2010). Large-scale infrastructure augmentations were undertaken, including 'rain independent' desalination plants and interconnected 'water grid' pipelines to enable greater transportation flexibility between storages and consumers. These responses drew some criticism from scholars, who argued this was a 'maladaptation' (Barnett and O'Neill, 2010); a solution which creates 'lock-in' to large inflexible infrastructure designed for one future scenario (Keath and Brown, 2009; Brown et al., 2011). Prolonged drought conditions challenged the reliability of current water supply approaches into the future, and the 'drought proofing' problem frame did not acknowledge the deficiencies of existing management paradigms. This view was shared by many practitioners, who noted an increasing politicisation of water issues, and subsequent management decisions which solved the 'supply security' problem in the short-term, at the expense of development and investment in longer-term options and planning (Head, 2010; Brown et al., 2011). Observers have argued that current water scarcity should be reframed as one example of the extreme events predicted from climate change scenarios (IPCC, 2007), so that water systems can be designed to meet multiple futures. Such a problem-frame suggests that increasing water supply flexibility through a portfolio of infrastructures, operating at different scales and able to deliver fit-for-purpose water, is a more appropriate solution (Brown and Farrelly, 2009b; Wong and Brown, 2009). Significant water savings achieved through citizens implementing innovative water saving and fit-for-purpose practices in their own homes, was a testament to the legitimacy of this argument. Alongside centralised system augmentations, a number of cities also instigated novel approaches to improve water efficiency at large

scales, including stormwater harvesting, aquifer recharge and wastewater recycling. Pockets of lot/precinct scale recycling schemes have also been implemented, including third-pipe systems and on-site harvesting and treatment of water. However, these smaller scale solutions remain secondary to the large-scale augmentation solutions, due to arguments around their financial viability, management and maintenance risks, and the level of redundancy they create in the system, conflicting with the optimisation and efficiency paradigm of current water services delivery (Milly et al., 2008; Brown et al., 2011).

Water Governance in Adelaide: exploring connective capacity.

Adelaide has become widely recognised for its innovative uptake of stormwater harvesting for non-potable supply. Initially, a local municipality began capturing and treating stormwater to provide water for public open space irrigation and wetland regeneration through managed aquifer recharge. As the drought continued, water supplies became limited, water restrictions were imposed and prices increased. As a result, stormwater became recognised as a 'new' water source with greater autonomy of use than the reticulated water supply. A local government-owned enterprise was established to expand the existing stormwater harvesting volume and develop the capacity to supply a range of fit-for-purpose uses. These currently include agricultural and industrial applications and residential use (non-potable) in third-pipe systems in new housing estates. Building on this innovation of a new water supply source, the South Australian Government now has a target of supplying 60 GL of fit-for-purpose supply from these municipal-scale production systems by 2050 (Government of South Australia, 2009). A combined investment of $150 million between the Commonwealth, State and local Governments and other partners (Wong et al., 2009) is also developing stormwater harvesting systems and knowledge in Adelaide, in recognition of the potential of this water source across the country (Kenway et al., 2011).

The dispersed nature of stormwater as a supply source entails a significant divergence from centralised reticulation systems, and the legislative, policy and regulatory arrangements that favour this type of urban water supply solution. Like all institutions, these arrangements have been formed retrospectively, modelled on past operating conditions through processes of negotiation and codification, and exist to provide order and certainty to collective endeavours (Dovers, 2005). As new operating conditions and alternative supply options challenge the suitability of these institutions, many questions are raised around the governance of future water management systems, (van de Meene et al., 2010). Appropriate risk management for human health concerns, infrastructure ownership, operation and maintenance, balancing cost recovery with equitability decisions and property rights to the stormwater resource itself are just some of the governance dilemmas (ACIL Tasman, 2005; Brown and Farrelly, 2009a). Many scholars have observed the 'institutional barrier' phenomenon, where these stabilising structures maintain the past order that created them, in the face of operating conditions that challenge their suitability (Dovers, 2001; Blomquist et al., 2004; Brown and Farrelly, 2009b). However in the Adelaide case, these governance dilemmas did not preclude the acceptance and implementation of alternative water supply options. While these practice changes sit uncomfortably within the current formal institutional setting of legislation, regulation and policy, some mediating influence has resolved the contentions and conflicts with this setting to allow novel approaches to co-exist with traditional solutions (Bartley et al., 2008). Many scholars are suggesting that 'informal institutions' or the norms, values, meanings, problem frames and other social constructs may play this mediating role. These tacitly known conventions enable and guide social actors to interpret, codify, enforce, challenge and change explicitly known 'rules' documented in formal institutions (Helmke and Levitsky, 2004; Lawrence and Suddaby, 2006). Thus, the combination of formal rules and regulations and informal 'rules-in-use' create an institutional setting which is the architecture for the governance of water. The movement of actors within this setting animates these structures and translates their embedded values, beliefs, norms and regulations into observed management practice. In this way, water governance results from the connections and disconnections, or connective capacity, between institutions (both formal and informal) and actors.

In Adelaide, the emergence of water supply innovation suggests the presence of some level of connective capacity, as a diverse range of actors were able to collectively navigate and challenge the formal institutions to implement and legitimise stormwater harvesting. Adelaide's water industry has been enmeshed by the immediacy of the shared water scarcity problem, bringing together actors with diverse water values, service needs, roles and responsibilities and problem frames. Also, the contemporary practice of integrated water

management and the nature of stormwater itself; diffuse in location, responsible for flooding and waterway health degradation and managed through drainage infrastructure, has resulted in cross-overs with a variety of disciplines and sectors. Thus while the focal point for this chapter is on the water services sector and the government departments, agencies and levels involved, the material also draws on the linkages between the natural resource management, spatial planning, land development, public health and community sectors observed in the Adelaide case. Subsequent formal institutional reforms, which have been initiated to 'institutionalise' stormwater as a future supply source, are creating new dynamics between formal and informal institutions and the agency of actors. This setting offers the unique opportunity to search for and explore the connective capacity which is enabling Adelaide to adapt its urban water governance arrangements to new environmental conditions through the dynamics of the institutional setting and the agency of its actors.

Research Approach

This chapter combines results of two unique, but highly inter-related research projects that explore adaptive governance of urban water using Australia's contemporary water scarcity experience. Adelaide is a common case for both studies, which use multiple case study designs (Stake, 1995; Yin, 2009). Project A focuses on the institutions underlying urban water governance. A broad definition of institutions as social constructs (norms, shared meanings, problem frames and strategies) that prescribe, permit or prohibit actions was employed. The Institutional Analysis and Development (IAD) Framework (Ostrom, 1998) was used to guide data collection and analysis. The emphasis of this project is to understand how institutional 'rules-in-use' facilitate, mediate or obstruct connective capacity by guiding the actions and interactions of actors. Project B utilises an agency-orientated perspective, drawing on leadership theories and the receptivity framework (Jeffrey and Seaton, 2004) to explore the strategies and characteristics of the actors navigation of these 'rules-in-use'. Thus, reminiscent of Gidden's (1984) classic arguments for the duality of both guiding structures and human capacity for agency, this chapter identifies the nature and some of the dynamics of connective capacity within the interplay of these two carriers, institutions and actors.

Data gathering was conducted for each project between August 2010 and June 2011 respectively. Both projects undertook in-depth semi-structured interviews (Project A: n = 19 and Project B: n=36 respondents) and focus groups (Project A: n = 12 and Project B: n = 24 participants). Participants in both projects included practitioners from water utilities, state government water, public health and land use planning departments, environmental regulation and natural resource management agencies, local government, politician's consultants, private land development companies, and local researchers in Adelaide's water industry. Qualitative data analysis methods were employed to build a picture of specific attributes of Adelaide's water governance setting from institutional and actor perspectives, and to explore the dynamics of these attributes. Both projects maintained internal validity through member checking processes, extended engagement in the case and on-going contact with key informants. Using the results of these two projects, this chapter provides an empirical exploration of the connective capacity resulting from institutional-actor dynamics underlying Adelaide's water management responses and evolving governance arrangements.

Institutional Carriers: Rule dynamics and rule change.

The institutional setting[1] of Adelaide's water sector was studied using a modified version of the Institutional Analysis and Development (IAD) Framework (Ostrom, 1998; 2005). Developed in a wide range of empirical contexts and fields of study (Ostrom, 2005; Ostrom and Cox, 2010) this framework is a recognised tool to map intricacies of collective action situations, such as the management of urban water, by understanding their institutional setting (Imperial, 1999; Madison et al., 2010; Pahl-Wostl et al., 2010). The IAD Framework describes this setting using a generalised conceptual model (Figure 1) and formal and informal 'rules-in-use' which characterise and connect the components of the model (Table 1). By describing the nature of these rules and the ways they interact, the IAD Framework provides analytical power to understand the dynamics within the institutional setting. It is from within this interplay that connective capacity can emerge.

[1] The formal and informal rules-in-use which describe how urban water is governed.

Interview and workshop data were coded according to the rule types (Table 1), and workshop participants mapped the interactions and effects of the rule confirmations that were identified. This produced a picture of some of the rules-in-use and their functional dynamics in Adelaide's urban water institutional setting. The following commentary discusses the forms of connective capacity identified in Adelaide's drought response, which were revealed in rule configurations and dynamics of this institutional setting.

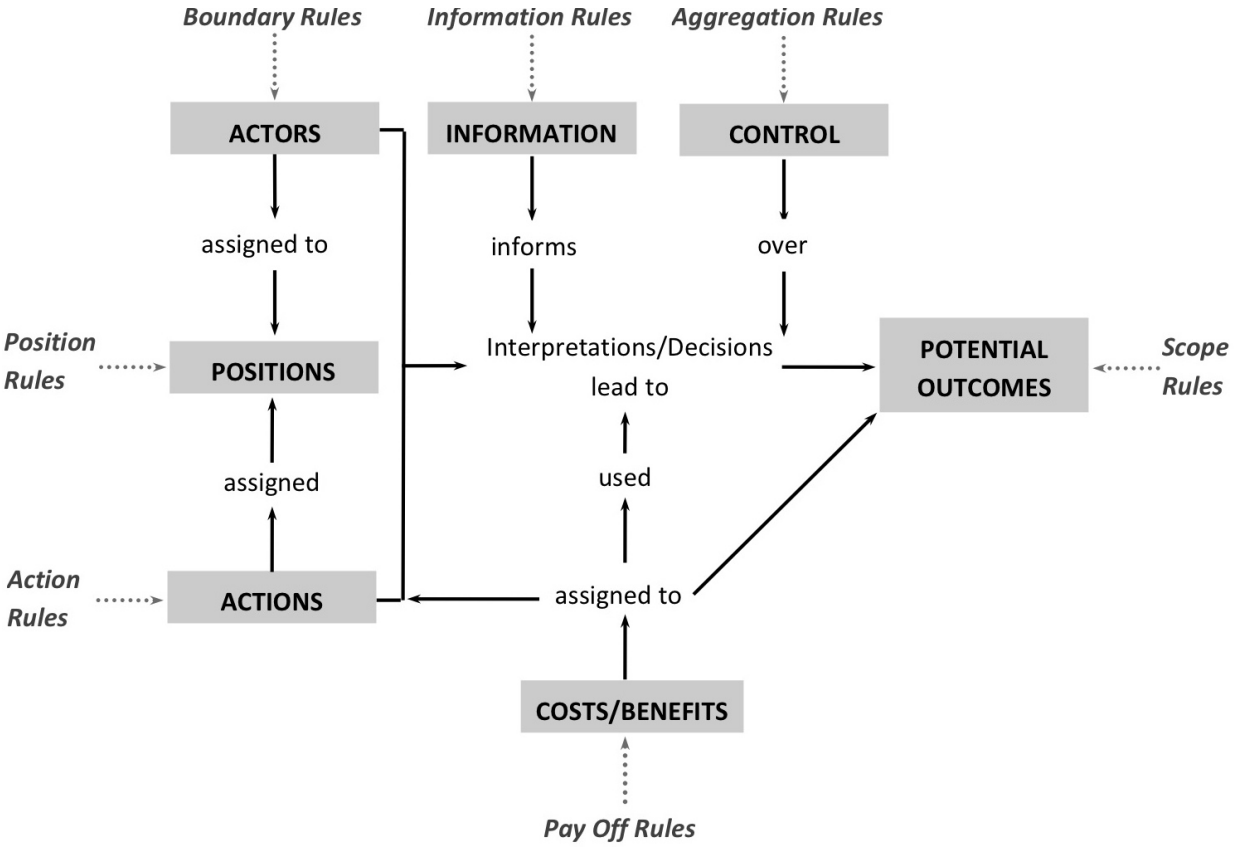


Figure 1 **Action Situation of the IAD Framework. Adapted from Ostrom, 2005.**

Table 1 **IAD Framework Rules-In-Use. Summarised from Ostrom, 2005.**

Component	Corresponding Rule	Rule Description
ACTORS	Boundary	Define actor's eligibility and selection/departure process to/from positions
POSITIONS	Position	Set the 'slots' that can be inhabited by actors and 'hold' roles and responsibilities and actions that can be taken to fulfil these
ACTIONS	Choice	Determine the range of actions (must, may, mustn't) and what should inform their selection
INFORMATION	Information	Set level of information available to inform participants choice of actions
CONTROL	Aggregation	Determine level of control of the action situation by setting which positions can be involved in certain actions by other positions.
COST/BENEFITS	Pay-off	Assign rewards and sanctions for particular actions
OUTCOME	Scope	Set what the desirable and non-desirable outcomes are

Connective capacity in the rise of stormwater harvesting

The provision of water supply in Adelaide is the responsibility of a single water utility, SA Water. Yet municipal councils, with no responsibility for water supply, developed stormwater harvesting techniques. The rules-in-use underlying this story provide some explanation as to what role, if any, connective capacity played in allowing a novel approach like stormwater harvesting to develop, gain legitimacy and move toward becoming a mainstream practice.

Formal boundary rules assign one actor (SA Water) to the position of 'water supplier.' But there was enough flexibility within the institutional setting to allow other actors to step into this position. This flexibility stems from informal boundary and choice rules, which determine what role an actor can play, and the actions they should take to fulfil this role. These informal rules enabled the council to reinterpret their position of 'stormwater manager' to include 'stormwater harvester, recycler and supplier,' and allowed them to change the 'actions' they take to operate drainage infrastructure, in order to accomplish this new role. Thus, flexibility for reinterpretation of rules allowed a new actor to connect the water scarcity problem to a new solution by operating in a different way. The lack of pay-off rules to penalise the council for this reinterpretation also added flexibility. The pay off rules, instead, produced incentives for the council to become a water supplier. Community demand for green public open space associated the council with water supply issues, previously not a large concern for them as SA Water had been providing reliable, cheap water for their needs. This community demand and the rising costs of water allied drainage engineers, environmental managers and parks and gardens staff within council around the water scarcity problem. Together, they developed the capability to supply stormwater and eventually engaged planning staff to realise council's new role as 'stormwater supplier' beyond demonstration projects and as an integral part of council's core business. This integration between town planning and water supply provision helped to associate the stormwater harvesting innovation with normative ideas of 'best practice' urban water management.

Such a flexible institutional setting does have the potential to introduce unintended consequences. For example, with actors free to interpret their own positions, clear responsibilities and accountabilities are not established. Similarly, flexible choice rules giving actors a high degree of autonomy to select their own actions can lead to narrow assessments of the potential consequences of these choices. Actors may overlook the true costs of their actions and/or transfer costs to others. These effects did not occur in Adelaide, due to the scope rules counter-balancing the flexible boundary-choice rule configuration. Scope rules to delineate preferred outcomes for water management in Adelaide were broad, but clearly shared amongst the actors. The city's heavy reliance on the River Murray for water supply, and a close affinity with the adjacent coastal environs, has resulted in water supply management mindful of the environmental impacts associated with extracting and discharging water. Also, the sophistication of community understanding regarding water management issues has developed through long-term community participation in catchment management planning. In turn, this has given the concept of integrated water management political weight to become a normatively grounded principle for water management in Adelaide.

> '…to ensure the success of Water for Good and all the benefits that the community expects, water will need to be managed in a more integrated way – through what we call total water-cycle management. This recognises that water supply, stormwater and wastewater services are interrelated components of catchment systems and, therefore, must be dealt with using a holistic water management approach that is ecologically sustainable.' (Government of South Australia, 2009:129).

Thereby, a shared understanding of what water management should achieve in Adelaide through these clear scope rules tied the actors to preferred outcomes. These rules-in-use ensured that the cost/benefits beyond the individual actors were considered in their choice of actions. This precluded the need for prescriptive choice rules, providing flexibility for innovation through reinterpretation of formal rules. Thus, the rule configurations and their dynamics described above led to an urban water institutional setting with forms of connective capacity that included:

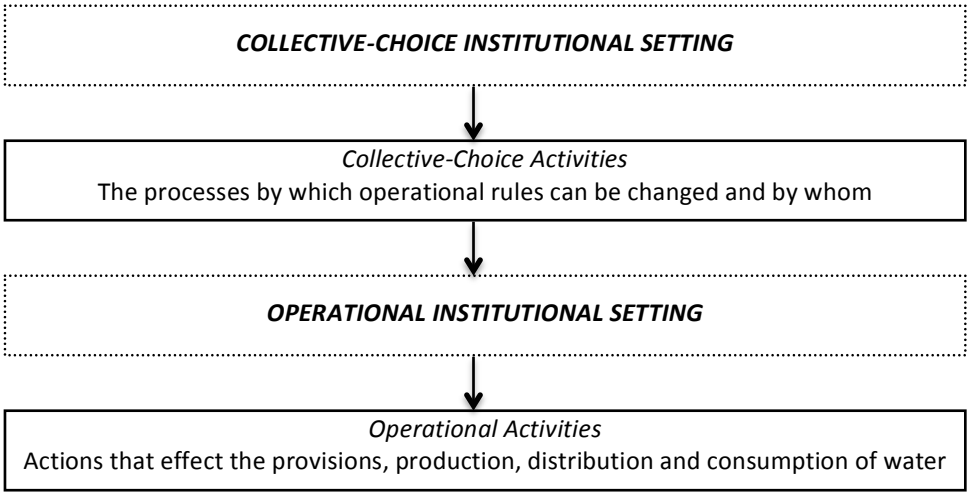
- Shared problem-frames (water scarcity) and preferred outcomes (integrated water management),

- Room for actors to reinterpret their roles and thereby find new solutions by doing things differently and finding new actors to collaborate with, and
- Incentives for actors to move outside their current roles and actions, and few disincentives for doing so.

Connective capacity in the change of rules-in-use

Addressing the water scarcity crisis in Adelaide provided a common and pressing goal for all actors to work towards solving. However, their actions and subsequent novel water supply practices challenged the suitability of formal institutional rules (legislative frameworks and regulations) and prompted their review. The way Adelaide's actors worked together to reassess and alter the rules-in-use to accommodate the innovations into water management operations is of fundamental importance to understanding governance change. As institutions are socially constructed, the formation of new rules and conventions must involve a collective process of reflection, assessment, development and codification of new rules. If water governance arrangements are to adjust to future uncertainties, understanding where and how connections are made to facilitate these adjustment processes are essential. The IAD Framework recognises this reassessment of rules governing 'operations' as occurring within a separate institutional setting, known as the 'collective-choice' setting. This setting is described by its own set of rules-in-use. These two settings, operational and collective-choice, represent a nested hierarchy (see Figure 2), where the day-to-day decisions and activities around water management are determined by the operational level setting, and activities to change the operational rules-in-use are guided by the collective-choice level setting, described by its own set of rules-in-use. In recognising these different levels, the IAD Framework provides analytical power to explore how operational rules-in-use change.

Figure 2 Levels of Analysis of IAD Framework. Adapted from Ostrom, 2005.



This provides the ability to look not only at how institutional settings and their constituent rules function to produce management practices and outcomes, but also at how these settings change overtime. Such a temporal understanding of institutions offers clues to when and why different governance arrangements become ill suited to their operating conditions and the role of connective capacity in adjusting governance arrangements to these new conditions. The following commentary presents the story of collective-choice activities in Adelaide as the drought, stormwater harvesting and the politicisation of water continued to question and challenge the suitability of the formal institutional setting for water management.

After a second summer of stringent water restrictions in 2008, public pressure to solve the water scarcity problem grew. There was continued media coverage, and interviewees noted that the community were strongly questioning the merits of current water supply solutions. This increased attention in public discourse created a political imperative to address the water scarcity situation. This political risk provided pay-off rules that gave actors incentives (political and community kudos) to step outside their traditional operational level positions to start acting at a collective-choice level and examining the barriers and deficiencies in current formal operational rules (legislation, regulation etc.). Actors across water services,

resource management, regulation and land-use planning began to recognise the systemic challenges to scaling up new supply solutions into mainstream practice within the formal institutional rules. These challenges included uncertainty over property rights to stormwater, difficulties justifying these types of projects within the planning system, and limitations in the water quality guidelines regulating stormwater. A proliferation of committees, working groups and other collaborative forums were created at officer and executive levels to review the implications of new water management practices for current policy/guidelines/legislation, and to advocate for change to these formal rules. This represents an informal collective-choice institutional setting being formed to deal with deficiencies within the formal operational institutional setting. For example, the municipal councils who had been experimenting with stormwater harvesting partnered with research institutions, regulatory agencies and private industry to monitor the water quality impacts of these schemes. The aim of this partnership was to generate the scientific basis of new guidelines that could acknowledge the different quality standards appropriate for stormwater supply along with those for the traditional reticulated sources. Many of these collaborative forums had little jurisdiction or power to address the deficiencies by altering formal operational rules. Nonetheless, individual actors collaborated in networks and coordinated their efforts to raise the issues, advocate for change, and in some cases initiate processes to adjust formal operational rules. This collaborative activity was facilitated through aggregation rules, which determine how actors influence each other's efforts. A number of the interviewees spoke of the relationships they had with practitioners from a range of organisations, which had built up over their working lives. Through their interactions over time, these individuals had built respect, trust, and knowledge of each other's skills, expertise and capacities within their own organisation or other networks. This shared history between individual actors created a solid base of informal aggregation rules to facilitate collaboration. By drawing on the capabilities of individuals in a strategic way, these actors were able to maintain the challenge to operational rules and progress their review and alteration. However, as the activities of the different networks and groups expanded, there was increasing confusion regarding roles and responsibilities, and concern about inefficient use of effort and resources. This eventually prompted the State Government to initiate a more systematic approach to review the formal institutions at the operational level. The creation of an independent Commissioner for Water Security with a mandate to develop a 'whole-of-government' fifty-year plan for strategic water management, and a new State Government Department for Water with overall policy responsibility for water resources management, were the main mechanisms implemented. These reforms aimed at consolidating activities and providing leadership and direction to deal with water scarcity. This represented a formalisation of the collective-choice institutional setting, whereby an actor (Department for Water) had been given the position to coordinate the reforms. Furthermore, the water management plan (Water for Good) set out a program for these activities and the other actors to be involved, further formalising the collective-choice institutional setting. The table below summarises the rules-in-use at this level, and represents the shift from informal to formal rules in some of the rule categories.

Table 2 Collective Choice rules-in-use in the Adelaide Case

Rule type	Summary	Example Quote
Boundary	Initially, boundary rules did not limit actors from taking part at the collective choice level. However boundary rules were eventually established and formalised in reform processes aiming to centralise coordination.	*'…started a big process of collaboration…it was such a significant issue from a political perspective that everyone wanted their piece of flesh..'*
Position	Position rules at this level appeared to be absent, as collaborative activities blossomed organically between actors. Reforms are now beginning to clarify position rules.	*'There was an explosion of different committees and reference groups…and it kind of all got a little bit too hard to manage there for a while. And there wasn't necessarily clear roles and responsibilities….'*
Choice	With positions not clearly set, the choice of actions at the collective choice level were limited and required actors to 'join forces' to enable action to be taken.	*'My boss understood that if we wanted to get it implemented in our region, we first needed to get Adelaide sorted.'*
Information	The 'crisis' response suggests a lack of information rules to collect/share monitoring data on the functioning of the operational level to provide timely feedback on its performance to the collective choice level and enable incremental adjustment.	*'You can't make those good policy decisions without good science and without good information sitting behind it.'*
Pay off	With water high on the political agenda and in public consciousness, there were strong rules creating incentives for action, and costs for inaction.	*'People were rightly asking questions about well, business as usual,… "Just rolling out more and more mains water from reservoirs is not necessarily the right way to go and what are you going to do about it?"'*
Aggregation	Initially, the aggregation rules appeared to be informal – with long-term relationships and informal networks facilitating the collaborations to deal with collective choice issues. Formal rules are to be established to facilitate cross-agency collaboration, but appear to be limited to specific issues (e.g. stormwater harvesting).	*'Adelaide's not that big and I think we knew most of the players around the table so I don't think things have changed that much, but it just formalised for us informal networks.'*
Scope	These rules were clearly defining the goal; governance arrangements to achieve water security, and provided the focus for coordination of actors efforts..	*'The drought drove a heightened emphasis on water security as an issue; it probably drove really good collaboration and initiative-making…'*

The collective-choice level of Adelaide's response to drought offers a key insight into the role of connective capacity in water governance. Governance is only transformed through alterations to the institutional rules that underpin how it is accomplished. These rules, being socially constructed, can only be altered through collective reflection on the performances of these rules, and consensual development and acceptance of new, more suitable rules. The capacity of the institutional setting to join actors to these processes, and to support the processes themselves through collective-choice institutional settings, is therefore critical for suitable governance to be implemented. The analysis of Adelaide revealed the following ways connective capacity was enabled institutionally to these ends:

1. Pay-off rules incentivising reflexive actions by actors to step beyond their operational focus and question/assess how formal rules accommodate innovative and more suitable practices.
2. Initially open boundary rules to link actors across disciplines and layers of government to shared issues, and allow a collective questioning of current rules broadly within the water sector.
3. Informal aggregation rules provided capacity to collaborate in spite of the lack of jurisdiction (formal choice rules), to initiate action to adjust formal operational rules.

4. The activation of an informal collective-choice setting prompted actors with designated responsibility for this type of activity (State Government) to acknowledge the issues with formal operational rules. By building on the informal setting and formalising its collective-choice rules-in-use, a better capacity for reflexive governance has been created.

There are many more rule configuration dynamics at work in Adelaide's urban water sector, but those presented here illustrate some of the key ways institutional settings provided structure for forms of connective capacity to emerge in Adelaide. As this commentary has suggested, this will depend largely on how actors react, interpret, navigate and further develop rules-in-use, particularly at the collective-choice level. Therefore, we now shift our focus from the overall institutional framework within which actors enact connective capacity, to the more specific strategies and activities used by actors to navigate the institutional rules they are subject to, to understand how they carry connective capacity.

Actors as Carriers: Leaders, networks and actor receptivity

The above commentary has described how institutional rules set boundaries within which actions can take place. As such, institutions as can be considered enablers and regulators of the actions of connective capacity. However, through their interaction with these rules, actors set the magnitude and potential impact of connective capacity. This will now be explored by taking a more actor-orientated exploration of the Adelaide case study.

Leadership types and connective capacity

Research has shown that leadership in the Australian urban water sector relies on a combination of formal authority (i.e. position and choice rules) and personalities (Taylor, 2010). Consequently, leadership is determined by both the context (i.e. institutional settings) that provide actors certain positions and opportunities to perform leadership roles, and the personalities of leaders at executive and project level in the urban water sector (Taylor et al., 2011). The Adelaide case study data revealed a number of leaders who have been responsible for recent innovation in Adelaide's urban water sector. These individuals fulfil their leadership roles through their formal positions or through their day to day work at a project level and come from a variety of relevant organisations, including the water utility, local government, state government water and environmental management departments, regional natural resource management agencies, regulatory authorities, research organisations and the private sector. Throughout the course of this research it was discovered that while a particular organisation may have conventional ideas about urban water management, key individuals in that same organisation may also have a clear, and sometimes different, vision for the future. This gap between the organisations vision/objectives and the vision held by the individual leaders could be thought of in terms of different scope rules, determining different outcomes being sought. As a result, these individuals may actively build networks with different disciplines and/or organisations to find opportunities to realise these goals. In the attempt, they also illustrate the legitimacy of their expanded scope rules to a wider group of actors. These individuals may even put their own reputation on the line in order to achieve breakthroughs by particular 'novel' projects that promote their different scope rules. However, this is not to suggest that there is no organisational leadership. Where government agencies have adopted a leadership role, we identified leaders at all levels of operations (practice), management (public administration) and decision-making (politics). Importantly, organisational leadership emerged from top-down, political aspirations, such as the appointment of the Commissioner for Water Security in Adelaide, and from the bottom-up. For example, the strategic cooperation between CEOs and project officers/directors in several municipal councils in trying to persuade their elected members and state politicians about the benefits of alternative practices, can be considered an example of bottom-up organisational leadership in the Adelaide case. The majority of interviewees indicated they were aware of their leadership roles and suggested five key motivating factors for adopting such a role:

1. Recognising and exploiting opportunities for innovation;
2. Frustration with current sub-optimal functioning of urban water systems;
3. Opportunities for demonstrating skills in information and intellectual transfer;
4. Community pressure regarding a) keeping public open space alive, and b) developing stormwater harvesting schemes because neighbouring councils are doing this; and
5. Wanting to implement a vision for the city that addressed water security.

It can be seen that factors two, four and five revolve around the broadening of scope rules; current water systems only achieving limited outcomes, community expectations requiring multiple outcomes to be met, and including water security as a specific objective in future water management efforts. The interviewees also suggested that the circumstances under which they operate influence their behaviour. For example, one interviewee explained that his/her formal mandate is to adopt a leadership role, but they deliberately take a "backseat leadership role". Thus while their position rules assign them a leadership role, they chose to interpret this role in a 'backseat' way because it is likely to generate mutual respect, opportunities to listen to others and engender informal discussions. The reinterpretation of this leadership position was seen as important for building trust among stakeholders (i.e. producing informal aggregation rules), and breeding momentum for innovation by collectively reshaping scope rules for a new shared vision and outcomes to work towards.

More prominent leadership roles were also identified. A few individuals, who are widely recognised as leaders, appear frequently in the media. This is effective for raising awareness of innovation opportunities and explaining the decisions made, and leads to greater acceptance of new approaches (hence new scope rules). This prominent leadership also attracts the attention of decision makers and politicians. In some cases this has generated tension between political aspirations and the on-ground capacity to deliver results. For example, within local government, individual leaders were identified that advocated for the uptake of stormwater harvesting systems and for stormwater to become an additional source of drinking water. The particular leaders claimed they could provide evidence that stormwater is safe for potable purposes. However, taking into account public health risk management and economics, there is little agreement amongst the industry on whether this is an acceptable policy response to water scarcity. As such, it provoked an official State Government position that direct and indirect potable use of stormwater is not on the agenda until further research has proved its economic efficacy and safety. Thus the gaps between shared scope rules and those of individual leaders may not always be reconciled, if a process to change the accepted scope rules (through collective-choice activities) does not accompany the leadership activities of these key actors.

This case analysis has demonstrated how the leadership of key actors generates connective capacity in two ways. First, by thinking 'outside the box' in terms of the outcomes being sought and using leadership strategies to bring about scope rule changes so these visions are widely embraced. Secondly, in gathering other actors together around these new visions, leaders strategically bringing together people, resources and knowledge (Olsson et al., 2006; Boal and Schultz, 2007; Uhl-Bien et al., 2007) to begin to challenge or change rules of the institutional setting, thereby enabling or initiating collective-choice activity. In these ways, leaders use windows of opportunity to trigger transitions to more sustainable urban water management. However the progression of governance change to support such a transition relies on collectives of actors, developing and building consensus for institutional changes. Some insights in relation to these networks of actors will now be discussed.

Connective capacity in networks

The research revealed the fragmentation of urban water networks in Adelaide. A disconnect was identified between different levels of government (predominantly between local and State Government), and between water management and land use planning. This disconnect was evident in the way actors interpreted their roles (position rules) and the reach of their individual work program or organisation's mandate (i.e. their interpretation of choice rules and the scope rules of the organisation). As an example, State Government saw local government as having responsibility for stormwater management, and State government planning staff viewed water management at the periphery of their core business; to develop land-use plans that provide appropriate development opportunities. Informal network formation was identified as an important element in overcoming this fragmentation. Informal networks are networks of actors who interact outside the scrutiny of formal forums such as regulatory, policy and planning processes (see also Gunderson, 1999; Olsson et al., 2006). Actors in informal networks do not need to behave in a way that officially represents their organisation or their authorised position. They are thus able to operate beyond formal position-choice rules and reinterpret institutional rules as an individual among like-minded colleagues, and will not be sanctioned by cost/benefit rules for doing so. Furthermore, informal networks

tend to occur between different disciplines and across different organisations, thus can bring together a diverse range of actors and overcome the fragmentation of formal networks, which are typically established through organisational ties.

The research identified a number of informal networks which consisted of individuals who collectively recognised they had shared problems, similar frustrations, interests, passions and ambitions. Individuals in these networks commented that they operate on a trust basis, are building on shared interests, contain a high degree of tacit knowledge and have fluctuating levels of interactions (i.e. communication may involve infrequent email communications). In relation to stormwater management, one clear informal network was identified where individuals were primarily concerned with stormwater quality management, but where experiences with stormwater harvesting and reuse were also shared. This particular network consists largely of individuals from practice and research, has an engineering bias and involves people from organisations including municipal councils, natural resource management agencies, research bodies, consulting firms and the water utility. The individuals involved mostly have experience in the practice of planning, design, operation and maintenance of water systems and interact on a case-by-case basis when, for example, they meet through projects, workshops, seminars or informal phone calls and/or emails. Members of this informal network are now pursuing the uptake of water sensitive urban design[2], and collaborate with each other to increase their own knowledge, share experiences, and influence policy makers and politicians. Thus this network, initially relying on existing relationships built up through shared history, now exists around dissatisfaction with the current formal operational rules.

Understanding actor receptivity to rule change and agency processes

As described in the previous sections leadership qualities and collective efforts are important attributes for connective capacity. However, the willingness of actors to employ their 'agency' abilities to these ends should also be considered. Do network actors have a reason to connect? Is there a problem to solve or an innovative solution to apply? While formal and informal rules provide structure and guidance, it is the motivations and personal assessments of cost/benefits rules by actors (e.g. 'Is this action worth risking my reputation on?) along with their interpretations of rules, which combine to enact the rules. Or alternatively, to challenge or change rules through collective-choice activities. As we have described above, leadership processes are acting as a catalyst to change the rules-in-use of the institutional setting by connecting the operational and collective-choice levels through the work of actors. Change can be initiated when actors interacting with leaders are receptive to such change. This potential receptivity of actors has been captured in a framework by Jeffrey and Seaton (2004). The receptivity framework distinguishes four non-sequential stages of receptivity to innovative technologies (e.g. stormwater harvesting and reuse) or innovative processes (e.g. interacting with 'new' network actors): 1) *awareness* about a problem or an innovation; 2) *association* of the problem's or innovation's values in a particular context; 3) *acquisition* of new competencies and skills needed to address the problem or apply the innovation; and 4) creating incentives and recognition of opportunities to *apply* an innovative solution in practice. The research data highlighted how informal networks can increase several aspects of receptivity to integrated ('governance') approaches that contain higher levels of connective capacity amongst different disciplines and levels compared to traditional ('government') approaches (see Table 3).

[2] A water management concept which aims to promote water in urban design through the integration of water services and protection of aquatic environments in urban design processes (Wong and Brown, 2009).

Table 3 Aspects of connecting levels and disciplines through informal networks.

Aspect	How achieved in informal networks?	Rules involved	Example Quote
Creating awareness	Putting topics on the agenda of different members of an informal network.	*Introducing new 'Information'*	*'We are facilitators, getting different people to talk to each other to realise that we've got similar objectives and that we're trying to achieve the same sorts of things so.'*
Association with issues and values	Identifying and discussing positive and negative (side-) effects of possible solutions amongst the informal network members from different organisational or disciplinary perspectives.	*Association of costs/benefits ('Pay-off'), identification of desirable outcomes ('Scope') and identifying which actors are involved ('Boundary') and why ('Position').*	*'I don't know how feasible it is was where we came to as a brainstorming exercise.'*
Acquisition of competencies and skills	Collaborative learning about possibilities needs and demands of different technologies, designs and processes through exchange of tacit knowledge across disciplines (mainly engineering, land use planning and natural resource management).	*Increase capacity to convert 'Information' into new actions ('Choice') and provide guidance for actors to fulfil their 'Positions'*	*'I'd rather have people outside the Institute come along and see what we're doing and talk to the people at our Institute, have a beer after and walk away and then be prepared to ring them up the next day and say 'saw what you're doing, can you help us out?''*
Recognition of opportunities to apply	Informing about opportunities, and negotiating needs, demands, responsibilities and the application of alternatives.	*Taking action ('Choice'), Identifying eligibility to perform action ('Boundary') and who should be involved ('Aggregation')*	*'I wheel and deal in anything that goes past my door provided I can make a buck out of it.'*

Overall, it could be argued that because informal networks are not constrained by bureaucratic procedures and are by their nature more responsive than formal institutional settings, they are critical to adaptive governance and should be facilitated, supported and strengthened where possible. However, as Gunderson (1999) points out, it is a challenge to create and foster informal networks, as support needs to be carefully constructed to ensure that the informal nature of these networks is not lost, as the more formalised these networks become, the less likely they are to successfully build trust. The data from Adelaide indicated that stimulating informal networks can occur through providing support for professional associations or other network organisations such as capacity building programmes. For example, many of the individuals who associate themselves with the informal stormwater network suggested professional associations such as the Stormwater Industry Association or the Institute for Public Works Engineering Australia act as a platform to meet like-minded individuals, exchange perspectives and share experiences. In Adelaide, such network organisations are actively aiming to increase awareness and acquisition of competencies and skills. However, they are less successful in improving the associated values (informal rules-in-use) of innovative solutions, for example, across the urban water and planning sectors (Brown et al., 2011; Farrelly and Brown, 2011). Similarly, the interview data suggests that research projects and demonstration projects are alternative mechanisms from which informal networks emerged and developed. In Adelaide such projects provided a platform on which 'real' problems and solutions could be discussed in 'safe spaces' without the initial scrutiny of bureaucratic forces. However, it has been shown that demonstration projects are not always successful at diffusing such innovations (Farrelly and Brown, 2011). This research has shown that these limitations of informal networks may be a result of a lack of change to the underlying rules-in-use, and

require more formalised collective-choice settings to ground the changes into normative ideas of best practice through alteration to operational rules-in-use.

These results from the Adelaide case reveal the different forms of leadership actors provide in navigating and reinterpreting formal rules, and utilising informal rules to create and enable informal networks. Due to informal aggregation rules which bind these networks, such as mutual respect, trust and expanded scope rules, these actors are able to work collectively on strategies to challenge and change formal rules. In particular, harnessing collaborative projects to join different organisations and disciplines and demonstrate the multiple benefits expanded scope rules could deliver to the broad water sector. Accordingly, leadership and informal networks serve to increase the connective capacity between different disciplines (service delivery, landuse planning, research, and natural resource management) and at different levels (state and local government, policy, regulation and operations). However, actors must also be motivated and given the authority to initiate the collective-choice activities needed for rule change, through rule configurations within the different levels of institutional setting.

Conclusion

This case study of Adelaide has revealed some key aspects of connective capacity in institutional settings, and within actor's navigation of these societal structures. Institutional settings, or the rules-in-use guiding behaviour and action, can enable and disable connective capacity through the characteristics and configurations of rules. Dynamics created by rule interactions provides the potential for connective capacity. The institutional setting also generates a range of incentives and disincentives to motivate actors to enact, bend or break certain rules. The different ways actors interpret rules and strategically utilise rule configurations creates different degrees and effects of connective capacity. Actors navigate formal rules via their own interpretations, and may draw on informal rules to circumnavigate constraints in the formal institutional setting. They may also draw on these informal rules to collectively change the formal rules, if a consensus around the inadequacy of these incumbent rules persists. The agency of actors (both individuals and organisations) thus realises the connective capacity inherent in institutional dynamics. Key expressions of this connective capacity are forms of leadership and the activities of networks. These bring practitioners together to recognise shared problems, the limitations of current governance arrangements, and to collectively reassess knowledge and 're-vision' the outcomes being sought. Once this collective problem frame is produced, networks may emerge from these interactions to further the ideas by pooling actors skills, strengths and positions in a strategic way to effect systemic change. These connective capacities, within institutional settings and conveyed by actors, are critical for the continual adjustment of institutional rules, to find 'best fit' governance arrangements in dynamic and uncertain operating conditions.

This research suggests prospective insights from further work to identify informal rules, understand how actors utilise them and for what purpose, and the rule configurations that build and support the receptivity of actors to adopt leadership roles and network activities. This knowledge would provide a broader understanding of the connective capacity created by these two carriers, and its potential for enabling adaptive governance through more timely and systemic institutional rule changes.

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4.1 PUBLICATION TWO: WATER SCARCITY AND INSTITUTIONAL CHANGE: LESSONS IN ADAPTIVE GOVERNANCE FROM THE DROUGHT EXPERIENCE OF PERTH, WESTERN AUSTRALIA

This publication provides an overview of the Perth case, providing results to meet Objectives 1, 2, and 3, namely – *to develop a conceptual understanding of how urban water institutions function; to empirically identify dynamic processes of change within cases of urban water institutional systems*; and *to identify and describe the mechanisms of adaptive capacity within urban water institutional dynamics.* The paper also offers insights into Objective 4 – *to contrast and understand the mechanisms of adaptive capacity within urban water institutional dynamics* – and adds important methodological detail to the thesis. Finally, the publication illustrates the practical application of the conceptual framework and supporting method, and uncovers some insights into adaptive capacity. These points are detailed below.

4.1.1 Method

This publication describes the final detailed methodology used to apply the conceptual framework to empirical cases of urban water management.

4.1.2 Results

Phase 1: Conceptualise. This publication presents a brief argument on the merits of using an institutional perspective to examine urban water issues. It then provides a description of the conceptual framework used to understand and examine institutional dynamics, thereby meeting Objective 1.

Phase 2: Contextualise. This publication illustrates the application of the conceptual framework to meet Objective 2. The analysis revealed a number of dynamic processes within Perth's institutional setting. First, by contextualising this setting through the identification of key domains in the institutional system, which were influencing change. Secondly, by providing commentary on the features of these domains and how they influenced the water sector. Some of the key processes identified in Perth included:

- The availability, access, dissemination, and interpretation of information in the form of external feedback, water system performance and cost/benefit analyses.
- A lack of socio-political capital to drive water issues onto political agendas, and a resulting mismatch between the expectations for water management, expectations of government performance, and the reality of water scarcity.
- Limited shared professional dialogue on water management issues or emerging problems, resulting in a lack of recognition of problems at a collective choice level.

Phase 3: Characterise. This publication describes some of the detailed institutional attributes behind the processes identified in Phase 2 in Perth, thereby meeting Objective 3. It provides a qualitative assessment of the institutional dynamics identified, and commentates on the cognitive, normative and regulative features of Perth's institutional system contributing to these dynamics. Some of the key results reported include:

- A dominance of maintaining dynamics throughout Perth's institutional system.
- Problematic mechanisms of creative institutional work, such as; limited leadership, disparate problem frames and lack of shared visions, and a policy

department with limited influence to effect change, despite having legislated powers to do so.
- Significant disincentives and penalties, both formal and informal, for questioning the performance of the current water management regime, or the cognitive frames, value systems and technological performance underlying the infrastructure system.

Phase 4: Compare. The discussion in this publication begins to offer some perspectives on the mechanisms of adaptive capacity, thus leading to the achievement of Objective 4. These insights included:

- The demonstration of system resilience in Perth, and the cognitive and normative origins of this adaptive response within the water management profession, stemming from a lack of recognition of feedback and narrow reflexive consideration of infrastructure performance.
- The disconnection between practice knowledge, policy knowledge and emerging issues, resulting from reduced professional discourse and limited ability of actors to 'boundary span' these levels via inter-intra organisational relations and collaborative and innovative professional norms.

4.1.3 Contributions

This publication begins to show the contribution to scholarship the research makes through the insights on adaptive capacity discussed in the previous section. It also demonstrates the potential contribution to urban water practice of the research approach. By generating an understanding of the institutional context through application of the conceptual framework, key leverage points for systemic intervention to create better capacity to adapt could be determined: creating system feedback, learning how to learn together and, fostering action at a collective level. The publication translates institutional instruments and mechanisms into practical recommendations to build this capacity in Perth's urban water sector.

DECLARATION FOR THESIS CHAPTER 4.3

Declaration by candidate

In the case of Chapter 4.3, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Formulation of the research problem; interpretation and positioning of the research in the literature; development of assessment framework; data collection, analysis and interpretation; writing	90%

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Brown, R.R.	Formulation of the research problem, interpretation of results and revision of writing	n/a
de Haan, F.J.	Revision of writing	n/a

Candidate's Signature		**Date:**

Declaration by co-authors

The undersigned hereby certify that:

1. the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors;
2. they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
3. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
4. there are no other authors of the publication according to these criteria;
5. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
6. the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	School of Geography and Environmental Science, Monash University

Signature 1 **Date:**

Signature 2 **Date:**

Water scarcity and institutional change: lessons in adaptive governance from the drought experience of Perth, Western Australia.

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Key Words:

Adaptive governance, adaptive capacity, institutional analysis.

Abstract

Urban water systems will be increasingly challenged under future climates and global pressures. Meeting challenges by reconfiguring water systems to integrate supplies and deliver multifunctional uses is technically well described. Adjusting the institutions that frame the management of these systems is not well operationalized in practice or conceptualized in theory. This study seeks to address this gap through an institutional analysis of Perth, Australia, a city where drought crisis has put under pressure both management practices and the institutional setting that underlies them. The study found that while trusted practices moderated water scarcity, the stability of the institutional setting may not facilitate a shift toward adaptable institutional configurations suited to future conditions. The results identified three key ingredients for a flexible institutional setting: i.) feedbacks in the system through better information management, ii.) reflexive dialogue and strategic use of projects to generate greater learning opportunities, and iii.) policy level support for sector-wide collaboration through progressive agendas, incentives for innovation and capacity building in stakeholder and community engagement. Further, the results suggest that a deeper understanding of institutional dynamics is needed to enable adaptive governance. The paper provides an analytical framework for diagnosing how greater adaptive capacity might be mobilized through influencing these dynamics.

Introduction

Cities around the world are facing complex water management dilemmas caused by diverse, interrelated factors. Population growth, ageing infrastructure, concerns about human and environmental health and increased frequency and severity of climatic extremes are creating increasingly complex operating conditions (Pahl-Wostl et al 2011). New water management paradigms such as Integrated Urban Water Management (IUWM) seek to address these challenges through an integration of knowledge and multi-objective management outcomes, with flexible technologies and management practices (Pahl-Wostl et al 2011). However, the lack of successful implementation has revealed incongruence between new management paradigms and the underlying rules, norms, beliefs and assumptions vested in the institutions responsible for structuring and directing management practice (Blomquist et al 2004). In other words, 'Adaptive management... has frequently failed because the existing governance structures have not allowed it to function effectively' (Walker et al 2004:7). Identifying and describing the urban water institutional setting to understand how it functions to organize and enable (or disenable) practice change, is therefore a key knowledge gap (Young 2010). Scholarship has emerged around the concept of adaptive governance to explain and examine this issue of practice change (Huitema et al 2009), focusing on social learning as the primary mechanism for generating the capacity to adapt (Bos and Brown 2012) and producing benchmarking tools to identify where such a capacity lies (Gupta et al 2010).

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There is growing recognition that this scholarship could benefit from an institutional perspective of governance regimes, to emphasize the relationships between these structures and how they organize society, with particular attention to how they adapt over time (Bartley et al 2008; Engle 2011). Scholars argue that a dynamic understanding of these complex processes of adaptation will aid development of the conceptual tools to diagnose governance failures and to navigate toward more sustainable societies (Ostrom and Cox 2010; Rijke et al 2012; Ferguson et al in press). An institutional perspective would also help to address critiques of adaptive governance that its focus on governance regimes misses the role of power relations (Sandström 2009) and the part that distributed actor agency plays in such processes of societal change (Eisenack and Stecker 2012).

Institutions can be described as socially constructed logics that societies use to make shared sense of reality and to act collectively. These shared meanings manifest in values, expectations, norms and problem frames (informal institutions) that underlie the creation, legitimization and enforcement of rules, regulations and laws (formal institutions). This study views institutional settings as dynamic interplays between formal and informal institutions (Helmke and Levitsky 2004), resulting in the on-ground practice of managing urban water (Bartley et al 2008; Huitema et al 2009; Young 2010). Within this interplay, processes occur to change understandings, meanings, and assumptions over time. Eventually, formal institutional structures are reformed to align with this change. Institutional adaptive capacity, must address the duality of institutions acting as stabilizing structures in society while also accommodating the adjustment of societal needs and the actions to achieve them in response to changes in the operating environment. Therefore, a deeper understanding of how adaptive capacity can be instilled within an institutional setting, to create systemic change, is needed to deal with challenges over time (Young 2010). This paper takes up this issue, using an adaptive capacity perspective of institutions to examine how the urban water sector in Perth, Western Australia, responded to a prolonged drought. This study contributes insight into the functional characteristics of institutional settings; to overcome the systemic challenges they pose and integrate flexibility and adaptability into these governance arrangements.

Methods

The case study method of Yin (2009) was applied to examine the underlying day-to-day practices and interactions of the institutions within the urban water sector of Perth, the capital city of Western Australia.

Case study context

Below-average rainfall since the mid-1970s has significantly changed operational conditions for supplying water to Perth citizens. Greater extraction from groundwater supplies has ensured water supply, but, with sustainability of this source questionable, a portfolio of options to secure supplies has been adopted (Water Corporation 2009). These include demand management, desalination, water trading, experiments with aquifer recharge schemes, and potential inter-regional transfers. This 'security through diversity' is a significant shift from the infrastructure, management techniques and philosophical standpoints of current centralized, reticulated supply systems. Tension between rhetoric and entrenched solutions in Perth has been identified (Werbeloff and Brown 2011). Thus, practice changes are unlikely to sit comfortably within current formal institutions, which have evolved to legitimize past practices. Processes of adjustment to find congruence between new management practices and legislation and regulations legitimizing their implementation are likely to be underway. Therefore, the case of Perth provides an opportunity to explore processes of institutional adjustment and to identify the capacities and dynamics that underscore them (for more detail on the Perth case context, refer to Bettini et al 2011). This study forms part of a larger multi-case research project, of which Perth provides an illustrative case.

Analytical framework

The study sought to describe how the urban water sector in Perth responded to drought. This required understanding the dynamic interplay between the formal and informal institutions structuring the city's urban water management practice. Other scholars have identified the lack of conceptual tools that can capture structural components of a system along with the functional

dynamics within it (Ostrom and Cox 2010; Ferguson et al in press). Using structuration theory (Giddens 1984), the urban water sector can be understood not only as institutional rules that shape and guide actions, but which also enable actors to change these rules. In this study, two institutional scholarships were drawn together to provide an analytical framework. The Institutional Analysis and Development (IAD) Framework (Ostrom 2005) described the institutional setting, while Institutional Work Theory (Lawrence and Suddaby 2006) added a dynamic aspect by focusing on the agency of actors. The key concepts behind these two scholarships are defined below:

Unit of Analysis: Rules-in-use are various laws and social conventions that guide and shape the way actors (individuals, networks, organizations) act and interact. These formal (documented) and informal (tacit) rules constitute the institutional setting (Ostrom 2005).

Institutional Dynamics: Institutional work consists of the activities that actors undertake, influencing the rules-in-use. Lawrence and Suddaby (2006) identify three types of institutional work:

- *Maintaining*. Conforming to current rules-in-use, thereby enforcing their legitimacy.
- *Creating*. Generating new rules-in-use by questioning the assumptions and conventions underlying current rules-in-use.
- *Disrupting*. Explicitly challenging current rules-in-use or undermining their legitimacy, creating an opportunity for institutional change.

Institutional Levels: Ostrom (2005) defines institutional settings as nested sets of rules-in-use, guiding activities at different levels. There are two levels relevant to this study:

1. *Operational*. In this study, this level involves day-to-day water service delivery, described by rules and regulations and their interpretation by practitioners. Water service providers and resource managers predominantly conduct institutional work at this level.
2. *Collective Choice*. At this level, day-to-day operational rules, which are described in strategic planning, policy and political processes, are monitored, evaluated and sometimes altered. As new rules-in-use must be understood and shared collectively in order for them to become legitimate and enforced, this institutional work is generally conducted by executive management within organizations, policy makers and regulators, in consultation with operational actors and broader stakeholders, such as the public.

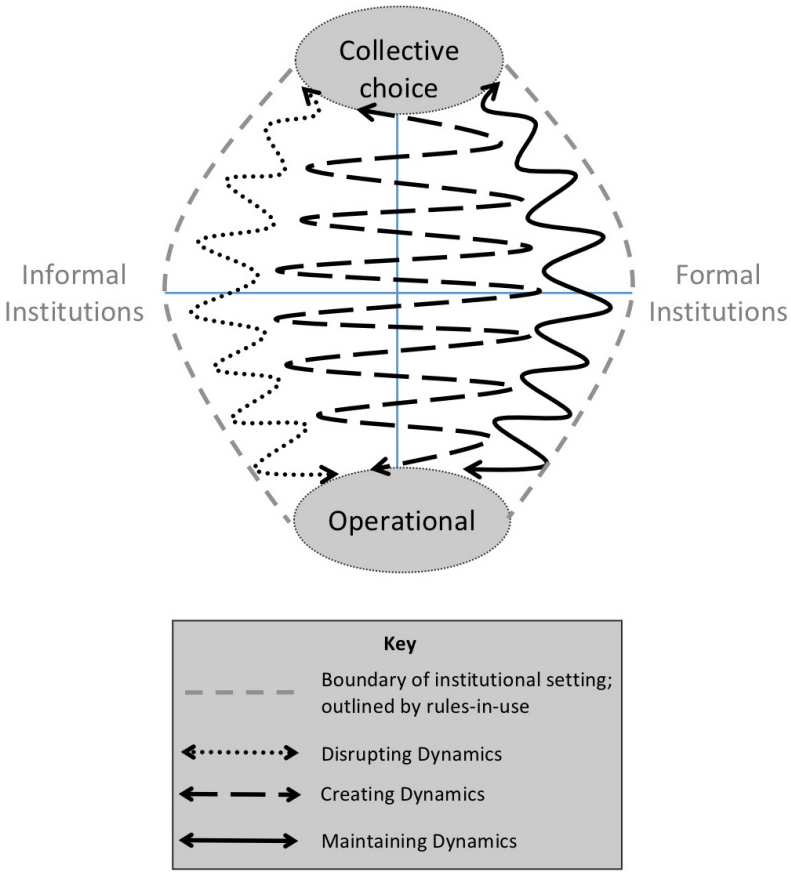
These concepts are used to understand the various processes of change occurring within the urban water institutional setting (see Figure 1) and to provide the analytical framework for exploring the dynamics of change.

The different levels of institutional activity (y axis) are bounded by both formal and informal institutions (x axis). The three forms of institutional work mediate between these levels, enacting both types of rules-in-use to manage urban water at an operational level, or generating interplay between operational and collective choice levels and/or formal and informal rules-in-use to alter this setting. Maintaining work enforces formal rules and regulations, thus conforming to these rules-in-use. In contrast, disrupting work seeks to challenge and undermine formal institutions, relying on informal rules beyond the sanctions imposed by formal rules to do so. Creating work mediates between these two, questioning formal rules with insights from disruptive activities, and using passive strategies of mimicry, advocacy and education to 'bend' the formal rules to accommodate and eventually legitimize these new ideas.

Data collection and analysis

The research was conducted in three phases. The first aimed to understand the broader operating context of the urban water management. The second sought to identify the institutional setting that underpinned practices, including tacit conventions and assumptions shaping the sector's drought response and the dynamic interplay between these and formal governance arrangements. The final phase described some of these dynamic processes by examining the actions and strategies of actors navigating this setting and how their institutional work altered the rules-in-use. The methodological approach for each of these three phases is described below. The data and their interpretation were validated by individual participants at the end of phases 1 and 2 and by participants at a workshop at the conclusion of phase 3.

Figure 1
Analytical framework of Institutional Dynamics.



Phase 1: Semi-structured interviews were conducted with urban water professionals of five or more years experience from a range of water management roles (n=10). Interviews identified management changes occurring as a result of the drought, how changes came about, and key challenges the sector faced. A modified form of axial coding (Strauss and Corbin 1998) was applied to transcripts, which revealed themes or domains of important influences affecting Perth's urban water sector. These domains of change were used to focus the analysis of data in subsequent phases. Domains were described by drawing together the narratives of interview participants, supported and enriched by content analysis of various secondary sources.

Phase 2: This phase sought to describe the institutional setting of water management in Perth. The informal elements of this setting, i.e. problem frame, norms and professional conventions, lie within the tacit knowledge of practitioners. Thus, a method was developed to identify and draw on their experiential knowledge. This involved three activities conducted at workshops with practitioners. The first activity provided participants with time and space to reflect on positive and negative influences on their professional activities and experiences. The second activity used a focus group approach to open discussion of these influences, identify common or contrasting experiences, and draw out the moral codes, decision logics and other implicitly shared understandings behind professional practice (Ambrosini and Bowman 2001). Thirdly, qualitative conceptual mapping techniques (Petrucci and Quinlan 2007) were used to connect the different influences and further draw out their implications for contemporary water management practices. Three workshops were conducted with a total of 21 participants, who responded to an open invitation. Participants held roles from operational to senior executive levels and included practitioners from local and state government (water, environment, planning and health areas), the water utility, natural resource management authorities, land developers, private consultants, and peak industry bodies.

Phase 3: The final phase explored the domains of change identified in phase 1 in more depth using data from phases 1 and 2. Interview transcripts

and supporting data from workshop activities were coded using the concepts described in the analytical framework as theoretical codes (Strauss and Corbin 1998). This enabled an exploration of the way Perth's institutional setting functioned, by understanding the actions of actors within this setting and how these served to maintain, create and/or disrupt the rules-in-use. Based on the coded data and using the contextual narratives (phase 1) and concept maps (phase 2) to compare and contrast the results, institutional dynamics were identified and described for each domain. Complementary and contradictory accounts were also identified to further refine the interpretations. The insights from the research data allowed, these institutional dynamics to be assessed, using a traffic light system. This indicated the influence (significant, limited or insignificant) of each type of institutional work (maintaining, creating, disrupting) within each domain, thereby providing an overall snapshot of the influence of institutional dynamics in Perth's urban water sector, with supporting commentary and illustrative maps.

Results and discussion

The domains of change in Perth's urban water institutional setting in response to drought was identified during Phase 1 of the research. These are listed below:

- *Governance setting:* Regulation, legislation, levies, policies and other formalized incentives and disincentives that shape the industry's operational environment.
- *Policy direction:* The purpose of water management in society, articulated and communicated in a policy agenda subscribed to across Government.
- *Inter- and intra-organizational relations:* The relationships and working culture of organizations across the urban water sector.
- *Strategic support:* Managerial support for reinterpretation of roles and responsibilities, and networks of frontrunners to disseminate and champion innovations.
- *Discourse:* Public debates and perceptions of water management, as understood by practitioners. Professional discussions on the beliefs, cognitive frames, professional identities and other assumptions underlying the current water management paradigm.
- *Information and feedbacks:* Information on system performance, opportunities, emerging issues and pressures from the broader contextual environment in which the urban water industry is situated.
- *Space for innovation and learning:* The culture of learning and experimentation across the sector, and the supporting structures provided by organizations and individuals for such activities.
- *Professional capacity:* Skills, capabilities and technical knowledge to manage urban water systems, and to develop innovative approaches to this task.

Table 1
Institutional dynamics in Perth

	Operational Level			Collective Choice Level		
Institutional domains	*Maintaining*	*Creative*	*Disruptive*	*Maintaining*	*Creative*	*Disruptive*
Governance Setting						
Policy Direction						
Inter/Intra-org relations						
Strategic Support						
Discourse						
Information and feedbacks						
Innovation and learning						
Professional Capacity						

Key:

Significant	Dynamics had an impact on urban water management practice
Limited	Dynamics had no substantial effect on practice
Insignificant	Dynamics had negligible effect on the way the water sector operated

Using the analytical framework and research data, institutional dynamics within these domains were assessed (Table 1), revealing whether the three types of institutional work had a significant, limited or insignificant influence at each level of the institutional setting (operational or collective choice). A significant rating indicates an impact on urban water management practice in Perth. A limited influence suggests that, while activities may be occurring, the dynamic produced had no substantial effect on practice. An insignificant influence indicates that the institutional work occurring had negligible effect on the way the overall water sector operated.

Analysis of the interview and workshop data (summarized in Table 1) helps to understand the way in which the dynamics within these domains influenced the city's response to drought. For example, it can be clearly seen that maintaining dynamics prevalent at the operational level, i.e. day-to-day water management activities, are effectively locking the sector into its current practices. Similarly, the limited influence of creative institutional work in the innovation and learning and professional capacity domains at both levels has lead to little innovation in practice. At the collective choice level, a lack of disruptive dynamics has generated no significant driver for reforms to be pursued. Also at this level, few creative dynamics exist to promote alternative practices and catalyze a shift in the current water management paradigm at the operational level.

These results are discussed in more depth in the following sections, with direct quotes from participants use to illustrate the results presented in Table 1. Recommendations based on these results are then discussed to enhance the capacity within Perth's institutional setting to adapt to water scarcity. In addition, these results have implications for current scholarship on adaptive governance.

Maintaining dynamics

Perth's urban water institutional setting is characterized by maintaining dynamics, as shown in Table 1. These dynamics predominate, primarily as a result of problems with feedback from monitoring and evaluation processes. Firstly, within the information domain, participants mentioned the lack of reliable and/or relevant information to inform the development of alternative approaches, and problems accessing information to review or challenge current solutions and the decision-making logics that select them. As a result, feedback informing the water sector of its performance within its operating context and the suitability of its objectives were suppressed.

'It's such a big concern when Water Corporation still hold all the information that will help people actually really work out what the cost-benefit is of these alternative sources of water.' – Consultant

A second significant form of feedback is public perception of water management, represented within the discourse domain. The community's expectations for water management (reliable, safe, cheap water with autonomy over its use) set criteria by which the Government's performance is judged.

'People can look out [at] our river from the city and they can see the dolphins jumping... then they go "What's the problem?".' - State Government, Water Department.

Social norms, beliefs and understandings that underlie community expectations may no longer be realistic under drought conditions. However, due to past political platforms and campaigns, water issues are framed as potential 'failures of Government'. As a result, water managers strive to meet these community expectations, often against their own professional judgment.

Connected to these feedback issues, maintaining dynamics also stem from lack of direction and leadership (strategic support domain). It is acknowledged within the sector that governance arrangements are not responsive to the new environmental conditions and that entrenched practices are becoming inappropriate. However, because of political sensitivities around water, it has been difficult to acknowledge these deficiencies, challenge their inappropriateness, and build the support and momentum for reform.

'The higher levels are scared of getting sacked.' – Peak Industry Body

Without the cohesion provided by a shared understanding of the water management problem, and vision and leadership support to address it, the sector suffers confusion over the appropriateness

of practices, and competing agendas arise. The coping strategy is to fall back on formal organizational positions, rules and processes, as, being embedded in current formal rules, these practices are not subject to risks, challenges or penalties.

Creating dynamics

The corporatized arrangements for water management in Perth do not encourage the creative dynamics needed to improve water management techniques through innovation (innovation and learning and governance domains). Water management has been separated functionally and philosophically into distinct services (supply, sewerage and drainage) to be delivered in optimized ways. Organizations delivering services are penalized if they operate outside the prescriptions of their licenses. Thus, they have little room to be inventive or to question service objectives.

'We don't have any government position in relation…alternative water supplies; it's got to compete with our current one.' - Water Utility

This prescriptive structure makes it difficult to alter objectives for water management in response to changing circumstances, for example, to shift to multi-functional drainage systems to harvest stormwater, as other Australian cities have done in response to drought. In Perth, due to the maintaining influences in the governance domain, objectives can only be adjusted through legislative reform.

'…until you change the policy, change the guidelines, change the standard... then the implementers will continue to implement.' – State Government, Water Department

A Department of Water has been created to take overall responsibility for water resources management but has not developed professional capacity, public support or political will to overcome maintaining dynamics (i.e. creative activities in policy direction, strategic support and professional capacity domains).

'The Department of Water is still an embryonic organisation, they're still building capacity.' - Researcher

Alternatively, creative activities can focus on changing the normative and cognitive assumptions behind legislation and regulation as a starting point for reform. However, in Perth, due to a long, proud history of the water professional's role in State development, there is a strong sense of professional identity connected to current management philosophies. To question or challenge the assumptions underlying professional practice threatens this identity.

'Everyone knows what their comfort zone is, what they know and love and have been doing for the last 30 or 40 years.' – State Government, Water Department

Some actors use formal rules to undermine or discredit creative and disruptive activities, to protect their sense of professional identity.

'… people 'pushing back' and only doing what's strictly in their job description…' – NRM agency

This generates a strong maintaining influence in the professional capacity domain that counters creative work needed in discourse, strategic support and innovation and learning to reassess the underlying beliefs, assumptions and problem frames of water management practice.

Disrupting dynamics

Questioning and challenging current practice is limited; due to the lack of public acknowledgement that the drought is putting water use practices under pressure and the political, organizational and professional sensitivities around water management (discourse, strategic support, inter-intra organization relations and professional capacity domains). This creates powerful disincentives for disruptive activity, as actors expose themselves to formal and informal sanctions.

'No-one will make the first step…no-one's going to go over the trench because they're going to, the machine guns are going to mow you down.' - State Government, Water Department.

This phenomenon of professional agency entrapment has been identified in other cases of urban water crises in Australia and internationally (Brown et al 2011; Werbeloff and Brown 2011). As a result, local practice innovations occur but they

are implemented *ad hoc* and not highlighted or connected to develop professional discussion about the limitations of traditional practice.

'…they do some really good stuff and yet unless it's business as usual, you don't really hear about it.' - Consultant

Without connecting the learnings from these projects with messages about the dissonance between formally and informally accepted practices, broader acceptance and momentum for institutional change is not built at the necessary collective choice level. This type of disruptive activity requires strategic maneuvering by leaders or champions (strategic support), but as discussed, water is too politically sensitive in Perth for such activities to occur.

'And people don't quite know how to challenge it and work their way through with you know, new sort of opportunities.' – Consultant

Recommendations

This study revealed that greater opportunities for creative and disruptive dynamics need to be generated in Perth to balance the dominance of maintaining dynamics. Analysis of dynamics within key domains of the institutional setting identifies where change is needed and where systemic interventions might generate preferable dynamics. For example in Perth, some of these leverage points and intervention strategies may include:

Creating system feedbacks by:

- Improving information collection and dissemination and addressing knowledge gaps.
- Instigating monitoring and reporting aimed at demonstrating the efficient, effective performance of the water sector overall, beyond service delivery objectives.
- Working towards better transparency and accountability throughout the sector.

Learn how to learn together by:

- Encouraging and facilitating professional discourse to generate shared problem frames, cognitive understandings and norms.
- Identifying projects where collaboration can share technical learnings as well as the governance implications of these initiatives.

Foster action at the Collective Choice level by:

- Providing direction to and support for change experiments in clearly formulated, forward-looking policy agendas, and use these to open a collaborative dialogue across the sector.
- Identifying and addressing the perceived risks and sanctions of doing things differently, and providing incentives to encourage champions of innovation to emerge.
- Providing capacity building in stakeholder and community engagement skills to activate networks and build momentum for change.

Further, the Perth case illustrates that efforts of reform through IUWM approaches have only been partially successful because of gaps in these dynamics. By focusing on reforming formal legislative and regulatory rules – and not adjusting the informal rules-in-use – past efforts have not generated the fundamental change (paradigm shift) in the institutional setting needed to create and mainstream practice change.

These results also revealed a contrary perspective to that presented in adaptive governance literature (Folke et al 2005; Young 2010): a crisis may not be sufficient to create a window of opportunity for change. Despite a significant crisis in water availability, Perth has been resilient to scarcity through the stable, certain and trusted way in which to respond to drought. Over time, the predominance of maintenance dynamics may 'lock-in' Perth to these practices, making the city vulnerable to future changes. In this crisis, Perth has been unable to utilize the opportunities provided by scarcity to reconsider and, where necessary, revise its water management practices (Keath and Brown 2009). The results of this study suggest that creative and disruptive dynamics are needed to review, question and sometimes challenge the suitability of current water management approaches. Therefore, a capacity for change within the institutional setting is critical to preparing for, utilizing and even generating opportunities: external drivers and pressures like crises alone may not be adequate to trigger change.

Conclusion

This research, through its focus on the dynamics within Perth's urban water institutional setting, revealed preliminary insights into processes and characteristics of adaptive governance. The analysis identified significant maintaining dynamics within particular domains of influence, such as strategic support, governance arrangements and inter-and intraorganisational relations. However, the analysis goes beyond identifying barriers, revealing the importance of disrupting and creative dynamics within the rules-in-use (or being part of an adaptive process). The former is crucial to challenge entrenched understandings, beliefs and assumptions, while the later is needed to form new cognitive frames and norms and the supporting rules-in-use needed to underpin practice change. The case revealed that, for an adaptive capacity to be generated through these creative and disruptive dynamics, institutional work that catalyzes and brokers connections between operational and collective choice levels is also necessary. These features enable the reflexivity and social learning that are recognized as cornerstones of adaptive governance and are key to governance arrangements that can adapt the management of urban water resources over time.

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CHAPTER 5: OPPORTUNITIES FOR IMPROVING ADAPTIVE GOVERNANCE

5.1 PUBLICATION THREE: UNDERSTANDING INSTITUTIONAL CAPACITY FOR URBAN WATER TRANSITIONS

This chapter consists of the publication:

- Bettini, Y., Brown, R.R., de Haan, F.J. and Farrelly, M. (forthcoming). Understanding institutional capacity for urban water transitions. *Technological Forecasting and Social Change.*Accepted 4/5/2013.

This publication describes the method used to apply the conceptual framework in detail, developed in Phase 1, thereby meeting the research aim – *to empirically map the dynamic institutional context of urban water governance*. It also provides the main results of Phase 3, and provides some insights that contribute to Objectives 4 and 5, namely – *to contrast and understand the mechanisms of adaptive capacity within urban water institutional dynamics*, and *to identify and analyse the role actors play in institutional adaptive capacity.* However, the main contribution this publication provides to the thesis is a consideration of the results of the research in relation to the applied governance framework of Transitions Management. This achieved the research aim – *to generating recommendations on how institutional adaptive capacity can be built into governance processes.* These contributions are outlined in detail below.

5.1.1 Method

This publication provides a description of the research design for Phases 2 and 3. To fit within the framing of the publication, Phases 1 and 4 were not described, and Phase 3 was divided into two. One phase to detail the method of identifying the institutional context, and another to describe it. Thus, in this publication the research phases are described as; Phase 1, Context gathering; Phase 2, Identifying the institutional setting, and Phase 3, Characterising the institutional setting. As such, the publication presents results for Objectives 2 and 3, detailed in the proceeding sections.

5.1.2 Results

Phase 2: Contextualise. This publication contributes to Objective 2, by presenting the summary narrative of the influence of each institutional domain in Perth and Adelaide. These domains were identified in each case through axial coding, but both analyses produced similar thematic codes, which in turn became the domains. These results were cross-checked with literature to test the transferability of the domains to other sectors, and to identify any gaps in the analysis. The domains where institutional dynamics were producing or influencing change dynamics in the urban water sectors of Perth and Adelaide were subsequently defined as:

- *Professional practices:* Skills, capabilities and technical knowledge resources for performing water management, and for deriving innovative approaches to this task.
- *Identity and mission:* Indicators of the purpose water management fills in society, articulated and communicated in a policy agenda subscribed to across Government.
- *Beliefs and cognitive frames:* Interpretational filters of feedback, opportunities, emerging issues and pressures from the broader contextual environment the urban water industry is situated in.
- *Governance setting:* Regulation, legislation, taxes, policies and other formalised incentive and disincentives that shape the industries operational environment.
- *Public discourse:* Public debates and public perceptions of water management, as understood by practitioners. (This domain was later expanded to include professional discourse.)
- *Inter-Intra organisational relations:* The relationships and working culture of organisations across the urban water sector.
- *Space for innovation and learning:* The culture of learning and experimentation across the sector, and the supporting structures provided by organisations and individuals for such activities.
- *Strategic support:* Managerial support for reinterpretation of roles and responsibilities, and networks of frontrunners to disseminate and champion innovations.

These domains were used as a device to organise data analysis in subsequent research phases.

Phase 3: Characterise. The publication contributed to Objective 3 by firstly, qualitatively assessing the influence of institutional work activities to provide an indication of the extent of maintaining, creating and disrupting work in each case, and secondly, describing the implication these dynamics may have for a Transition Management intervention in each case. The activities in Transitions Management are similar to some of the known factors influencing adaptive capacity, in the need for:

- Leadership or champions (identifying frontrunners for transition arenas);
- Shared visions (framing the problems and creating the transition visions);
- Space to innovate and experiment (developing transition pathways, agendas and designing experiments); and
- Monitoring, evaluation and reflexivity (implementing and monitoring the transition).

Thus, by exploring the implications of the institutional dynamics in each case study for these activities, the paper begins to describe the possible mechanisms for adaptive capacity that the results of the research have produced.

5.1.3 Contributions

The main element this publication provides to the thesis is in demonstrating its potential contribution to Transition Management. The overall argument presented in the publication is that the framework; with its institutional perspective, and the method of analysis developed; can be used as a robust systems analysis to produce relevant knowledge for input into Transitions Management activities, including:

- *Expert preparation:* To inform process design of the intervention and identify potential frontrunners;
- *Strategic activities:* Present a mapping method to structure problem discussion and build shared understandings;
- *Tactical activities:* Offer a tool to collect and apply participant's tacit knowledge to progress transition agendas;
- *Operational activities:* Supply detailed knowledge of the system to target intervention points; and
- *Reflexive activities:* Provide a way to represent the system in a dynamic way for monitoring and evaluation.

DECLARATION FOR THESIS CHAPTER 5.1

Declaration by candidate

In the case of Chapter 5.1, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Formulation of the research problem; development of assessment framework; interpreting the literature; positioning the research in this context; data collection, analysis and interpretation; writing	80%

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Brown, R.R.	Formulation of the research problem, interpreting the literature and positioning the research in this context, revision of writing	n/a
de Haan, F.J.	Interpreting the literature and positioning the research in this context, revision of writing	n/a
Farrelly, M.	Formulation of the research problem, revision of writing	n/a

Candidate's Signature		**Date:**

Declaration by co-authors

The undersigned hereby certify that:

1. the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors;
2. they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
3. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
4. there are no other authors of the publication according to these criteria;
5. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
6. the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	School of Geography and Environmental Science, Monash University

Signature 1 **Date:**

Signature 2 **Date:**

Signature 3 **Date:**

Understanding institutional capacity for urban water transitions.

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Key Words:

transitions management, institutional dynamics, systems analysis

Abstract

Transitions management (TM) is an emerging as an approach to governing complex sustainability problems. Critiques point to the need to understand dynamics of system change particularly, with regard to actor agency at micro and meso scales. This paper begins to address this scholarly gap by first developing an analytical framework of the institutional context of a transition that recognises forms of agency, providing a dynamic understanding of the system. Secondly, a method to apply the framework to empirical cases of urban water socio-technical systems is developed. The results revealed: i) ways to identify problematic features of current systems and underlying cognitive and normative frames, to assist with envisioning and transition pathway development, ii) a method for system analysis targeting leverage points and deficiencies, as a basis for strategizing transitions agendas and experiments, and iii) a dynamic description of the system to assist with evaluating TM interventions and monitoring transitions. By providing a systems analysis cognizant of contextual dynamics and targeted to the knowledge needs of TM activities, this analytical tool shows promise for improving TM practice and transition scholarship through further application in empirical research.

1 Introduction

There are significant environmental, economic and social pressures challenging the ability of many socio-technical systems to provide goods and services to human society. Scholars are observing that incremental changes achieved through current governance arrangements are not keeping pace with these sustainability challenges (Chapin et al., 2009; Polasky et al., 2011). Sustainability scholars argue this is an indication that societal organisation (governance) is unable to deal with the complex issues of sustainable development (Biermann et al., 2012; Biggs et al., 2010; Westley et al., 2011), and that the need for fundamental governance change to mitigate and/or adapt to global environmental change is now urgent (Westley et al., 2011). Adaptive governance is proposed as a new form of governance for organising society to 'adapt' to pressures (Chapin et al., 2009; Huitema et al., 2009; Polasky et al., 2011) by reflexively considering multi-scale feedbacks (Voß et al., 2006), using participatory processes to facilitate social learning (Olsson et al., 2006; Pahl-Wostl et al., 2007), and thereby enable social (as well as technological) innovation (Biggs et al., 2010). The Transitions Management (TM) approach has become a prominent contender for an operational from of the adaptive mode of governance (Loorbach and Rotmans, 2010; Rotmans and Loorbach, 2010c; Shove, 2010; Voß et al., 2009). By moving beyond institutional design principles to a tangible process of intervention (Frantzeskaki and de Haan, 2009; Meadowcroft, 2005), transition management aims to mediate and guide change processes.

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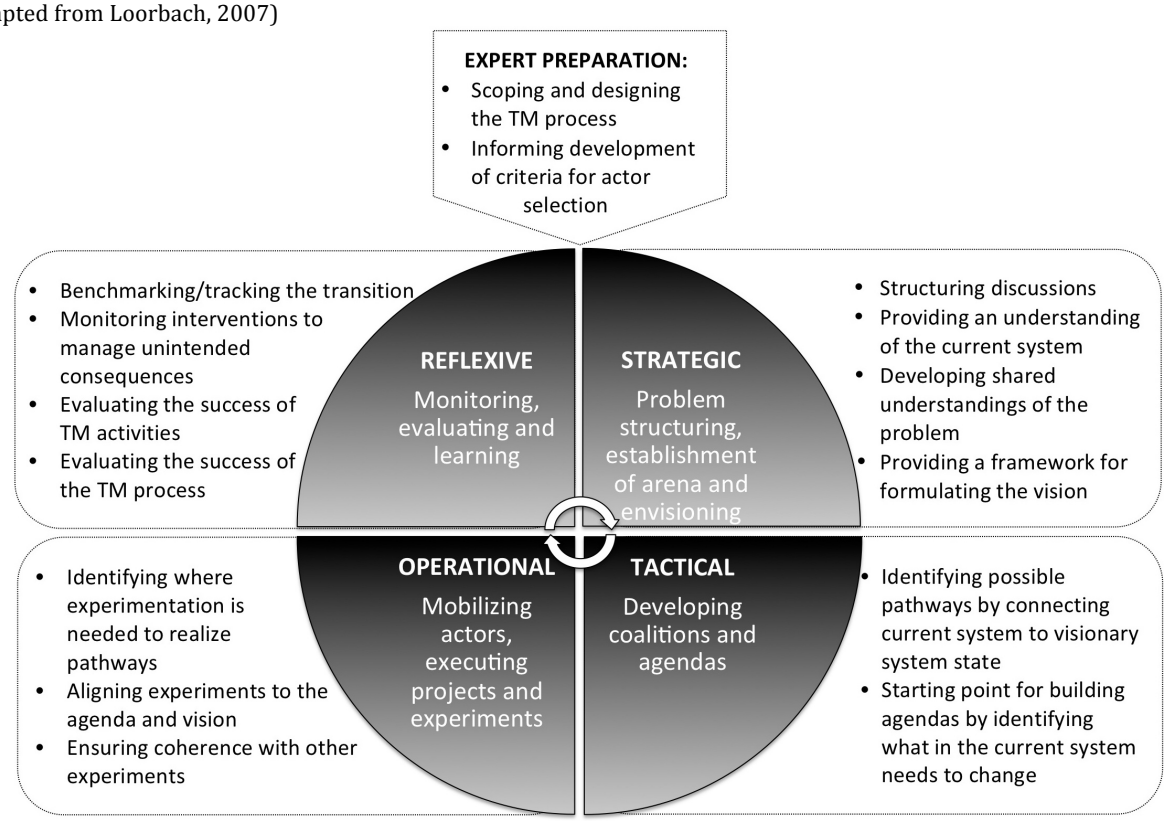
Experimentation with alternative practice (transition experiments) informs multiple intermediate strategies (transitions pathways) to possible futures (transition scenarios) linked to long-term sustainability goals and visions. However, the main strength of the approach comes through an emphasis on deliberative group dynamics (transition arenas) with key actors or frontrunners, to set up spaces for 'safe' experimentation and seed social learning (Loorbach, 2010). It is argued such an approach establishes a process of governance 'evolution,' rather than revolution through imposition of new governance forms and the large-scale structural changes they entail (Rotmans, 2001). The TM alternative is to establish transition arenas as 'shadow networks' working within niches parallel to dominant practices and regimes. By coordinating and aligning novel efforts to reinforce one another, TM scholars assert that when the opportunity arises these niches can compete with the incumbent regime, and adjust or replace governance arrangements (Frantzeskaki et al., 2012b; Loorbach and Rotmans, 2010). However, recent reviews of the transitions literature highlight that understanding how niches and regimes interact through a TM process to produce new forms of governance is a key weakness in the scholarship (Markard et al., 2012; Voß et al., 2009). Critics highlight the lack of explanatory power with regard to two key areas of the TM process: i) the internal functional dynamics of transitions arenas to recognise 'window of opportunity' and manipulate these broader change processes, and ii) the interplay between transition arenas and the regime to achieve a transition, particularly in terms of the conflicts and power struggles that arises as niches challenge the regime (Farla et al., 2012; Markard et al., 2012; Park et al., 2012). The first issue is important as TM relies heavily on the expert knowledge and collaboration of participants in the arena to develop and implement transitions experiments and agendas, and to commit to progressing a change agenda beyond the 'safety' of the arena. TM scholars argue that through careful selection of participants and facilitation, appropriate group dynamics can be generated to achieve this (Frantzeskaki et al., 2012b; Loorbach and Rotmans, 2010).

However key assumptions hinge on these group dynamics, that social learning will enable a new governance form to emerge, participants will commit to furthering a transition agenda, and that the distributed agency of these individuals can be harnessed to successfully implement strategies toward this agenda, in the face of likely opposition from the regime (Voß et al., 2009). The second main critique is concerned with the interplay between the TM intervention and the regime itself. According to the TM approach, the empowerment of frontrunners and coordinating role of the TM process provides the acumen to prepare for and influence/challenge the regime at an opportune moment (Loorbach, 2007; Loorbach and Rotmans, 2010). However, the details of how to identify these moments within the broader landscape context, and where to intervene in the functional dynamics of the regime to create change, have not been addressed clearly within transitions theory (Farla et al., 2012) or within TM methods and published empirical studies. As an emerging field, transitions theory development has focused on system level questions of how to characterise and describe the processes of transition (de Haan and Rotmans, 2011; Frantzeskaki, 2011; Geels and Schot, 2007; van der Brugge, 2009) and expanding the theoretical basis of different systemic instruments in the TM approach, such as scenarios and experiments (Bos and Brown, 2012; Farrelly and Brown, 2011; Sondeijker, 2009). Some attention to questions of power in transitions is providing detail on the dynamics of change (Avelino, 2009; Avelino and Rotmans, 2009). However, this stream of the transitions scholarship has not yet developed to explain where and how power is vested in transitions processes, or develop tools and methods to identify and utilise this agency in a TM process (Rotmans and Loorbach, 2010a).

Emerging from these critiques and current state of knowledge are key questions surrounding the identification of system dynamics for TM activities. Analysis of the system and sub-systems under transition are recognised as critical in all activity clusters of a TM cycle (Loorbach, 2010), as illustrated in Figure 1

Figure 1
Role of system analysis in TM activity clusters

(Adapted from Loorbach, 2007)



Within these different activity clusters of the TM approach, the purpose of the systems analysis moves from one of system description (expert preparation/strategic), to diagnosing systemic problems (tactical), informing the design of interventions (operational), strategizing when and how they should be implemented (strategic/tactical), and monitoring the transition to inform the TM process and evaluate the success of the TM intervention (reflexive). The TM approach (Loorbach, 2007, 2010), published empirical studies (Loorbach and Rotmans, 2010; Rotmans and Loorbach, 2010a), and guidance manuals (Frantzeskaki et al., 2012a) point to a range of methods to conduct the systems analysis at various stages of the TM cycle. Yet how these tools and their underlying scholarships address the variety of purposes the systems analysis performs through TM has not been explored. To these ends, and to address the scholarly gaps of TM identified in the preceding discussion, the desired features of a system analysis tool appear to be:

- A robust method(s) to access and organise expert knowledge from arena participants;
- Ways to identify system dynamics to generate a functional understanding of the system, in order to diagnose how and where interventions can be most effective;
- The ability to identify the agency of transitions arena participants, and how it might be utilised; and
- The ability to identify agency within the regime, and how this agency might be influenced.

These features are particularly important to enable the TM approach to be tailored to specific sustainability issues and contextual conditions.

This paper seeks to make a start on closing this scholarship gap by drawing on the intellectual resources of new institutionalism. The paper develops an analytical framework to describe the institutional context of potential TM interventions, in both structural and functional dimensions. In this way, the composition of the transition context and the powers of change vested within it can be captured. Secondly, a method to draw on tacit knowledge of experts to populate the framework is designed. Thirdly, the framework is applied to empirical cases of ongoing transitions in two Australian cities, which offer the opportunity to describe and explore the dynamic institutional contexts of systems under transition conditions. The results in each case are explored with regard

to their implications for the activity clusters of the TM approach, identifying potential capacities and intervention points needed to support a TM intervention. The paper closes with discussion on the merits of the tool as a heuristic device to identify and describe the system dynamics of a possible transition, and recommendations for further development of this approach.

1.1. The institutional context of transitions.

Fundamentally, socio-technical transitions are structural changes to the way society organises itself (Geels and Schot, 2007). A recent sociological turn in institutional theory is offering new perspectives and conceptual tools to understand processes of societal change, through the interplay between social actors and their institutional contexts (Bartley et al., 2008; Lawrence et al., 2011). Drawing on these scholarly developments, there has been a shift in the sustainability sciences in understanding institutions as organising structures to enable collective action (Geels, 2004; Ostrom, 2005), rather than barriers to change that create lock-in and path dependence through their inert character and affect. Application of this new conceptualisation of institutions is offering new and promising perspectives to understand sustainability challenges and their solutions (Huitema et al., 2009; Termeer et al., 2012; Walker et al., 2009; Westley et al., 2011; Young, 2010), and has been signposted by Geels (2004) as a useful frame to examine socio-technical transitions in particular. Using this institutional perspective, TM could be seen as a way of organising actors' power to change these organising societal structures (Avelino, 2009). Understanding the institutional context and the structuration of this system (the agency of actors and how it manifests and changes the institutional context) offers a way to explore some of the current gaps in transitions theory (Farla et al., 2012), and address the knowledge needs of TM interventions.

The Institutional Analysis and Development (IAD) Framework (Ostrom, 2005) provides a means of conceptualising the structure of this institutional context. Firstly, the concept of rules-in-use captures the variety of formal and informal rules that guide decisions, interactions and actions of various actors. These rules are a mix of:

- Legislation, regulation, and other formally documented and enforced institutions; and
- Norms, beliefs, values and other informal, socially constructed understandings.

These rules-in-use construct and bound the institutional context. Secondly, the IAD Framework captures issues of scale in the idea that sets of nested rules-in-use will describe and bound activities at different levels of the institutional context. The operational level is concerned with on-ground management activities, while the collective choice level is placed to monitor, evaluate and change these day-to-day operational rules-in-use. This process to change rules-in-use must be conducted jointly by stakeholders, as new rules-in-use must be understood and shared collectively in order for them to become a legitimate component of the institutional context. Likewise, the IAD Framework recognises a third scale, known as the constitutional level. The focus of this level of activity is with establishing the space and actors for collective choice actions, through the responsibility for a set of collective action rules-in-use. As the focus of this study is the dynamic between practice and governance (i.e. not to the level of the system of government), the analysis focuses between the operational and collective choice levels.

Cognitive frames, values, norms and other informal institutions mediate the interpretation and reinterpretation of the rules-in-use by actors, at operational and collective choice levels. Questioning these cognitive and normative underpinnings of formal institutions is the process of reflexivity, and a key activity in the TM cycle (Kemp and Loorbach, 2006). Thus using an institutional perspective to understand transitions requires identification of the dynamic effect of different activities and actions that lead to structural change. Institutional work theory (Lawrence et al., 2009; Lawrence and Suddaby, 2006) is a developing branch of new institutionalism that addresses this intellectual need. Focusing on the ways actors express their agency, and the effects of this activity on the way a system functions, it recognises three types of institutional activity or 'work' that actors conduct:

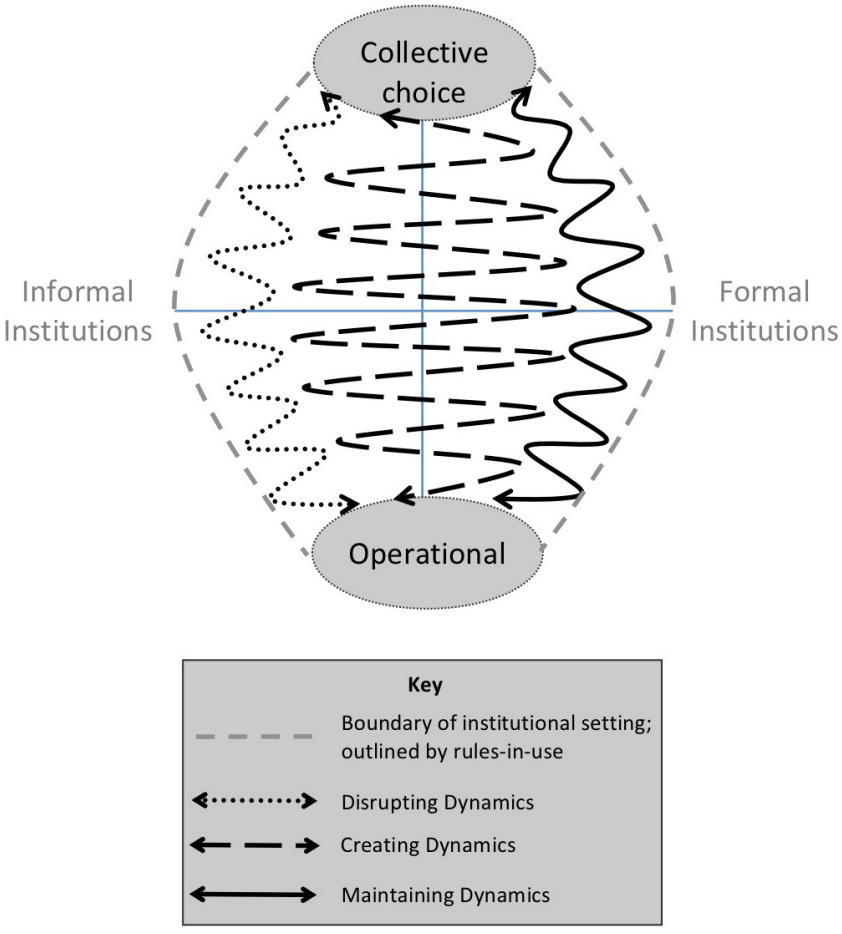
- *Maintaining work:* Activities that serve to maintain current institutions by enforcing or conforming to current rules.
- *Creating work:* Activities that create new rules and structures by questioning the assumptions and conventions behind current rules.

- *Disrupting work:* Activities that disrupt the order by explicitly challenging current rules or undermining their legitimacy.

Drawing together these scholarships, a framework for dynamically describing the institutional context of a system is produced (see Figure 2).

In Figure 2, the different scales of activity within this setting (operational to collective choice) are illustrated on the vertical axis. The institutional setting is structured and bounded by both formal and informal institutions, as a continuum along on the horizontal axis. The three different forms of agency (institutional work) manifest within this setting. Maintaining activities enforce and conform to formalised rules and regulations, and so do not need to draw substantially on informal institutions to be supported. In contrast, disrupting activities seek to challenge and undermine formal institutions, and so rely heavily on informal institutional mechanisms to conduct this work, beyond the bounds of the sanctions imposed by formal institutions. Creating activities mediate between these two, questioning current rules with insights from disruptive activities, and using strategies to 'bend' the formal institutional rules to show the legitimacy of these insights, thereby create new institutions. Creative institutional work can rely on both formal and informal institutions to achieve this. This institutional perspective provides the theoretical depth of a mature scholarship needed to analyse the complex context of transition processes. Moreover, using the broad definition of institutions as rules-in-use allows a wide range of contextual details to be captured at a level of generality. This enables comparison across different contexts and system scales. Therefore, the empirical application of this analytical framework has potential to be sensitive to the specific context of a transition, in order to inform and strengthen the timing and design of TM interventions. It also provides a general framework to conduct and compare empirical studies of transitions to aid the further development of the scholarship.

Figure 2
Analytical framework for understanding institutional contexts.



2. Methods

2.1. Case study design and selection

To apply this analytical framework, an *in situ* method was essential, as the research subject (institutions) exist in day-to-day work practices and interactions of people. Recent experience of prolonged drought in many Australian cities provided a unique opportunity to explore the dynamics of potential transitions-in-progress. Extreme water scarcity drove a re-examination of water supply technologies and systems (operational level) and the governance arrangements underlying these practices (collective choice level). A reconfiguration of urban water socio-technical systems to align with the new operating conditions was occurring. Thus the presence of a significant landscape driver, and fundamental system changes suggested a transition trajectory. With similar systems of government, governance arrangements, cultural contexts and external driver a comparative analysis of institutional dynamics in real-world cases could be conducted. Following a series of scoping interviews with key industry persons (policy makers, infrastructure managers, natural resource managers, regulators, consultants, researchers) from five potential case cities, and a number of people working in water management in a national context (from peak bodies, national policy agencies, and international consultants), the two cities of Perth and Adelaide were selected as purposive samples (Stake, 2008) of institutional change. Both these cities have similar landscape conditions in terms of:

- Environmental conditions; Mediterranean climate, limited surface water, groundwater usage;
- Administrative arrangements; Corporatized urban water services, drainage responsibility resting predominantly with local government, resources management and policy development conducted by State Government, with implementation in local government and regionally based agencies, state regulation through Departments and Environmental Protection Agencies; and
- Infrastructure systems; predominantly centralised, reticulated, with separated sewerage and drainage.

These conditions provided a basis for comparing their divergent management responses to water scarcity. In Perth, experimentation with decentralised system augmentations such as water sensitive urban design, third pipe systems and recycling schemes had occurred at the municipal and residential/industrial estate scales. However the city's predominant 'drought-proofing' response had been to augment the centralised reticulated system with seawater desalination, further groundwater extraction and large-scale recycling schemes (Geels, 2004). In contrast, decentralised solutions were the focus of the drought response for Adelaide. While seawater desalination and securing surface water supplies for the centralised system were also pursued, significant investment; financially, in policy development, and governance reforms; were also pursued to support the development and uptake of stormwater harvesting[1]. With the implementation of diversified infrastructure and focus on addressing the governance implications of this technological change, this move in Adelaide's water management system could be considered toward achieving the flexible structural conditions needed in the system for integrated and adaptive sustainable water management (Pahl-Wostl et al., 2011). These two cases offered retrospective studies with theoretical replication logic (Yin, 2009), in that contrasting responses to water scarcity were observed under similar conditions. As such, different patterns of institutional dynamics could produce reliable explanations of the origins of these different responses. Further, by identifying and understanding these dynamics, the institutional context analysis has the potential to inform what different TM interventions might look like for each of these cities.

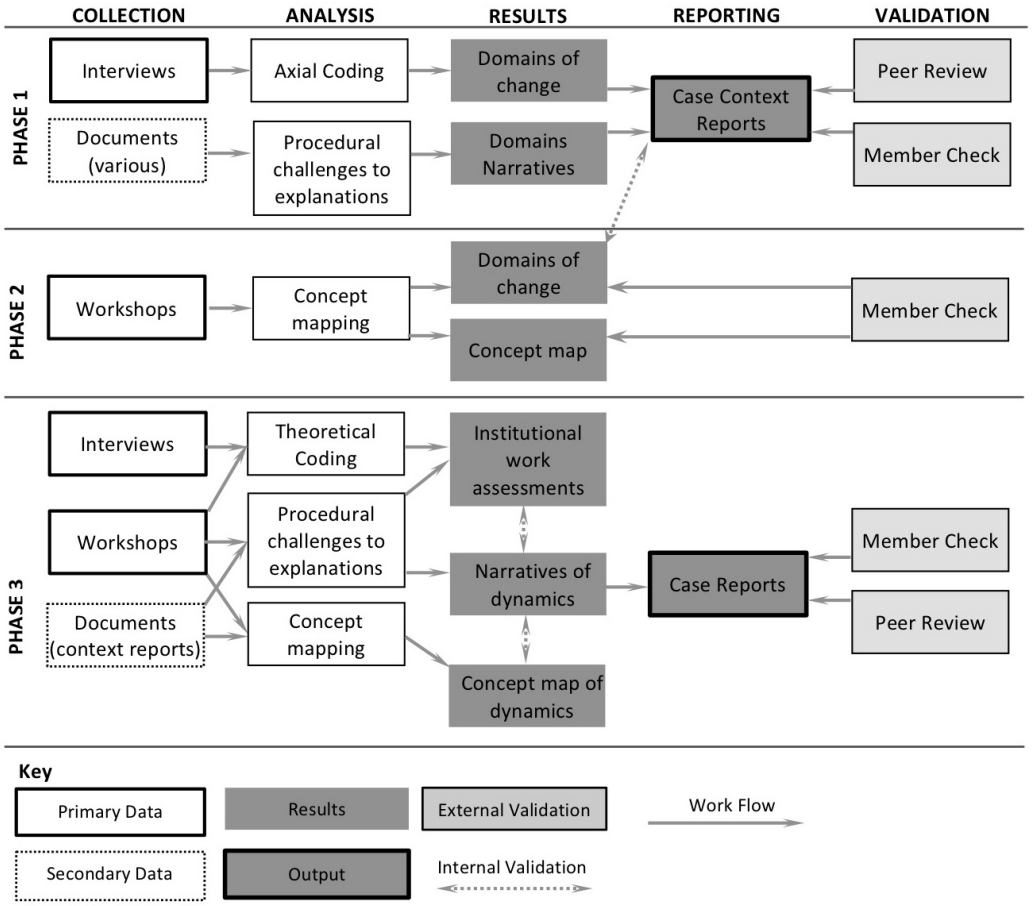
2.2. A three-phase method for institutional context analysis

Using the analytical framework described in the previous section, a three-phase process was designed and applied to populate the framework and analyse its content for each case. These phases were designed to be iterative, the results of Phase 1 feeding into Phase 2, and both informing Phase 3.

[1] Further background on the Perth and Adelaide case studies can be found in Bettini and Brown (2011) and Bettini et al (2012) respectively.

Throughout these phases, the role of the researcher was one of detached observer, with the exception of Phase 2, where the research took on the role of facilitator in workshops. In line with conventions of social research, a number of internal and external validation checks were included to confirm the interpretation and representation of the data as credible, dependable and transferable (Lincoln and Guba, 1985). The methodology for each phase is illustrated in Figure 3, and described in the following sections. Summaries of the method used in each phase are provided in Tables 1, 2 and 3.

Figure 3
Methodology for institutional context analysis



2.2.1. Phase 1: Case context gathering

In line with the conventions and strengths of case study research, this phase sought to understand the broader context of the cases (Stake, 2008). Data was collected through a number of semi-structured interviews with practitioners from each city, and some from a national level. Interviewees were identified by peers as stalwarts of the industry, with life-long careers in urban water management. As such, most held executive or management level positions in a range of organisations including; water utilities; State Government water, planning and health departments; natural resource management agencies; environmental regulators; peak industry bodies; consultants; and researchers. Interview discussions were guided around i) management responses to water scarcity, ii) the major changes to the water sector resulting from the drought, iii) influences behind those changes and how it had come about, iv) how the sector was performing under water scarcity, and (v) what the future challenges to the sector might be. These interviews were transcribed *ad verbatim* and coded using a modified version of axial coding to make thematic connections in the data. This analysis produced a number of thematic areas where various conditions, attributes or influences within the cities' institutional context were affecting the response to water scarcity (see Table 4). Thus, these represented domains in the urban water institutional context where dynamics were likely to be important in change processes. These domains were then ground-truthed using recent empirical

studies of system change in sustainable urban water management and sustainability sciences literatures, to test their credibility and transferability. A narrative about each city's water management experiences was then constructed, including any contrasting or conflicting storylines. These storylines were compared to written records, policy documents, newsletters, research reports, journal papers, and media articles to procedurally challenge explanations (Stake, 1995) by seeking corroborating and/or contradicting evidence or accounts. Narratives were documented in case context reports and sent to interview participants for feedback, as a member checking validation measure. Review by fellow urban water scholars provided a peer review validation.

Table 1
Institutional context mapping method, Phase 1 - Case context gathering

Data Collection				***Data analysis***	***Data reporting***	***Validation***		
	Participants/sources						**Participants**	
	Perth	*Adelaide*	*National*				*Perth*	*Adelaide*
Semi-structured interviews	10	12	4	Axial Coding	Narratives of domains of change	Peer Review	1	4
Document analysis	41	29	12	Procedural challenges to explanations	Narratives of domains of change	Member Check	4	4

2.2.2. Phase 2: Identifying the institutional setting

This phase sought to describe the institutional setting shaping each city's drought response, by identifying the 'rules-in-use' (Ostrom, 2005) embedded in practitioner's experiential knowledge. While this tacit knowledge can be difficult to access, Ambrosini and Bowman (2001) argue that by providing time for individual reflection around a practically based question, and using a focus group approach to generate discussion, an understanding of conventions, norms, assumptions, and underlying decision logics can surface. The workshops were therefore designed to generate these reflexive activities and consisted of:

Activity 1: Individual reflection on two broad questions: What helps you get your job done? What can hinder you achieving your job? Participants documented these influences on colour coded 'post-it' style notes.

Activity 2: Focus group discussion to collectively reflect on insights from the first activity. These discussions sought to corroborate influences, identify prominent ones, and elaborate on their effect on day-to-day activities and decisions. Discussions were audio recorded, and documented on a whiteboard.

Activity 3: Group activity to map these influences, identifying what effect they had on water management practice, and any connections between them. This activity used a concept mapping approach (Petrucci and Quinlan, 2007) to visually capture these discussions on a whiteboard. The 'action situation' model of the IAD Framework (Ostrom, 2005) provided as a generic model of collective action to map the influences practitioners had identified against. Whiteboards were photographed after the session, and the discussions were also audio recorded.

The maps from workshops were aggregated and organised using concept mapping techniques to describe key influences affecting the practice of water management and the relationships between them. Recorded discussions and participant's individual reflections were drawn on in the construction of these maps, and any conflicting influences were represented. These maps were used as a basis for discussion in interviews with key informants, as a member checking validation measure. Informants corroborated, expanded or offered contradictory perspectives on the results, which were captured in interview notes and added to the maps. These informants were identified in phase one. The final results of Phase 2 were institutional concept maps, noting the prominent dynamics and areas where system adjustments were being observed. An example map from Adelaide is illustrated in Figure 4. Within these maps, related clusters of rules-in-use were identified, which also aligned with the domains identified in Phase 1. These domains were found to be similar across both case studies, providing internal validation of the data.

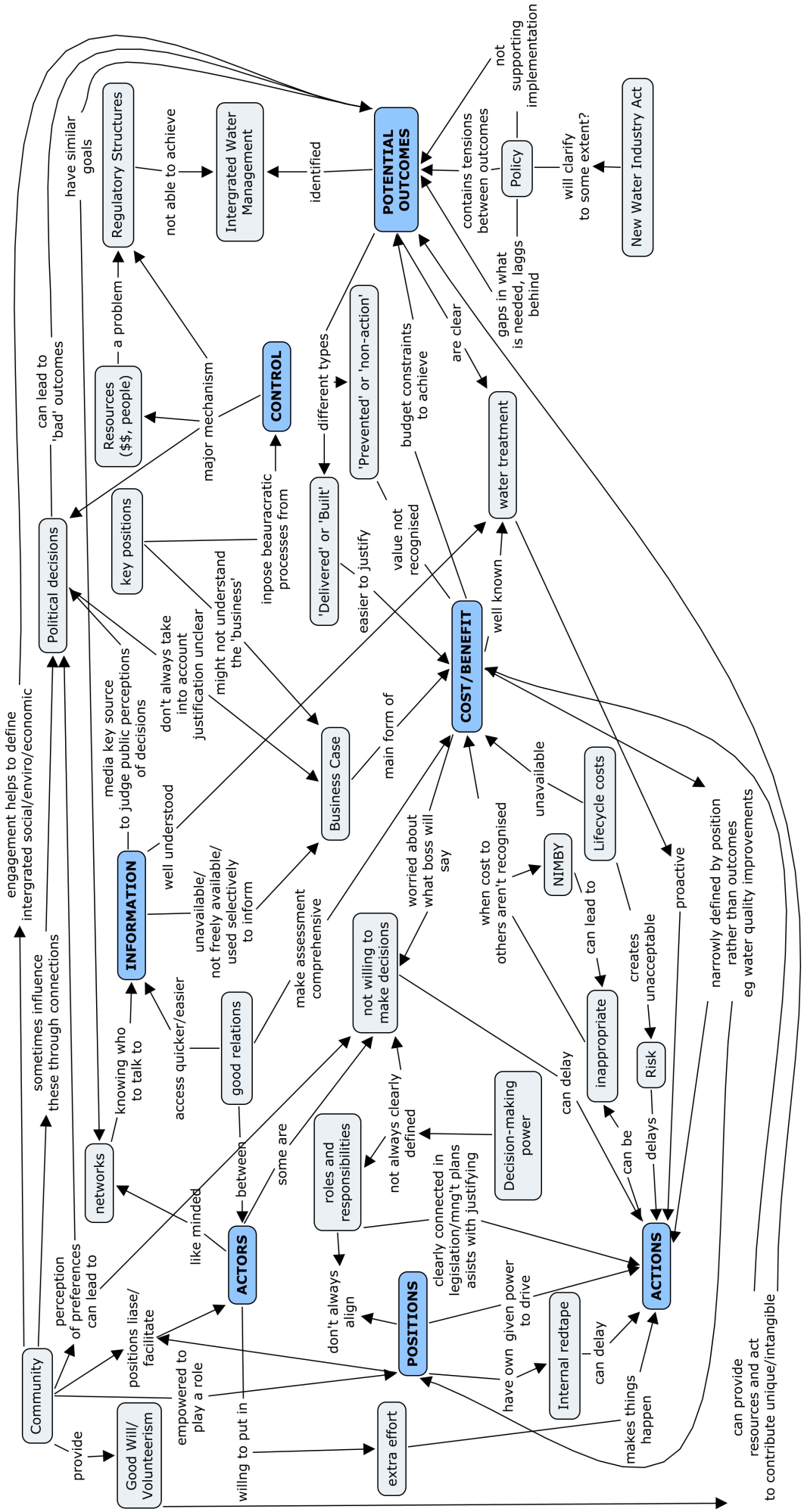


Figure 4
Example concept map of institutional dynamics.

Table 2
Institutional context mapping method: Phase 2 - Identifying the institutional setting

Data Collection			***Data analysis***	***Data reporting***	***Validation***		
	Participants/Sources					**Participants**	
	Perth	*Adelaide*				*Perth*	*Adelaide*
Workshops	3 maps 21 participants 3 audio recordings 136 reflections	2 maps 12 participants 2 audio recordings 58 reflections	Concept mapping	Combined conceptual map	Member check	9	4

2.2.3. Phase 3: Characterizing the institutional setting

The last phase was to characterise the dynamics that had been identified in the previous phases to understand their structuration of the institutional context. This was achieved by analysing the domains of change in greater depth, theoretically coding all the raw data according to the levels of institutional activity and institutional work described in the analytical framework. This produced a picture of the activities of actors at different levels of the institutional setting (operational and collective choice) and how these activities maintained or disrupted this context, and/or created new settings. Results were tabulated and an assessment was made as to whether the institutional dynamics were significant, limited or insignificant in their effect on the institutional setting. A significant rating was given where the institutional work had a notable effect on water management practices and/or formal rules and regulations. A limited rating indicated some institutional work, but not producing a notable effect, while an insignificant rating indicated a negligible impact on the institutional setting. This assessment was procedurally challenged using the case context report from Phase 1, and the concept maps and audio recordings from Phase 2.

Finally, drawing on all the available data, a narrative describing the dynamics within each domain was written. A conceptual map was constructed to show the relationships between the dynamics within and between domains, giving a visual account of the institutional context underlying each city's drought response. The institutional assessments, narratives and conceptual maps produced in phase three were documented in case reports and provided to all participants for feedback as a final validation of the results

Table 3
Institutional context mapping method: Phase 3 - Characterising the institutional setting

Data Collection			**Data analysis**	**Data reporting**	**Validation**		
	Participants/Sources					**Participants**	
	Perth	*Adelaide*				*Perth*	*Adelaide*
Semi-structured interviews	9	11	Theoretical coding	Institutional work assessments	Peer review	3	3
Workshops	136 reflections	58 reflections	Theoretical coding	Institutional work assessments	Member check	16	4
Workshops	3 audio recordings 3 maps	2 audio recordings 2 maps	Procedural challenges to explanations Concept mapping	Concept map of dynamics Narratives of dynamics			
Context Reports	1	1					

3. Results

During Phase 1, thematic areas in the data revealed institutional domains influencing the urban water sector's response to the drought. Domains were similar in each city (see Table 4), suggesting the institutional dynamics within and between these domains is important to enable system change in an urban water context. Given these domains correspond with factors found to be important for system change in the broader urban water and sustainability sciences literatures, they may also provide a tentative list of domains to use in the application of this institutional context mapping method in other fields. The second and third phases uncovered some of the manifestations of actor agency generating institutional dynamics, and the influence of these on the institutional setting. The resulting assessment of the dynamics are summarised in Table 5 and described in the commentary that follows.

The dynamics are presented as the types of institutional work (maintaining, creating, disrupting) being conducted within each domain, assessed as to whether there is a significant, low or insignificant, influence of each type of institutional work. While the analysis differentiated the two levels of institutional activity described in the analytical framework (operational and collective choice), for brevity, these levels have been aggregated in the results presented.

Table 4
Institutional domains of change

Attribute	**Description**
Professional Practices:	Skills, capabilities and technical knowledge resources for performing water management, and for deriving innovative approaches to this task. b, f, d, f, g, h
Identity and Mission:	Indicators of the purpose water management fills in society, articulated and communicated in a policy agenda subscribed to across Government. b, c, d, f, g
Beliefs and Cognitive Frames:	Interpretational filters of feedback, opportunities, emerging issues and pressures from the broader contextual environment the urban water industry is situated in. b, c, d, e, f, g, h
Governance setting:	Regulation, legislation, taxes, policies and other formalised incentive and disincentives that shape the industries operational environment. b, c, d, f, h
Public discourse:	Public debates and public perceptions of water management, as understood by practitioners. c, e, g, h
Inter/Intra-organisational relations:	The relationships and working culture of organisations across the urban water sector. a, c, d, e, g, h
Space for innovation and learning:	The culture of learning and experimentation across the sector, and the supporting structures provided by organisations and individuals for such activities. a, d, e, g, h
Strategic support:	Managerial support for reinterpretation of roles and responsibilities, and networks of frontrunners to disseminate and champion innovations. a, c, d, e, g, h

References: a (Bos and Brown, 2012); b (Penna and Geels, 2012); c (Farrelly and Brown, 2011); d (van de Meene et al., 2011); e (Westley et al., 2011); f (Pahl-Wostl et al., 2010); g (Gupta et al., 2010); h (Olsson et al., 2006)

Table 5
Assessment of institutional dynamics

3.1. *Professional Practices*

One of the key issues identified in this domain for both cities was access to information, knowledge and expertise of the 'water business.' In both cities problems accessing information to make and justify decisions and a lack of available information were generating a *maintaining* influence. However, in Perth most of the information and knowledge needed to evaluate novel water management approaches is held within a single organisation, with no obligation to share this information. This represents a significant *maintaining* influence, as the business case for alternative solutions cannot be made and compared to incumbent practices. In Adelaide, while there were noticeable knowledge gaps, information was shared between key organisations, enabling new practices to be developed (*creating* work). However, the ready access to information could also generate *disruptive* influences. In both cities, flexible interpretations of information could be used to further individual agendas, misinform public debate or key decision-makers such as Ministers. While corporate knowledge and expertise was valued in both cities, there were marked differences in the value of this knowledge, and ideas of professionalism. In Adelaide, this expert knowledge is often used to benchmark performance against other cities. Such thinking and an enthusiasm and willingness to 'go the extra mile' to improve on practices was recognised as a feature of good water management professionals. Both these features of professional culture in Adelaide help to produce *creating* work in this domain. In contrast in Perth, a predominant scepticism to developments and innovations from different operating contexts, and a tendency to seek tried and tested solutions to avoid unnecessary risk, is leading to strong *maintaining* influences.

3.2. *Identity and Mission*

A legacy from the pioneering culture that 'conquered' the dry western deserts for mining and agriculture, water engineering has a prestige in Perth that attaches pride to the profession. This strong sense of professional identity is generating a strong cognitive lock-in to traditional practices. In addition, lack of public recognition of water scarcity and a legacy of rights to access unlimited groundwater has led to little consideration of the value of water in Perth. Subsequently, there is no driver for a new vision for water management in the city under the expected drier future climate. Thus *maintaining* influences persist in this domain. The objective of urban water management is to find more water to meet demand. This mission is creating dissonance between the recognised ambit of organisations and likely future conditions leading to disparate, counter-productive activity across the urban water sector. In contrast, Adelaide, extracting water from Australia's highly politically contested Murray-Darling Basin river system, positions itself as being a responsible and sustainable user of water. Advocating for river health helps to increase its political bargaining power over water allocations. This identity as caretaker of the River Murray extends into the urban water management ideology for Adelaide, in particular to protect its highly valued beaches through best-practice catchment management. Long-term community engagement programs have generated strong, shared visions and aspirations for integrated water management in the city. Finding innovative solutions to balance supply needs with environmental protection objectives (*creating* work) has become a key political platform for the State Government, and a professional norm.

3.3. *Beliefs and Cognitive Frames*

In Perth the predominant framing of the water management problem has been an over-reliance on rainfall dependent water sources. A 'security through diversity' rhetoric (Pahl-Wostl et al., 2010) has led to new source development such as managed aquifer recharge and 'climate independent' seawater desalination. There is also an underlying assumption in current government policy that water is not a limiting factor to the state's future economic development. While there is dissonance between this worldview and professional interpretations and observations, this is largely at an individual level. An alternative problem frame has not coalesced across the sector to stimulate development of alternative solutions, or to challenge assumptions underlying current cognitive frames, and *maintaining* work is the norm. While in Adelaide, the solution of source development and diversification is the same as in Perth, the objectives of water management are multi-faceted; to protect the River Murray from continued over-extraction, safeguard the city's coastal environs and catchments, and supply water

to enable the city to develop and grow. These multi-objectives have generated *creating* work within this domain, driving Adelaide to consider multifunctional (rather than optimised and efficient) solutions such as water sensitive urban design, stormwater harvesting and enabling fit-for-purpose water use within the system through decentralised infrastructure.

3.4. Governance Setting

Perth's urban water sector is corporatised with a high level of regulation. This prescriptive setting provides a very strong *maintaining* influence, as the single water utility is disincentivised to innovate. This organisation's large shared of financial resources and asset ownership also stifle innovation by other organisations. While Adelaide's water sector is also corporatised, there are provisions for discretionary funding for 'public good outcomes' to be provided if the prescriptions of regulations require the water utility to act in conflict with such outcomes. With regard to water policy development, in Perth imbalances between policy-making powers and actual capacity and political support are resulting in a lack of an integrated, visionary policy agenda. Such circumstances support *maintaining* work by providing limited justification for breaking from current water management objectives and practices. In contrast, Adelaide's Government appointed an independent Commissioner for Water Security to oversee the development of a whole-of-government policy agenda for water management reform. The establishment of a dedicated water policy portfolio within Government also produced mechanisms for *creating* and *disrupting* work at the collective choice level.

3.5. Public Discourse

One of the marked differences between the two cities was the influence of public discourse on sectoral change. The lack of recognition of water scarcity in Perth, which has been suppressed by a government policy position, has generated little public recognition or debate to drive water reform onto the political agenda. Conversely in Adelaide, participants recounted how public opinion has demanded alternative options be put on the table (*disrupting* work), and consulting with the community assists managers to integrate and justify social and environmental objectives alongside the more easily quantifiable economic objectives (*creating* work). This domain had a profound influence on the institutional context, as it produced significant dynamics that influence other domains.

3.6. Inter/intra-organisational relations

Historic departmental and organisational restructures have segregated water professionals with already divergent professional philosophies; supply and sewerage services through engineering and environmental protection through 'soft' natural resource management solutions. Such reshuffles strain inter/intra-organisational relationships, as jurisdictional overlaps are negotiated and competition over resources ensues. In Perth this history, combined with a separate legislative framework and management philosophy for water services provision and water resources management, has produced a water sector operating in silos. While Adelaide's water sector has not been immune to similar tensions and turf wars, the smaller industry has required people to work together in the past, in many cases to pool resources in order to achieve shared goals. This has built trust and good working relationships in a networks of key champions. These individuals are able to make connections across the sector to enable collective action on water management issues, by conducting *disrupting* and *creating* work in other domains.

3.7. Space for Innovation and learning

Perth's prescriptive regulatory environment, distribution of resources and key assets, and limited forward looking policy direction, produces an environment unconducive to innovation and experimentation (*maintaining* work). In Adelaide, novel water supply solutions have been developed out of necessity to meet multiple responsibilities and objectives with limited resources. However, this innovation has been enabled by the ability to reinterpret organisational roles (less prescriptive regulation) and utilise assets in new ways (*creating* work). A political environment recognising scarcity, and therefore receptive to innovation, has diverted resources to develop and mainstream these alternative solutions.

3.8. Strategic Support

Perth's political sensitivity around water, strong professional identity and prescriptive governance setting filter down to influence individual decision-makers. These factors weigh

into actors' interpretations of costs and benefits, and the personal risk of supporting alternative choices. As a result, key decision-makers tend to rely on current practices to reduce their exposure to these risks, thus conducting *maintaining* work across the sector. Perth therefore suffers from a lack of frontrunners to champion novel approaches. In contrast, Adelaide's shared, multi-objective mission to use water responsibly, and network of key champions, has created supportive structures for moving beyond the safety net of formal roles, responsibilities, and decision-logics to explore new possibilities (*creating* work).

4. Discussion

If we consider these results within the basic propositions of transitions theory, significant drought has provided the landscape driver to prompt niche development around alternative water management practices. In Adelaide, a stormwater niche emerged; representing a significant change to traditional infrastructure solutions, while also meeting a range of water management objectives (fit-for-purpose supply, waterway and coastal health protection). This niche gained sufficient momentum to challenge the existing regime, leading to the acceptance of decentralised solutions. In Perth, the prominent niche is seawater desalination. While being a new technology in the water supply space, this solution represents a continuation of central supply augmentation to meet traditional water services objectives. Questions that arise from these results are; what are the institutional dynamics that could explain the different responses of these two cities; and what implications would this knowledge have for a TM intervention in these cases?

At the broadest level of analysis, the balance between *maintaining*, *creating* and *disrupting* work in the institutional context of each city is indicative of their different responses. Perth's dynamics are dominated by *maintaining* work in most of the domains (see Table 5). This serves to not only enact current formal institutional prescriptions, but dampens the emergence and influence of *creating* and *disrupting* work, as traditional practices are enforced. In Adelaide's institutional context, *creating* and *disrupting* work are predominant. However, the depth of analysis using this method provides a detailed insight into the system under transition. The ways this analysis can be targets to the knowledge needs of TM activities is now discussed.

4.1. Selecting frontrunners

As the key players in a TM intervention, the section of participants is a key to establishing a functioning transition arena (Loorbach, 2010). In Adelaide, the frontrunners of a potential TM arena are relatively clear. A network of people in positions of power and/or influence across a number of organisations/fields of water management was identified through the context mapping exercise. The mapping also revealed how these frontrunners use their strategic support capacity to promote new ideas, approaches, issues and ways of thinking, thereby meeting the criteria for selection discussed by TM scholars (Loorbach, 2007; Rotmans and Loorbach, 2010b). In Perth, due to the disincentives to introducing additional risk into practices (i.e. lack of *creating* and *disrupting* work in the governance setting and space for innovation and learning domains), people are unwilling to be perceived as 'risk-takers' who think beyond the bounds of current professional practice. This is evident in the lack of *creating* and *disrupting* work in strategic support and professional practice domains. It may therefore prove difficult to identify suitable participants and gain their commitment for a TM process in Perth. However, the analysis of Perth's institutional context could be deepened using this method to reveal where these disincentives for frontrunners lie, so that preparatory work can be done to enable the emergence of these actors. Thus, the institutional context mapping method can help to identify potential arena participants, and where and how to stimulate the innovative capacity needed in the system to support transitions arenas.

4.2. Framing the problem and creating the vision

A shared understanding of the current system and appreciation of the problems is the critical starting point for a transition arena. Adelaide has created its own vision for the future of the city in water and planning policies (Government of South Australia, 2010a, b). While a TM process provides an organised forum for these types of shared cognitive and normative developments, in Adelaide these *creating* and *disrupting* influences were generated by the public discourse domain. A history of consultative catchment management enabled informed public discourse to generate new

normative understandings and shared cognitive frames for water management objectives and practices. Such public debates influenced policy and decision-making, legitimising *creating* and *disrupting* work in other domains, such as the space for innovation and learning, professional practices, governance setting and strategic support. In Perth however, the process of problem framing and envisioning could be expected to be problematic for a number of reasons. Firstly, the lack of transparency about water scarcity provides little *creating* and *disrupting* influences to legitimise the reframing water management problems. Secondly, participants would likely have disparate understandings of water management problems and solutions due to the lack of reflexive cross-sectoral forums to consider these underlying assumptions (i.e. *creating/disrupting* work in beliefs and cognitive frame domain). Lastly, with historic tensions between some key organisations in Perth, organisational bias and lack of trust would need to be overcome before the type of productive discussion and debate required in the transition arena could occur (creating work in inter-organisational relations). Thus this context mapping reveals the assumptions and cognitive/normative dissonance in the system as part of problem framing and envisioning activities. It may also help to design productive forums by targeting problematic areas for collaboration.

4.3. Developing pathways and agendas, and designing experiments

The most critical phase of the TM cycle for functional knowledge of the system comes when pathways to the vision are developed, agendas to progress toward these are strategized, and experiments are designed. Inter-organisational relations and past network activity have built an appreciation of the operational context (with its constraints and opportunities) in Adelaide. This pooled knowledge of professional practices and system influences generates strategic support within a potential arena. Each participant has a working knowledge of the implications of, risks to, and contributions other participants can make toward experimentation and transition agendas. This enables strategic, coordinated actions to be formulated for the agenda. Thus in Adelaide, a potential TM arena has access to the wide range of resources, knowledge, status, political contacts, finances and institutional structures needed to design the activities behind the transitions experiments and agendas. That the stormwater harvesting niche has already infiltrated the decision-making of the regime (having been included in policy targets) attests to this capacity existing in Adelaide. Perth's capacity for developing and implementing these systemic TM instruments are very different. With inter-organisational relations strained, the trust to share this type of 'insider' information would need to be developed before *creative* experiments and potentially *disruptive* agendas could be formed and committed to. New relationships would be tested as arena participants discovered how to work together and were challenged by the *maintaining* work of the regime. It may, therefore, take time for Perth participants to learn how to align the resources available to them to design experiments and agendas. Having the structural as well as functional picture of the institutional context provided by this mapping method can help arena participants to design systemic TM instruments and align them to leverage change in the system. It can also help identify where capacity of the arena to conduct such activities might be built.

4.4. Implementing and monitoring the transition

Identifying where and how to apply TM interventions through windows of opportunity and monitoring progress, relies heavily on a detailed understanding of the system. In Adelaide, this analysis has traced how members of the stormwater niche mobilised to develop new technologies (*creating* work in professional practice) and connected these solutions to public discourse advocating multi-purpose solutions (*disrupting* work in beliefs and cognitive frames) to prompt change in water policy (*disrupting* work in governance setting domain). This mobilisation has been enabled by *creating* institutional work in strategic support, inter-organisational relations, and space for innovation and learning domains. In contrast, the space to innovate water management practice in Perth is limited by the strength of *maintaining* work, particularly in the governance setting and strategic support domains. While beliefs and cognitive frames are being challenged and altered through dissonance between professional knowledge and experience, this is largely at an individual level. Thus *creating* and *disrupting* work is not significantly influencing the sector as a whole. As a result, current professional identity and agreed objectives for water

management remain unchallenged or unquestioned. This situation, coupled with limited public debate around water management (i.e. limited *disrupting* work in public discourse domain), provides no driver for envisioning a new water future for the city, or the investment and development of alternative water management solutions. Finally, the lack of *creating* and *disrupting* work in the inter-organisational relations and strategic support domains provides a restricted capacity to effectively advocate for such envisioning and experimentation, progress a transition agenda or address the significant barriers to change in the governance setting.

In understanding these transition storylines through the dynamics of their institutional contexts, this analysis framework and institutional context mapping method provide a powerful tool for TM. Through these results we can see that these cities would require different forms of intervention to progress the transition of urban water management. In Adelaide, the emergence and uptake of stormwater harvesting testifies to there being sufficient *creating* and *disrupting* work to support a TM process. However, Adelaide's lack of *maintaining* work may indicate a TM process would be better targeted at identifying the institutional dynamics producing innovation and learning, to institutionalise these into new forms of governance to support these capacities into the future. The analysis of Perth suggests that a TM intervention targeted towards a system-wide transition would be unsuccessful, given the lack of *creating* and *disrupting* work in a number of the domains needed to support a TM arena; in particular the lack of productive relationships across organisations in the sector, the disincentives to innovative thinking and risk averse professional culture. These results suggest a TM intervention in Perth may need to be targeted at developing greater *creating* and *disrupting* influences in some of these domains, to provide base conditions for a TM cycle. This may include developing inter-organisation relations through collaboration on low-risk projects, and emphasising reflexive activities to start to jointly examine beliefs, cognitive frames, and professional identity underlying management practices. It may also need to involve opening up Perth's water management challenges for public discussion and debate to; understand how the Perth community values water; identify and integrate the services it needs to deliver (supply, waterway health, amenity and recreation opportunities etc.) and agree how best to manage the resource to achieve these objectives. This would provide a stronger starting point for a TM intervention, by generating *creating* and *disrupting* work in a number of domains to open the system to change.

5. Conclusion

The analysis of institutional dynamics behind these two cities' response to a significant landscape driver has revealed that an understanding of the institutional context is critical for planning appropriately targeted, context specific TM interventions. Understanding actors' capacities for institutional work in various institutional domains appears to be a useful way to diagnose where and how a TM intervention in the system could most effectively drive and steer towards a sustainability transition. These results suggest this method of institutional context mapping and could be beneficial to TM in a number of ways. Firstly, as a screening test to inform TM process design and preparatory strategies by identifying what dynamics exist and thus how the system is functioning (expert preparation). Secondly, this tool could help to generate successful deliberative dynamics in arenas by providing a more robust way to collect and apply participants' tacit knowledge and identify the distributed powers of participants and how they can be pooled to progress transition agendas (strategic/tactical clusters). Thirdly, the method offers a way of targeting the intervention points that transition pathways and experiments may need to utilise; by identifying the way power is vested in the institutional work of actors (operational cluster). Finally, this institutional contextual mapping tool offers a way to represent the system (visioning) in a dynamic way for monitoring and evaluation (reflexive cluster). Overall, this mapping tool allows TM to be more cognisant of the contextual conditions of a transition. Further work to test the identification and explanatory power of this analytical framework, and refine the mapping method appears warranted. In particular, application to further empirical cases of transition, backlash and breakdown trajectories, and a range of TM processes, would help to confirm and develop the heuristic capabilities of the tool. In conclusion, using an institutional perspective as the basis of the analytical framework of this study has shown the potential to address key knowledge

gaps in the scholarship, how different actors come together to work on a common problem in a specific context, and how actions can be aggregated to guide transitions by strategically generating systemic change dynamics.

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CHAPTER 6: EXTENDING THEORY

6.1 PUBLICATION FOUR: PROPOSITIONS FOR A THEORY OF INSTITUTIONAL ADAPTIVE CAPACITY

This section consists of the publication:

- Bettini, Y., Brown, R.R. and de Haan, F.J. (under review). Propositions for a theory of institutional adaptive capacity. *Global Environmental Change*.

This publication provides the results that meet Objectives 4 and 5 – to *contrast and understand the mechanisms of adaptive capacity within urban water institutional dynamics,* and *to identify and analyse the role actors play in institutional adaptive capacity* respectively. The publication includes a description of the methods used in Phase 3 of the research. This publication also demonstrates the contribution the thesis makes to adaptive capacity scholarship, thereby fulfilling the aim – *to extend theoretical insights on adaptive capacity.* These points are detailed below.

6.1.1 Method

This publication outlines the analysis method used to conduct Phase 3 (Compare).

6.1.2 Results

Phase 3: Compare. This publication presents the results against Research Objective 4 - *to contrast and understand the mechanisms of adaptive capacity within urban water institutional dynamics*. The paper reports the institutional dynamics identified in the case studies, and identifies the key configurations of these dynamics that provided the mechanisms for each city's response to water scarcity. These key configurations revolved around activities in the system relating to; information, feedback and learning; translating ideas to actions; and implementation and agency.

The publication also describes the various activities actors were conducting to form these configurations of institutional dynamics, and examined how the institutional system empowered or disempowered actors to conduct various types of institutional work, in order to address Objective 5.

6.1.3 Contribution to scholarship

This publication reports the contribution this research makes to adaptive capacity scholarship, outlining the finding that a capacity to adapt involves three forms of capacity; to learn, to decide and to act.

The publication then outlines how these forms of capacity are shaped by the dynamics within the institutional system; formed by its structural conditions and the institutional work conducted by its actors. The publication also injects a temporal aspect by using the Adaptive Cycle and proposing the different forms of capacity and their underlying institutional conditions at each phase of the Adaptive cycle (Lock-in, Crisis, Reorganisation, Stabilisation).

DECLARATION FOR THESIS CHAPTER 6.1

Declaration by candidate

In the case of Chapter 6.1, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Formulation of the research problem; interpreting the literature; positioning the research in this context; data collection, analysis and interpretation; writing	90%

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Brown, R.R.	Formulation of the research problem and context of the research in the wider literature, revision of writing	n/a
de Haan, F.J.	Formulation of the research problem, interpreting the literature, positioning the research in this context, and revision of writing	n/a

Candidate's Signature		**Date:**

Declaration by co-authors

The undersigned hereby certify that:

1. the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors;
2. they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
3. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
4. there are no other authors of the publication according to these criteria;
5. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
6. the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	School of Geography and Environmental Science, Monash University

Signature 1 **Date:**

Signature 2 **Date:**

Propositions for a theory of institutional adaptive capacity.

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Key Words:

Adaptive capacity, institutions, transformation, water management

Abstract

The concept of adaptive capacity is widely held as a key mechanism for system resilience and transformation. Yet the depth of knowledge extends to broad conditions or principles that may lead to its emergence. There are two key questions to understanding this system condition and how it might help address sustainability challenges: What and how do capacities combine to produce adaptive capacity? And when and how can they be utilized to enable system adaptation? This paper addresses these questions by exploring temporal and agency dimensions of adaptive capacity in practice. An analytical framing of adaptive capacity through the lens of institutional dynamics is used to examine empirical cases of systemic change in an urban water management context. The study found that three forms of adaptive capacity appear critical for adaptation: the ability of a system to learn, to decide and to act. Further, the use of an institutional lens provided insight into the types of dynamics and their underlying forms of agency that generate these forms of capacity. While further research is required, this study has produced theoretical propositions for further validation and refinement on i) the role these three forms of adaptive capacity take in system adaptations, and ii) the key institutional dimensions (domains, dynamics and agency) conducive to the emergence of forms of capacity.

1 Introduction

The last decade has shown an increase of scholarly focus on the social dimensions of global change (Janssen and Ostrom, 2006; Vogel, 2006). Researchers have turned to governance (Folke et al., 2005; Huitema et al., 2009; Loorbach, 2010), institutions (Gupta et al., 2010; Ostrom, 2005; Sandström, 2009) policy and decision-making processes (Huitema and Meijerink, 2009; Polasky et al., 2011), social learning (Pahl-Wostl et al., 2007; Reed et al., 2010) and social innovation (Biggs et al., 2010) as new disciplinary perspectives to explore the sustainability challenge. There are many complementarities between these perspectives, but a predominant concept drawn on is that of adaptive capacity (Brown and Westaway, 2011; Engle, 2011); the coping capacity of a system to respond to stressors (Chapin et al., 2010; Yohe and Tol, 2002). Adaptive capacity is increasingly cited as a key ingredient to enable human society to adapt to the complex and uncertain conditions the future presents (Chapin et al., 2010; Gupta et al., 2010; Huitema et al., 2009). Engle (2011) notes that this potential stems from the connotation that *capacity* is a property that can be harnessed. It is therefore of relevance to decision-makers and more readily applicable to policy interventions (Engle, 2011). Others recognize the potential of the concept to engage social actors in change processes, by providing an action-orientated understanding of adaptation (Eisenack and Stecker, 2012), as a basis for sustainability decision-making (Polasky et al., 2011), and a connector for various disciplines (Brown and Westaway, 2011; Janssen and Ostrom, 2006). However, no firm understanding or explanation the concept has been developed (Gallopin, 2006; Hinkel, 2011) and the frameworks available to research and assess adaptive capacity are focused on characterization (Gallopin, 2006; Hinkel, 2011). These tools produce static benchmarks, identifying the presence and absence of suspected determinants of capacity at a given point in time (Engle, 2011; Hinkel, 2011).

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Engle (2011) argues this originates from the concept's use in vulnerability assessment. Modelled on risk management, these assessments identify factors of exposure and sensitivities to various risks, focusing on the identification and measurement of capacity to reduce vulnerability through indicators (Yohe and Tol, 2002). As Hinkel (2011) argues, a focus on indicators is problematic, as it risks disguising the diversity of problems and influencing factors at the local level through aggregation. As such, this approach to studying adaptive capacity offers little understanding of the process of adaptation, how capacities combine to produce system change and therefore, cannot inform initiatives to increase adaptive capacity (Brown and Westaway, 2011; Smit and Wandel, 2006). Recent work has sought to address this issue by examining adaptive capacity in decision-making processes (Park et al., 2012), institutional design (Gupta et al., 2010; Huntjens et al., 2012), action-oriented studies looking at preparedness for change (Engle, 2012), and actor-orientated studies seeking how to utilize adaptive capacities (Brown and Westaway, 2011; Eisenack and Stecker, 2012). Eisenack and Stecker (2012) argue that an action-orientated perspective (as opposed to a systems-orientated view) can provide analysis frames capable of assessing adaptation as actions. However, this theoretical lens risks missing the broader system conditions and drivers that impact on actor's abilities to exercise their adaptive capacity. Within the literature, there has been a shift in focus of seeing adaptive capacity, not as a system condition, but as a dynamic system state; capacities are only adaptive if they can contribute to system change. These arguments represent growing calls in the adaptation/global change literature for scholarship on adaptive capacity to move toward theories and models (Gallopin, 2006; Hinkel, 2011; Huitema et al., 2009; Smit and Wandel, 2006), to understand relationships between determinants and processes of adaptation, and the outcomes they produce in various contexts and at a range of scales (Nelson et al., 2007). Thus, studies are needed that explore the relationships between the determinants of adaptive capacity, within the dynamic context of adaptation, in order to begin to explain how 'adaptations and adaptive capacities work' (Smit and Wandel, 2006: 289).

This paper seeks to take-up this research agenda by developing a set of theoretical propositions for adaptive capacity. Firstly, adaptive capacity is framed within the process of adaptation to provide a temporal dimension to understanding the concept and the role it plays in adapting systems. Secondly, by using an institutional perspective to understand the socio-political dynamics of systems, the agency behind adaptive capacity mechanisms and actions can be captured. A method for identifying and mapping these dynamic institutional conditions is then developed. The approach is then applied to empirical cases of urban water systems in flux, to begin to unpack the dynamic process of adaptation and the role of adaptive capacity. Consequently, empirically based propositions for further theoretical development are drawn from these results. In taking up the challenge to provide a stronger epistemological base for adaptive capacity (Eisenack and Stecker, 2012; Gallopin, 2006), and using an institutional lens to do so, the paper promotes further research to generate greater prospects for implementation of adaptive governance.

2 Defining adaptive capacity

The concept of adaptive capacity has roots in organizational theory, ecology and anthropology (Engle, 2011; Gupta et al., 2010; Janssen and Ostrom, 2006) but has emerged predominantly from adaptation studies in the social-ecological systems literature (Yohe and Tol, 2002). Its definitional nuances (de Haan et al., 2011; Janssen and Ostrom, 2006) and relationships to other adaptation terms pose potential barriers to further scholarship (Eisenack and Stecker, 2012; Gallopin, 2006). Many authors have made attempts to reduce this linguistic confusion (Brown and Westaway, 2011; Engle, 2011; Gallopin, 2006; Janssen and Ostrom, 2006; Nelson et al., 2007; Smit and Wandel, 2006; Walker et al., 2004), and this paper does not seek to duplicate this work. Instead, to further application of adaptive capacity to meet global sustainability challenges, this study seeks to explore what role adaptive capacity plays in the adaptation process, and how it can be enabled and utilized. To these ends, a working definition of adaptive capacity is put forward which deals with the two key issues for realizing adaptation, process and agency; what is the result or outcome of system adaptation and how is this produced (what skills/knowledge/resources/strategies combined to form capacity to produce these results)?

2.1 Clarifying adaptation

Definitions of adaptive capacity diverge in the literature in relation to the two commonly held forms of adaptation, resilience and transformation. Both denote systemic change, but depart on the question of whether the functional purpose (objectives) of the system remains constant or are transformed.

Resilience is to be able to change the way a system is structured, but the overall objectives of the system remain unchanged (Walker et al., 2004). A system is resilient because it can absorb shocks and perturbations from the external operating environment without significant loss of results (Berkes and Folke, 1998). In contrast, a transformative adaptation involves altering the system so it meets fundamentally different objectives (Walker et al., 2004). The structure *and* functional purpose of the system is reconfigured to realigning the outputs to suit new operating conditions. Some authors are ambiguous when it comes to the differences between these two change processes, and attribute this ability to be transformative to a resilient system (Folke et al., 2005). Definitional nuances aside, both forms of change are legitimate, as sometimes incremental adjustment to maintain resilience is preferable to large-scale costly system transformations (Huitema et al., 2009; Park et al., 2012; Walker et al., 2004). Conversely, there can be opportunity costs to pursuing a resilience strategy for too long (Huitema et al., 2009), and scholars note the phenomenon of lock-in when the system becomes less cognizant of its operating conditions in the pursuit of its functional purpose (Walker, 2000). Scholarly discourse on adaptive capacity concedes that it has a role in achieving both system resilience and transformation (Folke, 2006; Walker et al., 2006). However, without clarity on the nature of these two forms of adaptation, it is difficult to trace the processes that led to these outcomes, in order to determine what types of capacity within the system are causally linked. From an empirical standpoint, it also makes it difficult to recognize adaptive capacity in practice. This paper adheres to the distinction between resilience as *resisting* fundamental change and transformation as *necessitating* fundamental change, so that questions of how adaptive capacity contributes to differentiated forms of system change can be explored. We argue using these two distinct forms of adaptation provides analytic scope to understand adaptive capacity, by encompassing a wide range of systemic changes, and providing a means of comparing different forms of adaptive capacity within them. In addition, understanding when to pursue system resilience, and when to transform, are important pragmatic questions that need to be addressed.

2.2 Clarifying capacity

Despite definitional confusion, there are some consistent determinants of adaptive capacity recognized in the literature. Through a comprehensive bibliographic and consultative process, Gupta and colleagues (2010) described these determinants as; variety in problem frames, actors, levels, sectors, and solutions; learning capacity in the form of trust, reflexivity, the acceptance of doubt and failure, and institutional memory; capability for autonomous change through access to information, and space for improvisation; leadership in various forms; resources including financial, human and authority; and governance that is supported (legitimate), equitable, responsive and accountable. These determinants combine to create responsiveness in the system to internal and external feedback and the ability to adjust the system structurally (to become resilient) or to change its functional purpose (to transform). However there appears to be a divide in the literature as to whether the properties themselves are adaptive capacities, or the combination and deployment of them represents adaptive capacity. In other words, does adaptive capacity include the skill to utilize various system characteristics and abilities? To avoid the need to create another term for the process of agency that realizes adaptation, the use of adaptive capacity here includes both the skills and resources needed to adapt, and the access, power and capability to harness and combine system attributes into adaptation processes. Thus in this light, we define adaptive capacity as:

The ability to mobilize and combine different capacities within a system, to respond or anticipate economic, environmental or social stressors, in order to initiate structural or functional change to the system and achieve resilient or transformative adaptation.

Within this definition is an emphasis on agency – ability, mobilise, respond, anticipate, initiate. This is specifically targeted to the purpose of generating

insights on utilizing these qualities to enable adaptation to global change. It therefore differs on this point of agency from the use of the term in other disciplines. For example in ecology, adaptive capacity may only eventuate through the emergent dynamics of complex systems, and not as a purposive intervention.

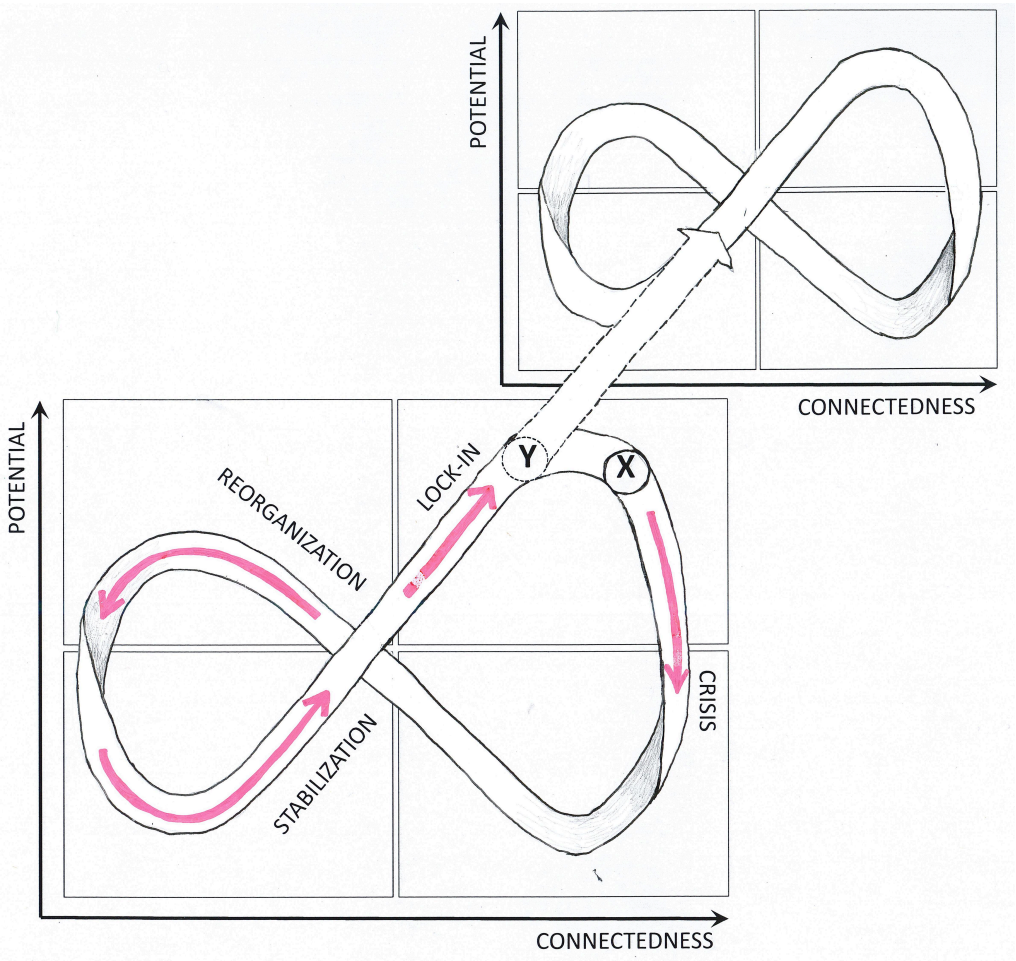
3 Dynamic framing of adaptive capacity

While there is general consistency in the determinants of adaptive capacity in the literature, further explanation as to how these capacities combine to enable system resilience or transformation, and what specific capacities are needed under particular contextual conditions, have not reached a depth to enable utilization of adaptive capacity in practice. What are the contributions of the variety of determinants to achieving adaptive capacity? Do they need to be present all the time? Or are there periods when some are required more than others? And how can they be identified and employed? To answer these questions, adaptive capacity needs to be framed beyond a condition or static property of a system. An understanding of how adaptive capacity changes through time, and the variety of ways it can be employed to achieve system change are needed. This section discusses these temporal and agency dimensions by drawing together established theories of system change.

3.1 Temporal dimension

The Adaptive cycle (Figure 1) from the social-ecological systems literature provides a frame of reference for understanding adaptive capacity within the process of adaptation (Holling, 2001; Holling and Gunderson, 2001). This Cycle provides a well-established intellectual tool for exploring the iterative process of system change. While developed in studies of ecological systems (Holling, 1973), it has been employed for social research using a variety of perspectives (Biggs et al., 2010; Young, 2010). A hypothetical example of urban water management in response to drought is used to illustrate the description of the Cycle.

Figure 1
Adaptive Cycle



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In this conceptual model of adaption, a system progressively increases its efficiency in achieving potential (front loop). However, it eventually becomes locked-in to this way of operating, due to increasing connections in various structural elements of the system (e.g. water infrastructure, legislation and regulation, professional practice conventions, public perceptions and expectations). At a point in time (X) the system begins to decrease potential. This may be because either the system is not longer structured appropriately, or the outcomes it produces are no longer tenable, as a result of changes in its operating context (e.g. during drought, there is not enough water to fill dams, or providing reliable, cheap water for any type of use is no longer possible). The system enters a crisis phase, when connectedness decreases and potential is no longer achieved (e.g. water supplies cannot meet water demands and some water uses like garden watering need to be sacrificed). In response, new ways (connections) to deliver outcomes (achieve potential) are developed and tested (e.g. desalination technology). The structure of the system (e.g. organizational responsibilities, problem frames, management paradigms, physical infrastructure) is then reconfigured in the back loop, to adopt or mainstream new solutions (e.g. new regulation for desalination is implemented). The system then flips into a phase of stabilization, where new solutions are supported by new system structures (increasing connectedness), and outcomes are once again delivered with increasing efficiency (potential increases) (e.g. desalination comes online and water demand is met). This represents a resilient adaptation, as the potential the system strives to achieve remains the same (water supply to meet demand). In a transformative response, at some point (Y) the system shifts to produce a different potential, i.e. its functional purpose changes (e.g. water demand is changed through new values and norms). This model provides a means of situating different forms of adaptation in a continual cycle of change. By exploring what contribution adaptive capacity makes to determining and achieving potential, and creating or disbanding system connectedness, the role different capacities play in adaptation can be understood.

3.2 Agency dimensions

To balance an ability to seek detail on the agency dimension of adaptive capacity, with an understanding of the contextual conditions, Gupta et al. (2010) have suggested that institutions provide a useful analysis unit for researchers. As foundational organizing structures in society, these formal and informal understandings, shared constructs and rules of conduct not only shape and guide actors behaviour and actions, but enable social actors to rally and respond to sustainability challenges through collective action. As Scott defines in his theory of New Institutionalism, (2008) there are three forms of institutions; cognitive, thought processes, frames and logics; normative, beliefs, cultures and behaviours; and regulative, rules, sanctions and rewards. Institutional work is a developing branch of institutional theory focusing on the ways actors express their 'agency,' and the affects of this activity on the way an institutional setting functions (Kraatz, 2011; Lawrence et al., 2009). It can therefore provide an agency dimension to adaptive capacity, by identifying the various activities and strategies of actors that change the way a system functions, and eventually lead to the institutionalization of that change (i.e. structural change). It is based on the premise that there are three types of institutional activity or 'work' that actors conduct;

- *Maintaining work:* are activities that serve to uphold current institutions. These can present barriers to changing inappropriate institutions, but they can also incorporate changes into pre-existing routines and patterns, and engage and socialize new actors into the institutional setting.
- *Creating work:* is about establishing new rules and new rewards and sanctions to enforce these rules. While the ultimate outcome of creative work is of a regulatory nature, there are significant normative and cognitive shifts which need to occur in the lead up to the establishment of new institutions.
- *Disrupting work:* involves undermining the social controls that lead members to associate and comply with institutions. It may involve directly attacking compliance mechanisms or covertly manipulating the boundaries of institutions by redefining or problematizing cognitive or normative understandings of these boundaries. These activities challenge the relevance of current

institutions and open them up to review and reconfiguration.

Certain types of institutional work focus on a specific form of institution; these are described in Table 1. This connection between types of institutions and the dynamic mechanisms by which they change offers greater analytical depth to explore what impact institutional work is having on the institutional setting (system), thus where agency for adaptive capacity lies.

These temporal and agency dimensions provided by the literature create a dynamic, agency-orientated framing of adaptation, through which better understanding of adaptive capacity can be explored. These theoretical lenses provided an analytic framework to study empirical cases of system change, in order to explore the questions of where, when and how adaptive capacity contributes to adaptation processes. A method to identify, describe and explore adaptation using this dynamic institutional framing of adaptive capacity is described in the following section.

Table 1
Institutional dynamics and mechanisms of institutional work (Adapted from Lawrence and Suddaby, 2006)

	Creating	Disrupting	Maintaining
Cognitive: *Thought processes, problem frames, decision logics*	**Mimicry:** Associating new practices with taken-for-granted practices in order to ease adoption **Theorizing:** Development and specification of abstract categories and chains of cause and effect **Educating:** Teaching actors in skills and knowledge necessary to support a new institution	**Undermining assumptions and beliefs:** Decreasing the perceived risks of innovation by undermining core assumptions and beliefs	**Embedding and routinising:** Actively infusing the normative foundations of an institution into day-to-day routines and practices
Normative: *Beliefs, assumptions, norms of behaviour, cultural constructs*	**Constructing identities:** defining the relationship between an actor and their operational field **Changing normative associations:** re-making the connections between practices and the moral and cultural foundations of those practices **Constructing normative networks:** inter-organizational connections through which practices are normatively sanctioned and formation of a peer group for compliance, monitoring and evaluation	**Disassociating moral foundations:** Disassociating the practice, rule or technology from its moral foundation	**Valorising:** Providing positive examples that illustrate the normative foundation of an institution **Demonizing:** Providing negative examples that illustrate the normative foundation of an institution **Mythologizing:** Preserving the normative underpinnings of an institution by creating and sustaining myths regarding its history and relevance
Regulative: *Rules supported by rewards and sanctions*	**Defining:** Constructing the rule system that confers status, identity, defines boundaries or creates a hierarchy **Vesting:** Creating rule structures that confer rights **Advocacy:** Mobilizing political and regulatory support	**Disconnecting sanctions and rewards:** Disconnecting rewards and sanctions from a set of practices or rules	**Deterring:** Establishing coercive barriers to change **Enabling:** Creation of rules that facilitate, supplement and support current institutions, such as authorization or diverting resources **Policing:** Ensuring compliance through auditing, monitoring and imposing sanctions for non-compliance

4 Examining adaptive capacity

4.1 Research design

To look at a longitudinal problem like adaptation, a multiple case study design was employed. As Yin (2009) notes, a case study research strategy is applicable when the context of a phenomenon under study is critical to its understanding. Cases of potentially adapting systems would thus offer suitable sources of data, providing an understanding of the process of adaptation in the context of changes in their operating environment, through the system's response to these changes. By choosing cases driven by similar external conditions, theoretical replication in the research design provided the opportunity to seek tentative explanations of the role adaptive capacity and how it was generated, through the comparison of multiple cases (Yin, 2009). The recent experience of prolonged drought in Australia offered an opportunity for such a study. With reduced rainfall from as early as the 1970s, by 2006 the situation had reached a crisis point and forced a major rethink of how water security could be achieved in State capital cities. With relatively similar socio-political, cultural, environmental and water governance contexts, the differing responses cities took to respond to water scarcity provided an opportunity to explore adaptive capacity in practice.

As this research was exploratory, an emergent research design was employed so tentative findings could progressively focus results and explanations (Creswell, 2009). To maintain structure to this approach, three successive study phases were designed to contextualize, characterize and compare the case studies. This design enabled results of each phase to inform subsequent phases, and provided opportunities for internal validation. Specific data collection, analysis and reporting methods employed in each phase are described in sections 4.3, 4.4 and 4.5, and the results of each phase were validated using various member checking and peer debrief techniques (Creswell, 2009).

4.2 Case selection

To provide opportunities for theoretical replication between cases, and to provide robust insights on adaptive capacity, cases at different stages of the Adaptive cycle were needed. To select cases, initial scoping interviews were conducted with practitioners from five State capital cities working in water utilities, water and environmental departments and agencies, and practitioners from national water policy agencies and peak bodies (n= 30). The two cities of Adelaide and Perth were subsequently chosen, as they offered similar contextual conditions (water industry structure, infrastructure system, use of groundwater as a supply source, climatic conditions), while presenting contrasting adaptation responses. Perth was selected as a case of Lock-in adaptation (top right quadrant of Figure 1 as its predominant strategy was 'source development' – supplementing centralized reticulated water supplies with increased groundwater extraction and seawater desalination (see Box 1). While Adelaide employed similar strategies, the city also invested in decentralized water supply solutions, progressing governance reforms (see Box 2). Given these responses, Adelaide's urban water system could be undergoing the Reorganization phase of the Adaptive cycle (to left quadrant of Figure 1). An overview of each city, a timeline and commentary of their response to water scarcity are provided below to illustrate these differing responses and justify case selection. This information was drawn from the initial scoping interviews (Perth; n = 10, Adelaide; n = 6), cross-checked through an analysis of policy documents, industry and consultant reports, media articles, scholarly papers and newsletters (Perth; n = 41, Adelaide; n = 29).

4.2.1 Perth

Perth is a city of 1.7 million people (Australian Bureau of Statistics, 2012a) inhabiting a coastal strip of south-western Australia. Winter dominated rainfall, hot dry summers (Australian Bureau of Meteorology, 2012) and sandy, porous soils make Perth one of the highest domestic uses of water in Australia (Water Corporation, 2009). Since the mid 1970s south-western Australia has experienced a decrease in rainfall (Australian Bureau of Meteorology, 2010), and inflows into Perth's dams have declined significantly (CSIRO, 2009). To meet demand, the city increased extraction of the region's extensive groundwater systems. However, monitoring has shown a decline in the main aquifers used to supply the city (CSIRO, 2009). Detail on the management and governance responses to water scarcity are summarized in Box 1.

Box 1.
Perth case study overview

1975 - 2000	50% reduction in inflow to surface water storages based on pre 1975 long-term average. Various demand management water restrictions implemented. Groundwater extraction is increased to meet supply demands.
1986-1993	Concept of Water Sensitive Urban Design (WSUD) emerges in research and guidelines for implementation are developed.
1996	Following national water reform and competition policy initiatives, the WA water sector is corporatized into a services utility (Water Corporation), water resources development and conservation agency (Water and Rivers Commission) and regulatory body (Office of Water Regulation).
2001 – 2010	Surface water storage inflows continue to reduce. Total inflow of 6.2GL for 2010 is lowest in a century long record.
2001	Seasonal water sprinkler ban introduced.
2003	State Water Strategy released. Sets broad agenda for sustainable water management, and acknowledged the need for governance reforms. Various education, research, industry engagement and rebate programs to promote water efficiency established.
2004	Kwinana recycling plant opens to supply fit-for-purpose recycled wastewater for industrial use. 'Security through Diversity' approach to water management adopted by Water Corporation. Includes plans for desalination, development of groundwater sources, and further demand management education campaigns.
2005 – current	Mining resource boom drives high economic growth and subsequent population growth and land development.
2005	Opposition looses State election largely on basis of water policy platform. 12 year catchment 'thinning' trials to increase run-off begin. Dedicated water policy agency, the Department of Water, is created.
2006	*A blueprint for water reform in Western Australia in 2006* released, providing key recommendations on governance reform. WA becomes signatory to the National Water Initiative. *Water Resources Legislation Amendment Bill* transfers many functions and powers for water management to the Minister for Water (administered by the Dep. Of Water). The Perth Seawater Desalination Plant, Australia's first, is bought online to supply 45GL of Perth's potable water supply.
2007	State Water Plan released. Provides strategic framework for water resources planning and management.
2008	Better Urban Water Management released. Provides guidance on incorporating WSUD into land development through State Planning policies.
2009	Water Corporation's water supply management plan, *Water Forever*, released. Plans for reducing water demand, increasing water recycling, and development of new water sources. CSIRO Sustainable Yields research finds that groundwater systems are experiencing stress.
2010	Significant water restrictions imposed. Three-year trial of Managed Aquifer Recharge begins.
2011	Water Corporation releases updated *Water Forever* plan. Emphasis on increasing recycling, desalination capacity and securing groundwater sources to offset current surface water supplies. The Southern Seawater Desalination Plant bought online, supplying 50GL of potable water. The WA Local Government Association develops an investment plan for the Swan-Canning Catchment, raising issues and options for drainage governance.
2012	Water services legislation is passed to cut red tape, increase competitiveness and ensure service efficiencies and standards. Relevant organizations sign partnership agreement to improve urban drainage management.
2013	The Southern Seawater Desalination expansion due for completion, increasing the city's desalination capacity to approx. 50% of its potable water supply needs. Governance reforms to water resources management legislative framework ongoing.

Perth's response to prolonged drought conditions has been characterized by its 'security through diversity' rhetoric (Werbeloff and Brown, 2011). Centrally reticulated surface and groundwater supplies have been augmented with desalination and increased groundwater extraction, supplemented by demand management and some experimental fit-for-purpose infrastructure.

Thus the management response has been dominated by a source development strategy. Other initiatives such as the creation of a dedicated water portfolio within Government, legislative reforms, a shift to integrate land and water management through the planning system, and urban catchment works and drainage governance to address water quality issues, have been second priority to the identification and development of new water supply sources.

Box 2.
Adelaide case study overview

1990's - current	Inflows to surface water storages reduce to approx. 65% of long term average. Inflows to Murray-Darling Basin system also reduced. City of Salisbury experiments with stormwater harvesting and aquifer recharge to maintain wetland health. Begins using harvested water for public open space watering, eventually expanding operations into a local government owned water utility supplying fit-for-purpose domestic and industrial water use.
1995	Following national water reform and competition policy initiatives, water utility corporatized (SA Water Corporation). Outsource major functions through private sector contractors. *Catchment Water Management Act* establishes regional management of water resources, with the provision of funding for catchment improvements through a levy. Drives significant community education and engagement activities.
1997 – current	A number of wastewater recycling projects progressively increase city's capacity to recycle 25% (as at 2012) of wastewater for non-potable reuse.
2003 – current	Range of water restrictions and education campaigns reduce domestic water consumption.
2004	*Natural Resources Management Act* replaces *Catchment Water Management Act*, representing an integrated approach to natural resource planning, protection, water allocation and management. Includes formal mechanisms for community involvement in catchment planning. SA a signatory to the National Water Initiative. SA signs Murray-Darling Basin (MDB) Water Agreement, a Commonwealth led initiative to reduce over allocation and improve the health of the Basin.
2005	Diversification of water sources discourse emerges in Government water planning strategy, *Water Proofing Adelaide.*
2006	Driest period on record experienced in late winter/early spring. Murray-Daring System experiences lowest inflows on record. Adelaide's water security is significantly threatened. SA Government mandates the installation of rainwater tanks on all newly built homes.
2008	Independent Commissioner for Water Security appointed. Tasked with producing a whole-of-government strategy for water security. Agreement on significant governance reform of the Murray-Darling Basin signed by relevant State, Territory, and Commonwealth Governments. Through this agreement SA secures greater storage capacity to capture Adelaide's full water extraction entitlement from Murray-Darling Basin system.
2009	Economic Statement of the South Australian Economic Development Board recognizes access to water as a limiting factor to the State's economic growth prospects. Capacity of the desalination plant to be expanded to 100GL, supplying approximately 50% of current potable water demand. $150 million investment from Commonwealth, State and Local Government to provide non-potable supplies through stormwater harvesting, with an interim target of 20Gl by 2013.
2010	*Water for Good* strategy for securing water supplies is released by Commissioner for Water Security. State Government Department for Water formed to take carriage of water policy and provide a focal point for integration of water management activities. *30 Year Plan for Greater Adelaide* released by the Dep. Planning and Local Government. Includes explicit objective to reduce water consumption in new dwellings.
2011	Adelaide Desalination Plant (ADP) comes online at 50GL/annum capacity.
2012	SA Water announces the ADP to be placed in 'standby mode' when sufficient, cheaper water is available. *Water Industry Act* introduced to open water services provision up to greater competition, with supporting regulatory and consumer protection mechanisms. Department for Water amalgamated into the Department of Environment, Water and Natural Resources.

4.2.2 Adelaide

Adelaide is a city of 1.2 million people (Australian Bureau of Statistics, 2012) stretching along the eastern coastline of the Gulf of St Vincent, and spreading inland to the Mt Lofty Ranges. Like Perth, Adelaide's climate is hot and dry in summer with winter dominated rainfall (Australian Bureau of Meteorology, 2012). However, limited surface water resources make Adelaide the driest capital city in Australia (The Office for Water Security, 2010). Like much of the south-east of the Australian continent, Adelaide's climate began to shift to drier conditions in the late 1990s (Australian Bureau of Meteorology, 2010). While the Adelaide region did not experience water scarcity till the mid 2000s, the city's major water source, the River Murray, had been experiencing record low runoff from 1997 (CSIRO, 2008). As an inter-jurisdictional, over-allocated and nationally iconic river system, the health of the River Murray generated nation-wide public discourse and political discussion on the fate of its water resources. Due to Adelaide's high reliance on the river for potable supplies, water management, inter-state politics and public engagement in water issues are influenced significantly by these national

debates. As such, Adelaide's management responses to the drought outlined in Box 2 have close ties to agreements and initiatives regarding the Murray-Darling Basin.

Adelaide's drought response was similar to Perth's in that a strategy of diversifying water sources was employed. However, the portfolio of options was broader in scope. Targets for water recycling and stormwater harvesting for aquifer recharge indicated a commitment to move these technologies beyond experimental alternatives to mainstream, decentralized supply system augmentations. In the same vein, the appointment of an independent Commissioner for Water Security, the progression of a legislative reform agenda, and the decision to place the city's desalination plant into 'standby mode' when conditions improved, suggested a drought response looking beyond the traditional water system and its service delivery goals.

While revealing, these contextual conditions do not provide a detailed description of why and how each city responded differently to water scarcity. Thus, further examination of the adaptive capacities behind these two cases would offer insights into the role of adaptive capacity in adaptation processes.

4.3 Study phase 1: Contextualising

Consistent with case study methodology, an understanding of the case in its context is critical to interpreting the case itself (Stake, 2008). Using a modified axial coding method (Strauss and Corbin, 1998), scoping interview transcripts were analysed to identify key drivers, influences, events, conditions and changes within the urban water sector of these cases (Perth, n = 10; Adelaide, n = 6). Through the coding process common themes were aggregated from the data. These represented domains within the institutional setting of each city where key adaptation activities were taking place, and similar domains emerged in both cases. The domains were crosschecked with empirical studies of system change in the global change literature to corroborate these findings and identify any gaps in data interpretation. These domains and their descriptions are listed in Table 2.

Table 2.

Domains of change in institutional setting

Domain	Description
Beliefs and cognitive frames	The values placed on water, aspirations to be achieved through its management, and the problem frames and other logics by which water management is conducted (e.g. risk perceptions)
Discourse	The informal discussions, debates and conversations that occur about water management and its issues. Distinction between 'in-house' professional discourse and more public debates, usually captured in the popular press.
Governance setting	The formal structures in place to manage water, such as legislation, organizations and their remits, and regulatory processes
Information	The information flows in the system. Includes access to and quality of information and performance monitoring and reporting. May also include information gaps and issues around interpretation and reporting of knowledge
Innovation and learning	The activities to experiment with new alternatives (be they technologies or new management approaches) and learning mechanisms that apply new knowledge within the system (as distinct from the information flows)
Organizational relations	The informal connections and interactions between key water management organizations, as distinct from their formal requirements for collaboration and consultation (e.g. as referral agencies on development applications). Encompasses the concepts of horizontal and vertical integration
Policy direction and development	The statement of intent. A collectively agreed direction, or process for determining a direction, for water management. May include a vision for the city, targets and objectives.
Professional capacity	The skills, knowledge, trust, networks, working relations and general workforce capabilities available for water management praxis
Strategic support	Various 'as needed' resources for driving changes to water management practice. Includes discretionary funding, the work of champions, and managerial or organizational support for innovations, political will, and community advocacy. These resources are distinct from Professional capacity, as they are injected into the system at various points to initiate, influence or drive change (purposively or inadvertently), as opposed to the stable, certain resources required to carry out water management (e.g. maintenance works budgets)

These domains were used to organize and focus data interpretation and reporting throughout the subsequent study phases, as they represented areas where practitioners had indicated important change (adaptation) influences on the overall urban water system were present, hence adaptive capacity was expected to be found. Narratives of these domains in each case were constructed from the interview data, and a document analysis corroborated these interpretations. Where discrepant accounts were identified, these were included in the narratives. This provided a holistic account of the context of each case (Creswell, 2009). Further detail of the Perth and Adelaide cases can be found in Bettini et al. (in press-a) and Bettini et al. (in press-b) respectively.

4.4 Study phase 2: Characterising

The data to inform this study exists, not in the management responses documented in Boxes 1 & 2, but in the tacit and experiential knowledge of urban water practitioners. Using techniques to draw out this type of implicit knowledge (Ambrosini and Bowman, 2001), workshops combining individual reflection, focus groups and conceptual mapping were utilized as a data collection method. Practitioners from water utilities, local government, State government water, environment and health departments, regulatory agencies, environmental management agencies, and consultants attended the workshops through an open invitation process (Perth, n = 21; Adelaide, n = 12). At each workshop practitioners first reflected individually on the factors or conditions hindering or enabling their work practice, documenting these influences.

A focus group discussion then confirmed and elaborated, or presented contrasting accounts of these influences, drawing out the norms, behavioural scripts, underlying beliefs, assumptions and cognitive frames, and some of the formal institutional constraints guiding practitioners in their day-to-day tasks. Finally, these influences were mapped on a whiteboard, drawing connections between these influences and beginning to identify the impact of these on the urban water system and the management responses that has been observed during the drought. Workshop discussions were audio recorded to aid interpretation and analysis of the data. Initial workshop data analysis was then discussed in semi-structured interviews with a different set of practitioners to validate, refine and add to the results (Perth, n = 9; Adelaide, n = 4).

Two methods were used to interpret data. Firstly, qualitative concept mapping techniques (Ambrosini and Bowman, 2001) were applied to the workshop data to identify and organize the key concepts illustrated in the maps, and show the relationships between them. These concepts aligned with the domains identified in phase 1, thus providing internal validation of these domains. A consolidated concept map of the dynamic connections and interactions occurring between domains within the institutional setting of each city was produced (Figures 2 and 3). Secondly, all available textual data were theoretically coded according to the concepts in the institutional framework described in sections 3.2. This identified the types of dynamics (maintaining, creating and disrupting) and the mechanisms of agency creating them (cognitive, normative and regulative), which connected domains and generated change within the institutional setting. A qualitative assessment of the relative influence of the different types of institutional work within each domain was then conducted. This assessment drew on all the available data to determine whether particular types of institutional work, generated within each domain, were exhibiting a significant, insignificant or limited influence on the institutional setting. This provided a snapshot of the dynamic influences present in each case, and along with the concept maps, provided an account of the dynamic processes of agency and change within the institutional setting of each case study. Narratives of these processes within each domain were constructed using the available workshop data and informed by the contextual information provided from phase 1. This provided a rich picture of the conditions *and* mechanisms underlying the adaptive response of each case study. These results, the concept maps and summarized narratives, are presented in Section 5.

4.5 Study phase 3: Comparing

The final phase of the research sought to qualitatively explore the institutional conditions and dynamics underlying adaptive processes, to reveal insights about adaptive capacity. Firstly, the institutional assessments of each case were compared to identify similarities and differences. Concept maps and narratives from phase 2 were then used to qualitatively explain these points of

similarity and difference, by investigating patterns of connections (configurations) between domains, dynamics (maintaining, creating, disrupting) within these configurations, and the institutional work (cognitive, normative and regulative) generating the dynamics. Further narratives describing how these configurations connected to the management practices, governance changes and other manifestations of system change identified in each case were then documented, drawing on all the available research data. Finally, using the results of the two cases of Lock-in and Reorganization, and drawing on the analytical framework described in Section 3, propositions were extrapolated to describe the possible institutional dynamics, institutional work, and forms of adaptive capacity within the Crisis and Stabilization phases of the Adaptive cycle. These configurations, narratives and propositions from this last phase of the research are discussed in Section 6.

5 Results: Cases of dynamic adaptive capacity

This section presents the results of the case analyses from phase 1 and 2 of the research. A concept map of each city's institutional dynamics is presented in Figures 2 and 3 respectively. These maps show the connections and linkages between domains within the institutional setting that were key to the management and governance responses documented in Boxes 1 & 2. A sample of the activities and strategies (institutional work) generating these institutional dynamics are then provided in Tables 3 & 4, evidenced by direct quotes from study participants.

5.1 Institutional dynamics

During the research workshops, an understanding of how informal institutional conditions interact and connect with formal management and governance arrangements was produced. These are illustrated in Figures 2 and 3, and provide a rich but non-linear description of Perth and Adelaide' drought response. In each map, short descriptions of the conditions within each domain are provided. To understand the influence of these domains, the relationships between them are described by the dominant dynamic (maintaining, disrupting, and creating). These relationships are further explored in Section 5.2, when the strategies and activities of various actors in the system (i.e. types of institutional work) are discussed.

Perth's institutional dynamics, as illustrated in Figure 2, were dominated by maintaining influences and activities. The sources of these dynamics could be attributed to conditions or activities within key domains of the institutional setting, encapsulated in the following statements:

- A corporatized governance system which segregates water management responsibilities, uses regulatory compliance as the key mechanism for service delivery, and prescribes water management objectives (Domains: Governance setting, Policy direction).
- Displaying problems with information and feedback flows, both within the industry to inform decision-making, and with regard to public transparency and accountability on water issues (Domains: Information, Discourse).
- Exhibiting historic tensions between key organizations and a lack of collaborative culture across the water industry (Domain: Inter-intra organizational relations).
- Demonstrating disincentives to innovation or promotion of new practices, and a professional aversion to risk-taking or challenging the status quo (Domains: Innovation and learning, Professional capacity, Strategic support).
- Viewing water as a highly politicized issue (Domains: Discourse, Strategic support).
- Containing disparate beliefs, values and problem frames between urban water practitioners, politicians and the public. (Domains: Beliefs and cognitive frames, Discourse).

The complex connections and influences of these domains can be traced through Figure 2. However, the prevailing outcome is an urban water management system displaying cognitive, normative and regulatory lock-in to traditional water management practices. This has provided institutional stability, producing a resilient response to the drought crisis. However, it has also produced an over-reliance on groundwater and expensive desalinated water, and little investment into scaling up alternative solutions. Furthermore, the suitability of the current system has not been openly considered, given the significant change in the operating context.

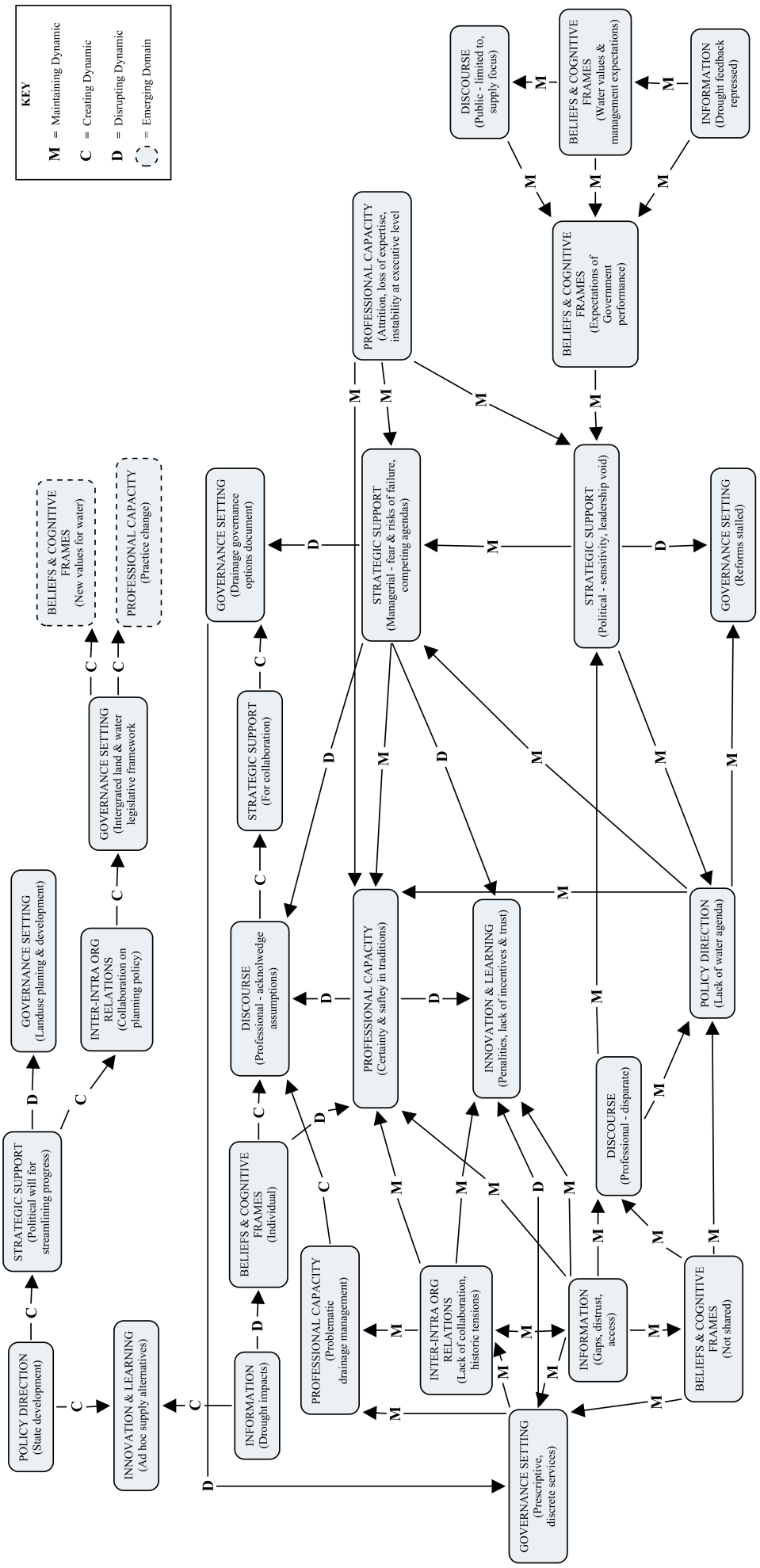
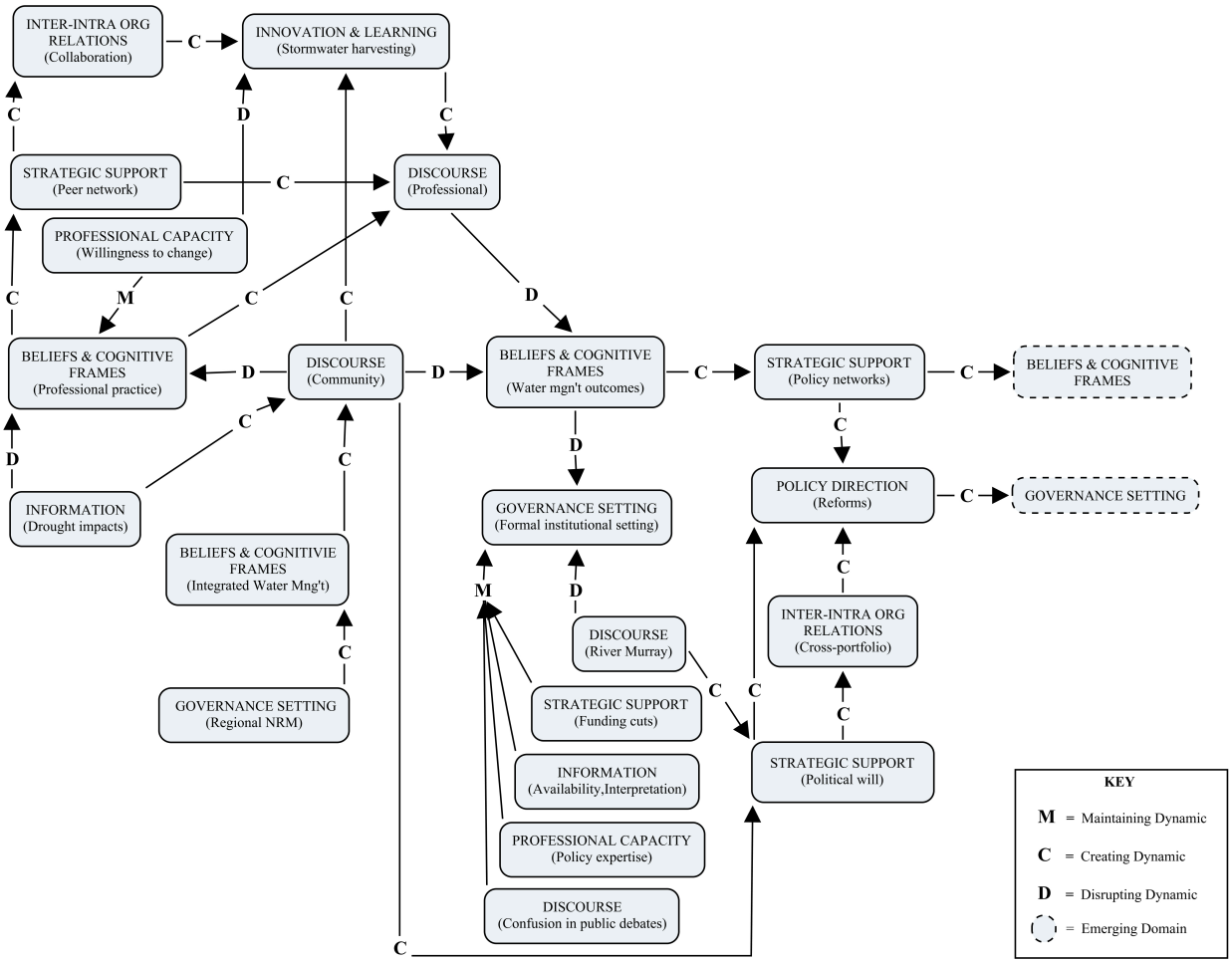


Figure 2.
Perth institutional dynamics

Figure 3.
Adelaide institutional dynamics



The institutional dynamics behind Adelaide's drought response are illustrated in Figure 3. These begin to provide some insights into how a transformation in Adelaide's water management system emerged.

The overall impression provided by this map of Adelaide's institutional dynamics is the predominance of creative and, to a lesser extent, disruptive work. Interestingly, maintaining work is confined to influencing predominantly the Governance setting domain. The limited maintaining influences on and between Professional capacity, Beliefs and cognitive frames and the Discourse domains appears to have enabled practitioners and organizations to innovate and learn through experimentation. Examining some of these links and connections between domains more closely, Adelaide's institutional setting displays the following characteristics:

- On-going public engagement and literacy in integrated catchment management and water supply, built through long-term participatory natural resources management arrangements (Domains: Governance, Beliefs and cognitive frames, Discourse).
- A significant influence from national Murray-Darling Basin debates, providing political will for governance reform, so that a position as a responsible water manager can be taken by the South Australian Government in Basin negotiations (Domains: Strategic support, Policy direction).
- The ability for a range of organizations to innovate new water management technologies, practices and approaches (e.g. stormwater harvesting in local government, community engagement in catchment management planning in statutory authorities), and for these developments to be acknowledged and shared across the sector (Domains: Innovation and learning, Inter-intra organizational relations, Discourse).
- Containing a group of practitioners who, with a long history of working collaboratively in different roles and on a variety of issues, had developed trust,

industry knowledge and appreciation for one another's positions, power and influence. This enabled them to work strategically to champion new ideas and solutions (Domains: Professional capacity, Strategic support).

- An active public discourse around water management, questioning the underlying assumptions and suitability of objectives for water management under the drought conditions (Domains: Discourse, Beliefs and cognitive frames).

5.2 Institutional work

To understand the mechanism of system lock-in identified in Perth's institutional dynamics, examples of the strategies and activities of actors that generate these dynamics are presented Table 3. This institutional work is evidenced by direct quotes from research participants. In some quotes, participants highlighted the lack of or need for this type of institutional work. These are indicated with an asterisk (*).

Table 3
Examples of institutional work in Perth

	Maintaining	***Creative***	***Disruptive***
Cognitive	***Routinizing:*** 'Water Corp does have such a strong, clear mandate, and that's what they want to stick to, so it's really difficult to get them to shift beyond that.' ***Embedding: …'***there's this strong middle layer management that just want to keep doing it the same old way.'	***Mimicry:*** 'Politicization of water is a big issue, and relate to the lack of expertise being used to make decisions. Need to be able to engage with Minister's advisors better and understanding what they base decisions on.'* ***Theorizing:*** 'Not willing to investigate or innovate as this is a liability.'* ***Educating:*** 'There have been some great projects… but how do we make it mainstream?'*	***Undermining assumptions and beliefs: '***Now they've formed the so-called C21….support by the WA Local Government Association, they're the ones that are driving the broader questions, things like urban water drainage, and water quality.'
Normative	***Mythologizing:*** 'It would help to have greater access to research and information on WA circumstances. Much of the research that is easy to locate is international or interstate. ' ***Demonizing:*** '…both of them would point the finger at the other one and say 'Oh they won't let that happen'. And yet he'd get them in the room and they'd both say well you know, 'Isn't this you that's stopping this?' And then they'd say 'No, not us, isn't it you?'	***Constructing identities:*** 'Everyone knows what their comfort zone is, what they know and love and have been doing for the last 30 or 40 years.'* ***Changing normative associations:*** 'Department's focus is on what they have to deliver, as there will be repercussions if they don't deliver that. So they are focusing on the legislative/regulative side of things, not on the whole road map. No overall vision.'* ***Constructing normative networks:*** '[There's] lots of networking to figure out the agenda.'	***Disassociate moral foundations:*** 'You've had total sprinkler bans in the East; we've never got near that and our Government's reluctant to go near that.'*
Regulative	***Deterring:*** '…until you change the policy, change the guidelines, change the standard... then the implementers will continue to implement.' ***Policing:*** '… people 'pushing back' and only doing what's strictly in their job description…' ***Enabling:*** 'Stated goals that say one thing, while in reality you're not trying to achieve that.'*	***Vesting:*** 'No one asking questions about the governance behind them [demonstration projects]. Liabilities just being created and shifted. Demo projects not thought of in terms of what should be 'demo'd [demonstrated].' ***Defining:*** 'The Department of Water is still an embryonic organization, they're still building capacity.' ***Advocacy:*** 'People not willing to make decisions – fear of recriminations of making decisions.'	***Disconnecting sanctions and rewards:*** 'And people don't quite know how to challenge it and work their way through with you know, new sort of opportunities.'*

** Denotes examples where this type of institutional work is not present, and practitioners are recognizing this gap.*

Table 4
Examples of institutional work in Adelaide

	Maintaining	*Creative*	*Disruptive*
Cognitive	***Routinizing:*** 'These funny people who are responsible for the approval process and just sick of all these rules which have been there for donkey's years.' ***Embedding:*** You need the formality to kick in and make sure what you've set up continues.'*	***Mimicry:*** '…try and make our legislation work with what we've got.' ***Theorizing:*** 'We were starting to think about well, if we got high salinity flows in the River Murray what does that mean to us?' ***Educating:*** '...apparently there was this kind of standout meeting between CEOs of key departments… when there were forecast around current inflows and what we want to get in the future, and the fact that we were in serious trouble.'	***Undermining assumptions and beliefs:*** 'Got to get political… you've got to actually embarrass the politicians into agreeing with you.'
Normative	***Mythologizing:*** 'You have old school thinking still influencing the public debate.' ***Demonizing:*** 'I think grappling with it from a basic policy perspective of 'why would you do it in the first place', really. There are competing views across government…'	***Constructing identities:*** 'And we will have a, we will end up having a healthy debate with them about that and we will take some pain with regard to that.'* ***Changing normative associations:*** 'I had to go through a consultation process… basically convince the community that this was going to be within, a lower impact on their aquatic reserve.' ***Constructing normative networks:*** 'Networks in Adelaide are key. The people in them have been in the business for a long time, so they know the business well, and have long held relationships with trust, and know how to work strategically together.'	***Disassociate moral foundations:*** '…people coming through will say, "What the hell are you doing? Why aren't you doing this?" And they are already doing it, in the press.'
Regulative	***Deterring:*** '…that has really suffered because no one has really stood up and said, well, we're responsible for stormwater.' ***Policing:*** 'And particularly when times get tough… the accountants in the departments say "Oh, well, why are you looking at those development applications from the EPA when it's not our business?".' ***Enabling:*** 'It's about time it's coming from the top down …there'll be a support structure, there'll be legislation... a state government requirement rather than a nice-to-do thing.'*	***Vesting:*** 'And [authorities] were asking these questions all the way along. They weren't saying 'You mustn't do this' or 'You mustn't do that'. The institutions and people…were constantly asking these questions; so we effectively were closing off on all of these questions as we went….in there doing applied research.' ***Defining:*** '…it's quite clear and recognizable that [Dep. for Water] are responsible for water management policy. SA Water…historically, they were the provider of policy advice to the minister…and now the department is so… there's a transition phase that it still needs to go through …'* ***Advocacy:*** 'A lot of the work we've done, we try to do it in collaboration with the local government councils to get closer to the people and help it work better, which it does.'	***Disconnecting sanctions and rewards:*** 'We, as an authority, waive the requirement for rainwater tank if they're using recycled water.'

* Denotes examples where this type of institutional work is not present, and practitioners are recognizing this gap.

These examples of the experiences, behaviours and strategies of water practitioner's in Perth clearly demonstrate some of the ways the institutional setting is being maintained through the institutional work of actors. Regulative activities by some actors are deterring the application of new ideas and practices, or enforcing current institutions by adhering to established scripts of action and 'pushing back' those actors trying to reinterpret these rules. Similarly, the problem frames and knowledge assumptions of organizations or individuals has perpetuated practice and management paradigms. While from a normative standpoint, the ineffectiveness of current water systems and acknowledgement of the need to explore alternatives is not recognized across the industry. Without these underlying assumptions unchallenged, it is difficult to influence change in the sector.

Perhaps more revealing in the Perth case is the institutional work, or lack thereof, to generate creative and disruptive dynamics within the institutional setting. Study participants recognized many of the possible examples of these two types of institutional work as absent or problematic. For example, while a new department exists to develop water policy and drive reforms, institutional work to undermine this role, and a lack of credibility needed to legitimately question normative associations and knowledge assumptions, have hindered the Department's ability to conduct creative institutional work. From a more normative example, some practitioners used routinizing, demonizing and policing strategies to protect the professional identity of water engineers. While networks of like-minded professionals formed around some water management issues, this did not generate open professional discourse to change cognitive frames through theorizing, educating, or by using mimicry to facilitate the acceptance of new ideas and practices. As such, traditional professional cognitive frames and norms prevailed. As a flow on effect of these guarded ideas of professionalism, the use of demonstration projects to vest new ideas, concepts and objectives into water management practice, and work to advocate for change, was not peer-supported. Given these highly embedded and extensive maintaining influences, it was difficult for practitioners to question and challenge the status quo through creative and disruptive work, without significant threat to their professional reputations. In contrast, samples of the variety of institutional work enabling the reorganizing conditions within Adelaide's institutional setting are presented in Table 4. Examining the types of maintaining institutional work conducted in Adelaide, the sector experienced similar activities to Perth. There were regulative institutions being employed to deter consideration of emerging issues or solutions (such as stormwater), and to insist on adherence to procedure. From cognitive and normative angles some practitioners were content to follow traditional routines. Some went as far as attempting to entrench these routines by elevating them to myth-like, taken-for-granted beliefs, or by demonizing the need to explore alternatives. However, within the forms of maintaining work present in Adelaide, there were some activities to embed new ideas and approaches into the water management profession, and begin to enable these changes in formal regulative reforms. This indicates that while some institutional work perpetuated historic organizing structures and resultant routines, there was also activity to reorganize these structures, to routinize alternative practice and achieve a new set of water management objectives.

In addition to these dual maintaining dynamics, a variety of creative and disruptive institutional work was also revealed in Adelaide's institutional setting. Cognitively, practitioners were reinterpreting and stretching the bounds of legislative frameworks, mimicking the traditional logics contained in these formal institutions to gain acceptance of alternative practices. The stark impacts of the drought and open public discourse led to theorizing; considering the consequences of various water scarcity scenarios. Communication of these impacts also educated the public and executive levels of Government on water issues. Normative work included networks of actors, (informal and those formalized in working groups and committees), forming around different water issues. Across the sector, assumptions about water management were tested in these interactions, and new beliefs and values emerged. For example, at a local municipal level, consultation to gain resident acceptance of new urban drainage installations promoted the multiple objectives they could deliver, and highlighted the limited performance of older

technology. At a state-wide scale, the economic implications of poor water quality in the River Murray generated greater appreciation of the value of aquatic ecosystem health. The questioning of these underlying norms, beliefs and values of water management relied on the collaborative inter-intra organizational relations. Challenging such first principles of water management can threaten the very roles (hence existence) of organizations and professional identities. However, the collaborative networks of practitioners behind these inter-intra organizational relations assisted the 'healthy' debates about organizational norms of operation, roles and responsibilities. This allowed the normative and regulative underpinnings of sectorial organization to be redefined and negotiated, without detrimental conflicts arising. Such a collaborative approach was also identified in creative regulatory institutional work, where advocacy with the public and local government was seen as a key goal and benefit of stakeholder engagement. Also, experimentation with new technologies engaged researchers and regulators as a strategy to help vest new knowledge and understanding into approval processes.

Finally, various cognitive, normative and regulative disruptive dynamics were also identified, from engaging in political discussion and debates to challenge the underlying premise of water management, public comments questioning first principles of professional practice, to regulatory bodies themselves redefining the incentives and disincentives of regulatory frameworks.

6 Discussion: Propositions for a theory of Adaptive Capacity

The application of an institutional lens to explore system adaptation has revealed some institutional dynamics leading to lock-in or practice change in urban water systems. These underlying change mechanisms empirically confirm the anticipated position of these two cases on the Adaptive cycle. Firstly, looking at the connectedness of the institutional settings, Perth's connections are extensive and complex, with domains often displaying an influence on a number of others (Figure 2). This suggests a highly connected and therefore locked-in system, according to the prescriptions of Holling (1973). In comparison, Adelaide's connections tend to follow more linear pathways towards clear change to some domains. For example, there is a clear flow of influence from the information domain on drought impacts, through beliefs and cognitive frames of professional practice and the development of peer networks, to collaboration in the inter-intra organizational relations, leading to experimentation with stormwater harvesting (Figure 3). This is suggestive of a system re-establishing processes and connections to achieve newly recognized potential (i.e. stormwater harvesting for fit-fir-purpose supply). Secondly, Perth displays a dominance of maintaining dynamics with extensive connections across the institutional setting, while Adelaide's setting is dominated by creative dynamics, with some disruptive. Finally, looking at the range of institutional work identified in each case (Tables 3 & 4), not only are there limited examples of creative and disruptive work in Perth, there were also clear examples of cognitive, normative and regulative maintaining work directly influencing management practices (Table). This indicates Perth's urban water sector is confined to its current system configuration and service delivery objectives (potential) through cognitive and normative institutional work, as well as regulative mechanisms. In contrast, Adelaide's maintaining influences are related to governance arrangements and policy thinking (Table). With a lower level of connectedness and maintaining work directed away from the enforcement of traditional practices, Adelaide's the urban water sector had the flexibility to conduct creative work. This has produced a practice change to include decentralized forms of water supply alongside central reticulation (i.e. system reorganization) and recognize new principles and objectives for water management, such as fit-for-purpose water supply (i.e. new potential). Further, the recognition that embedding and enabling work are missing from the mix of institutional dynamics by the study participants, in suggests that Adelaide's urban water sector is moving toward the stabilization phase; seeking to formalize new institutions by building connections to legitimize these adaptations.

Given these cases represent Locked-in and Reorganizing systems, comparisons of key similarities and differences in their institutional settings could be expected to yield forms of adaptive capacity present at these contrasting stages of the Adaptive cycle. Following a process of cross-case comparisons (described in Section

4.5), qualitative similarities and differences between Perth and Adelaide's institutional configurations of domains, dynamics and institutional work were identified. A summary narrative of some of these configurations is provided below and illustrated where possible with subsets of the institutional dynamics from Figures 2 & 3).

6.1 Information, feedback and learning

A common factor of adaptation recognized in these cases and often cited in the literature is the availability, access and interpretation of information to provide feedback to the system. In their empirical study of governance transitions, Olsson et al. (2006) established that the generation and dissemination of new knowledge were key for preparing systems and utilizing windows of opportunity for change. In this study, both cities recognized gaps in knowledge of the new environmental conditions, and the water management system's performance in light of these. This generated key maintaining influences, particularly on decision-making processes. However, comparing the configuration of dynamics the Information domain in each case, differences in the extent of influence of this factor are highlighted (see Figure 4).

In Adelaide, while availability and divergent interpretation of information lead to some uncertainty and fallback on existing rules and regulations, information on drought impacts was also publically acknowledged. This generated community discourse and challenged the assumptions and principles of professional practices (Figure 4a). These developments then generated further disruptive and creative influences on other domains (Figure 3). In contrast, suppression of the full extent of drought impacts in Perth maintained water management assumptions and limited public discussion of water issues and expectations of Government's service delivery performance (Figure 4b). This influence extended to increase political sensitivities (hence decrease strategic support), as achieving the public's expectations for water supply, which were uninformed by the limitations of the drought, became an increasing public relations issue for Government as the drought continued.

In addition, the lack of access and distrust in the science and business case behind current water management practices generated positive feedback loops between a number of domains (Figure 4c). In effect, these conditions amplified the maintaining influences, shutting out recognition of the need for adaptation and opportunities for learning.

These dynamics surrounding the information domain pertain to ideas surrounding the role of learning in the system. Social learning is often cited as a key ingredient of adaptation (Chapin et al., 2010; Lee, 1999; Pahl-Wostl et al., 2007; Pearson et al., 2010). However, it has been recognized as a problematic concept (Reed et al., 2010), as somewhat of a silver bullet solution (Huitema et al., 2009) and operationally difficult in terms of identifying the target audience and inevitable conflicts arising from different worldviews and contested knowledge (Ison et al., 2007). The results confer with this literature, in that while representing an important capacity of the system for adaptation (evidenced by the lack of learning opportunities in the locked-in Perth case), the depth and subject of learning will vary across the Adaptive cycle. To illustrate, the extent of learning in the Adelaide case included the re-evaluation of water's value to society, and thereby what first principles of water management should entail. This reflexive consideration of the frames of reference for water governance is referred to in the literature as double loop learning (Bos et al., in press; Pahl-Wostl et al., 2007). Meanwhile, the Perth case presented examples of single loop learning (Pahl-Wostl et al., 2007), where information and feedback is processed for the purpose of optimizing current system performance, as opposed to re-evaluating that performance in light of operating context changes. Further exploration of the extent of and mechanisms for learning within adapting systems is needed to advance knowledge of the role of social learning in generating adaptive capacity (Pearson et al., 2010).

Figure 4.
Configurations of dynamics surrounding the Information domain

Figure 4a. Information Dynamics in Adelaide

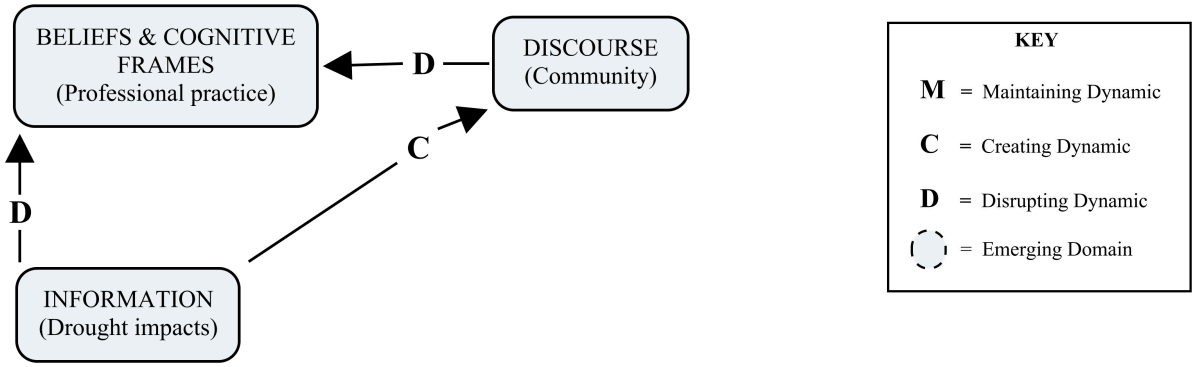


Figure 4b. Multiple maintaining information dynamics in Perth

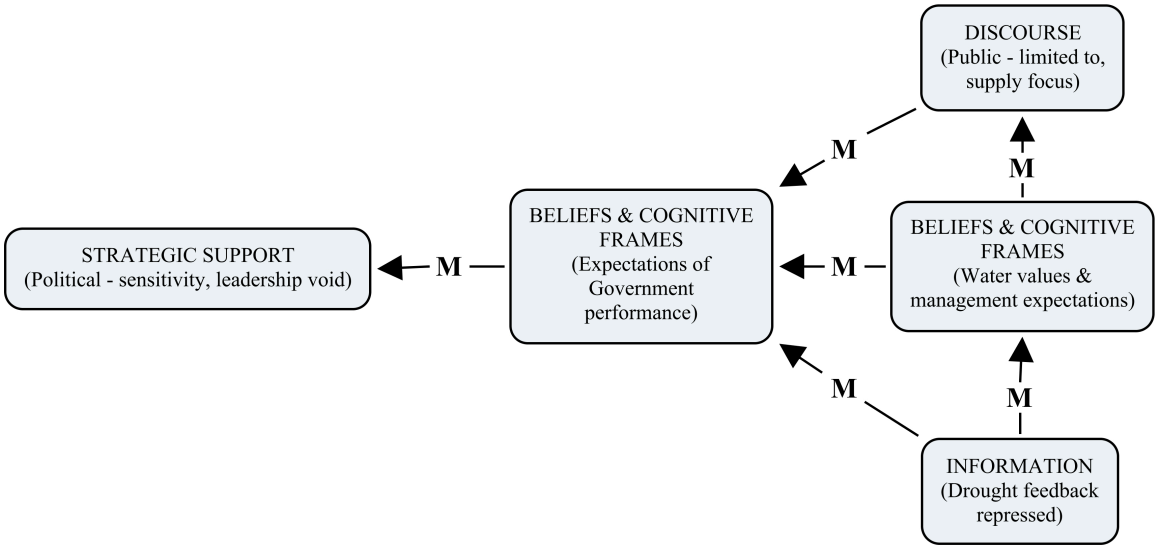
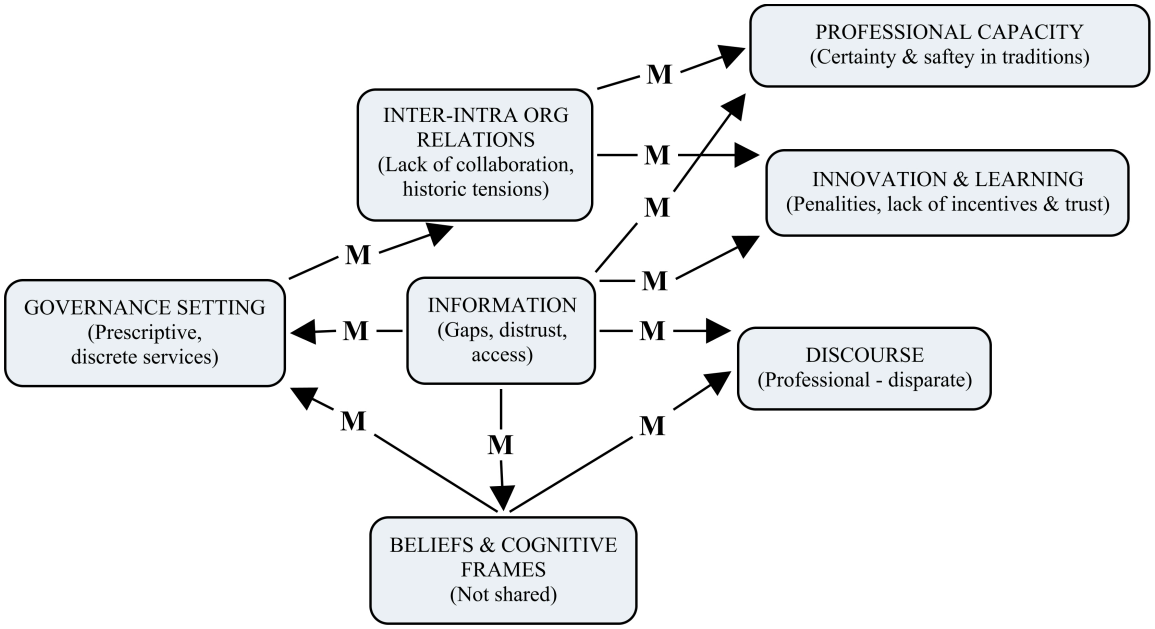


Figure 4c. Positive feedback information dynamics in Perth



6.2 Translating ideas to actions

Another similarity observed between the cases is the translation of new ideas and concepts from the Beliefs and cognitive frames domain into tangible and applied policy directions. Each case showed creative institutional dynamics emanating from this domain, and drawing on strategic support and inter-intra organizational relations to connect this influence to the Policy direction and Governance setting domains (see **Figure 5**)

Figure 5.
Configurations of dynamics surrounding Beliefs and cognitive frames and Policy direction domains

Figure 5a. Translating ideas to actions in Perth

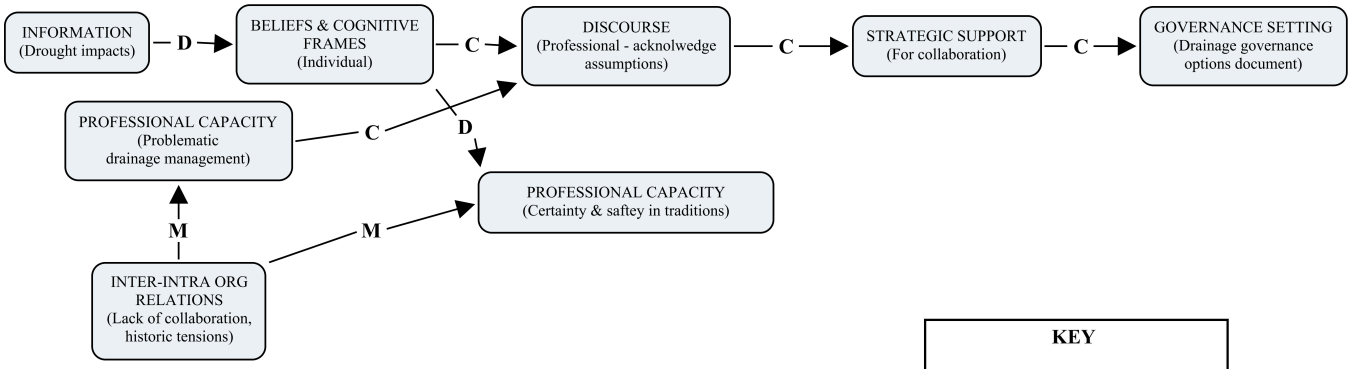
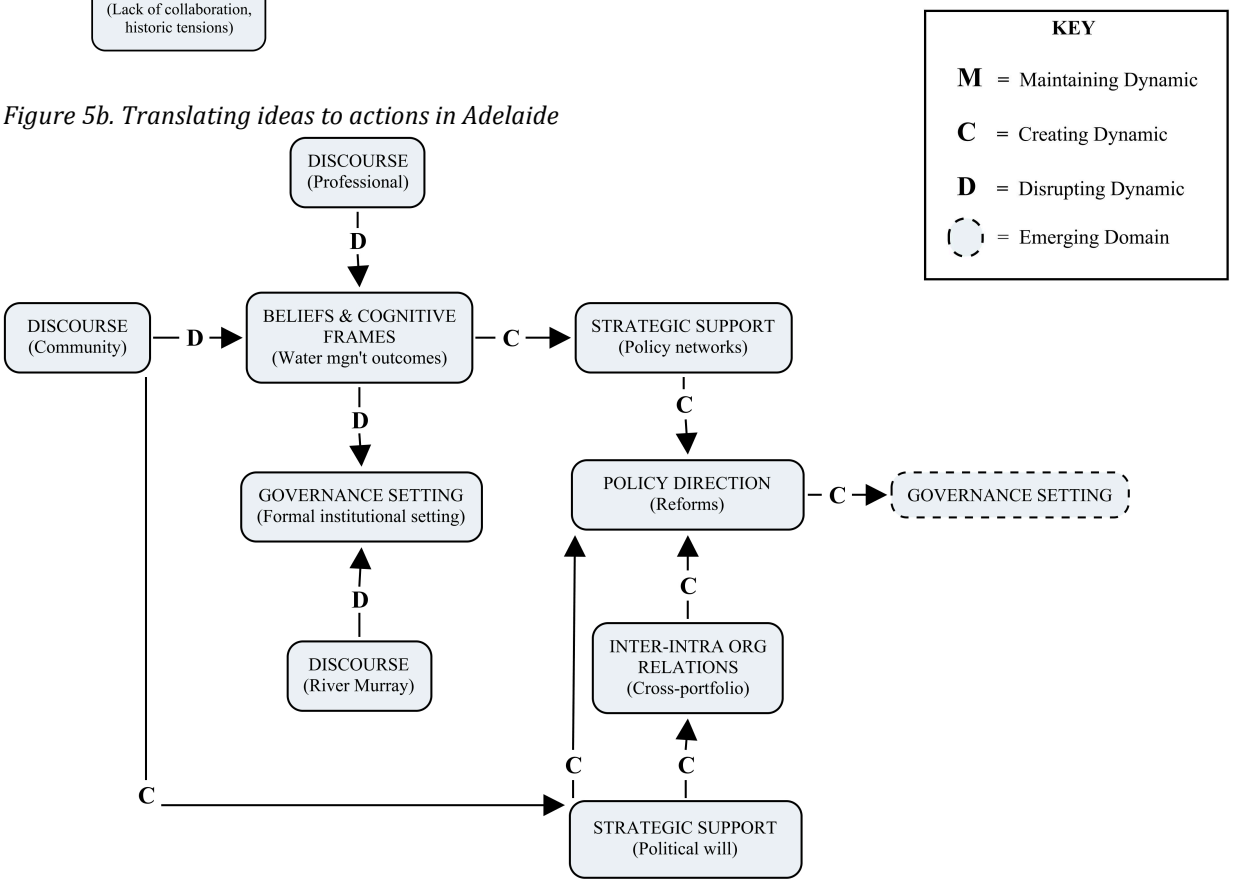


Figure 5b. Translating ideas to actions in Adelaide



While these dynamics led to further changes to the governance arrangements for water management in both cities, in Perth this progressed only to a scoping and options report on drainage governance issues (Figure 5a). Indeed, broader reform of urban water management arrangements had stalled in Perth (Figure 2). The key difference explaining these results rests in the dynamics created in the discourse domain. This domain is critical for producing new shared understandings of assumptions, new problem frames and solution options. In the Perth case, beliefs and cognitive frames were challenged at an individual level, but maintaining dynamics resulted in a professional capacity domain seeking safety in tradition. This

disrupted the ability for discourse on the dissonance between tradition and emerging frames of reference for water management. Some discourse did generate strategic, but in the form of agreement to collaborate to explore issues, not yet address them through agreed actions (Figure 5a). In contrast, challenges to beliefs and cognitive frames in the Adelaide emerged from both professional and public discourse on water issues. These domains generated widely shared frames of reference, as well as momentum in the form of policy networks and political support to progress these ideas (Figure 5b). These differences with regard to progressing new ideas and concepts into stated actions were also affected by conditions within the Inter-intra organizational relations domain. These insights on translating new ideas into proposed actions correlate with the literature. The need to involve stakeholders, so that multiple views and perspectives can be aligned and common values, and problem frames established, provides the basis for developing shared visions or objectives, and gaining commitment to these through policy or other formalized means (Gupta et al., 2010; Olsson et al., 2006). However, this process is often linked to forms of learning (Bos et al., in press; Ison et al., 2007; O'Brien, 2012). These results suggest the translation of such informal understandings into formalized forms is more one of negotiation and decision-making. Learning has altered the frames of reference for urban water management in both cases to greater or lesser extents. But collective decisions about the implications of these cognitive developments for the current system, what (if anything) needs to be done as a result, and how best to make any required adaptations need to then be made. Some scholars appropriate this collective process to social learning or innovation (Biggs et al., 2010; Pahl-Wostl et al., 2007), however this label tends to disguise the contested nature of these decisions (Ison et al., 2007; Mollinga, 2008; O'Brien, 2012); who is included? whose perspective and voice count? who wins and who loses, and what is at stake?

Understanding how these questions are answered, and hence the decision logic behind the translation of learning into plans for action, involves understanding where in the institutional setting power and influence lay (O'Brien, 2012). In the Perth case it is apparent that power is embedded in the strength of traditional institutions and their protagonists, where as in Adelaide, influence from public discourse, River Murray debates and the empowerment of practitioners themselves has mobilized strategic support in political will. These results suggest that examining the translation of new knowledge into shared objectives and action plans as a process of negotiation and decision-making, would capture these contestations and the dynamics they produce to influence the system. This would provide a fruitful understanding of what capacities are needed to reach shared visions and objectives.

6.3 Implementation and agency

A final difference between these two cases is the creation of a pathway to realize practice change through innovation and experimentation (Figure 6). In Adelaide, an informal pathway to the implementation of alternatives (stormwater harvesting) was observed (Figure 6a). Changes in beliefs and cognitive frames behind professional practice led to peer networks coalescing around new ideas. Drawing on the collaborative culture instilled in inter-intra organizational relations, experimentation with new technologies demonstrated their successful performance. The existence of working alternatives provided a key driver for further examining underlying assumptions and management objectives, in particular looking at the performance of traditional solutions in respect to the changed cognitive frames. This disrupted governance arrangements and drove further strategic support at the policy level for reform.

Figure 6.
Configurations of dynamics surrounding practice change

Figure 6a. Practice change in Adelaide

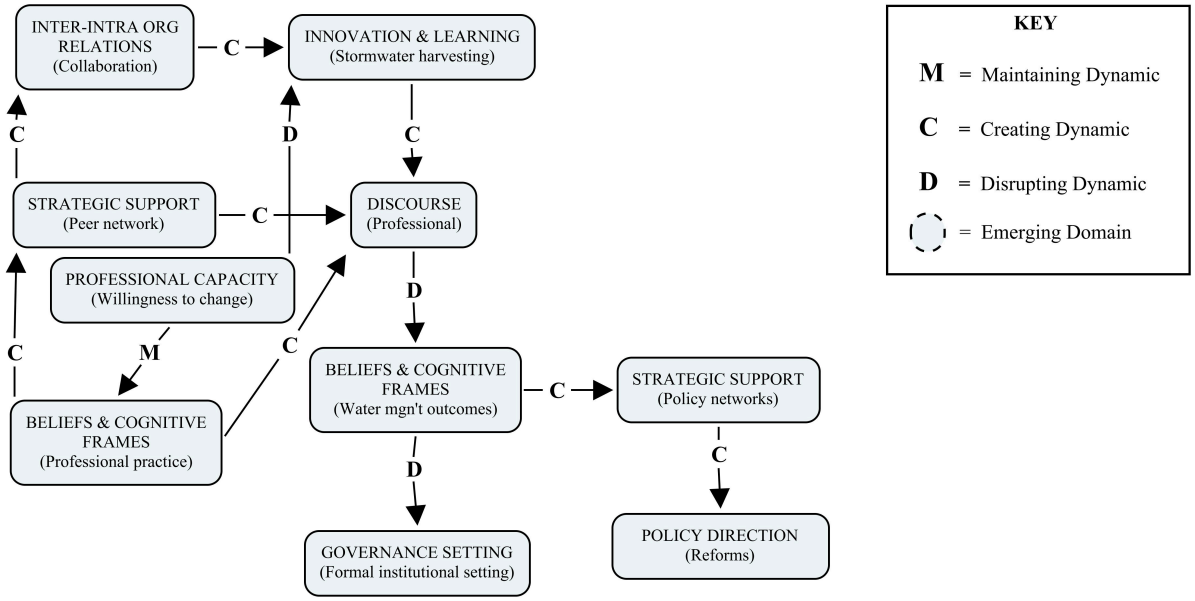
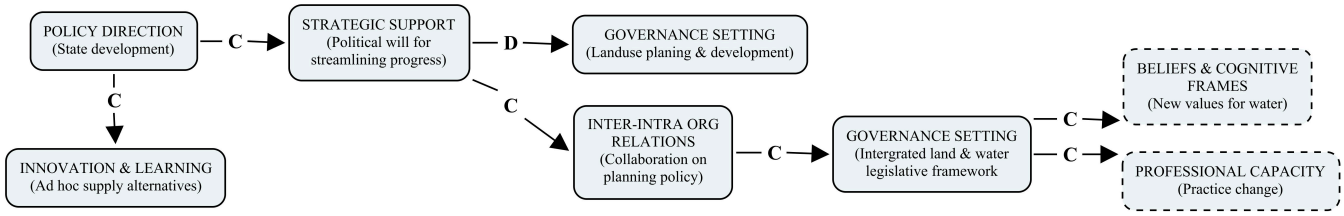


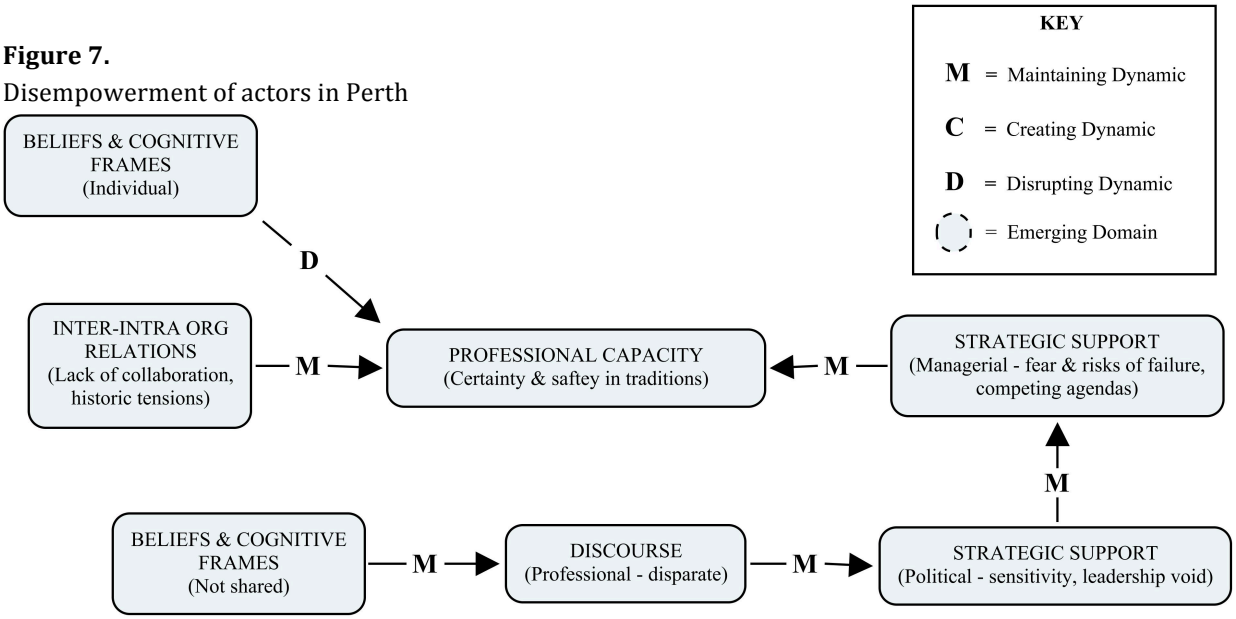
Figure 6b. Practice change in Perth



In the Perth case, land use development policy placed the onus of finding water supply for new developments largely on land developers, driving innovation out of necessity. This policy direction also generated support for integrating land development and water management in the planning and approvals legislative frameworks. This is influencing new cognitive frames and regulatory practice in these areas (Figure 6b). However, the alternative water supply demonstrations are not translating new water management objectives they espouse, or the information and knowledge they can create, into other domains within the water sector. This could be attributed to the lack of strategic support for practice change. While the policy direction from the landuse planning sector has prompted strategic support for change at the policy level, this support has not encompassed the alternative water servicing installations at an operational level.

This raises questions around a key factor for success recognized in the literature – leadership. In their seminal study, Olsson and colleagues (2006) recognized that the process of navigating adaptation processes is a significant knowledge gap. They identified leadership as a key capacity for strategizing and coordinating the various activities within an adaptation process. This study supports such conclusions, but also reveals that the emergence of leadership functions can also be highly dependent on the institutional context. As the Perth case demonstrates, if maintaining dynamics are too strong, the cost of leadership are higher than the perceived benefits to challenging the status quo. Actors, both individual and organizational, are then unlikely to risk professional reputations to advocate for change or champion alternative practices. (Figure 7).

Figure 7.
Disempowerment of actors in Perth



These results suggest that further understanding of where different forms of agency are enabled (or disabled) in the institutional context, and how they combine to influence, legitimize and generate change (or lock-in), will be critical to understanding how to mobilize adaptive capacity.

6.4 Learning, deciding, acting

Examining these key configurations which emerged in the comparisons between cases of different forms of adaptation, capacity *to learn*, *to decide*, and *to act* appear to be key to the process of adaptation. Injecting these three capacities in relation to the definition of adaptive capacity developed from the literature in Section 2, it can be inferred that adaptive capacity in a system enables:

1. The ability to recognize feedback from the operating context (e.g. recognize the limited water availability in drought);

2. The ability to assess this feedback in terms of how it effects the current system's structural integrity (e.g. determine what likely impact water scarcity will have on the water supply system);

3. The ability to assess the implications of this feedback for the system's functional purpose or objectives (e.g. establish what water scarcity means for the value and acceptable use of water in society);

4. The ability to determine, based on the outcomes of the two previous steps, what type of adaptation is needed, resilient or transformative (e.g. can the current water system be reconfigured to meet current societal needs, or should the needs and expectations be changed along with a system to deliver them?); and

5. The ability to reconfigure for resilient adaptation (e.g. augmenting the current water supply system with new water sources) or transform to deliver new outcomes (e.g. deliver fit-for-purpose water).

Steps 1 – 3 represent learning capacity, step 4 deciding, and step 5 acting. These steps may not necessarily occur sequentially. Indeed in Adelaide's experience, Step 5 occurred in anticipation of the results of Steps 3 and 4. These case study results imply that at various points along the Adaptive cycle, a system with adaptive capacity will display these three forms of capacity, to greater or lesser extents.

In addition, using an institutional perspective in this study has provided initial insight in how these three forms of capacity are created in the system. The level of connectedness and various dynamics between different areas of the institutional setting, and most importantly the types of agency creating these dynamics, can be used to identify and explain where adaptive capacities are manifesting in the system. Extrapolating from the results of these two cases, the following propositions about the institutional conditions and resultant forms of adaptive capacity in the four phases of the Adaptive cycle are put forward in Table 5.

Table 5.
Propositions for a theory of adaptive capacity

		Lock-in	Crisis	Reorganization	Stabilization
Institutional conditions	***Connectedness and potential***	High connectedness, optimized performance to deliver outcomes	Rapid disconnection, following ineffective performance and/or inappropriate outcomes	Development and testing of new connections, sub-optimal performance as new outcomes are identified	Increasing connectedness, continual improvement in performance to deliver outcomes
	Dominant Institutional Dynamic	**Maintaining**	**Disruptive**	**Creative**	**Maintaining:** Embedding and Enabling
	Dominant Institutional Work	**Normative and regulative:** Institutional stability formed through entrenched practices and first principles	**Cognitive and normative:** Dissonance between normative foundations and emerging cognitive frames cause regulative to lose legitimacy	**Cognitive and normative:** New normative associations and related cognitive frames and logics developed	**Regulative and normative:** New cognitive frames are institutionalized in regulations and norms
Forms of adaptive capacity	***Learning capacity***	**Single loop:** System focused on optimizing performance	**Double loop:** Crisis highlights assumptions behind system structures and functional outcomes. System must reassess 'fit' to new operating conditions.	**Double + Single loop:** System monitors performance against new objectives, refining objectives and actions to achieve.	**Triple loop:** System moves toward formalizing new objectives, principles and assumptions in governance arrangements
	Deciding capacity	**Day-to-day:** Objective clearly defined, established logics to decide actions	**Fundamental:** Values, beliefs, assumptions and first principles no longer hold. Significant decisions about purpose of system need to be made	**Complex:** As the system reorganizes, many interrelated decisions about how best to deliver new outcomes need to be made	**Day-to-day:** Systems fine tunes performance to new objectives
	Acting capacity	**Highly entrenched:** Traditions scripts of behavior and standard operating procedures prescribe actions	**Disparate and conflicting:** Outcomes and objective unclear, actions become uncoordinated and may conflict	**Learning-by-doing:** Widespread experimentation with new practices to establish 'best practice'	**Narrowing:** As system becomes more efficient, range of activities narrows

7 Conclusions and a future research agenda

An ability to characterize the system conditions and dynamic processes of agency behind the different phases of the Adaptive cycle (lock-in, crisis, reorganization, stabilization) provides promising prospects for revealing what adaptive capacity looks like in practice, and how it might be fostered, built and utilized. Further, the analytical framework employed in this research offers a means of identifying and exploring the institutional dimensions of systems in depth, to understand how various attributes and activities generate these three forms of capacity:

- Through the connectedness of different domains of the institutional setting
- By understanding the nature of these domain configurations in the dynamics they generate (maintaining, creating and disrupting)
- By identifying the specific types of institutional work (cognitive, normative and

regulative) employed by actors that produce these dynamics, and
- By recognizing how configurations and dynamics within the institutional setting empower or disempower actors to express their agency

The exploratory nature of this research method provides opportunities for further refinement and strengthening of the analysis approach. Further application to a range of cases at different phases of the adaptive cycle and from a range of contexts will be needed to validate and refine the approach. In particular, application to smaller-scale snapshots of adaptive processes is needed to build knowledge of the details of institutional work; its specific impacts and how interplay between different forms of work may produce different capacities. From a more pragmatic point of view, the Lock-in phase should be a targeted area of study, as this 'rigidity trap' in the system is where adaptive capacity is seeming least available, but most critical for anticipating whether resilient or transformative adaptation might be required. However, comparing these two cases of lock-in and reorganization has provided some tentative propositions regarding, firstly, the role of adaptive capacity in adaptation (to learn, to decide, to act) and secondly, key dimensions for understanding the institutional ingredients needed to generate adaptive capacity (connectedness, dynamics and agency). We see both theoretical and empirical value in further testing of these propositions, and anticipate this paper has gone some way toward building a research agenda to engage a range of disciplines on further studies of this phenomenon.

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CHAPTER 7: SYNOPSIS, CONTRIBUTIONS AND IMPLICATIONS

7.1 INTRODUCTION

This thesis examined the social dynamics behind urban water management. Drawing on international literature on urban water management (Sections 1.1-1.6), the study is framed by contemporary water issues identified across the developed world. The research approach sought to empirically explore these real-world problems by using a unique institutional lens (described in Chapter 2). In doing so, three sequential aims toward understanding how adaptive capacity could be utilised in governance processes to improve sustainable urban water management were accomplished. First, to empirically map the dynamic institutional context of urban water governance; second, to generate recommendations on how institutional adaptive capacity can be built into governance processes; and third, to extend theoretical insights on adaptive capacity. The research findings toward these aims are outlined in the following sections. Beginning with the substantive contribution to theory development, the contributions of the research are traced backward from this end point; through recommendations for governance processes that were derived from the results, to empirical insights and the methodological developments employed to ascertain them.

While the research employed Australian case studies for this exploration, the methodological approach employed has produced results that can be extrapolated beyond this context. By deriving an analytical framework from accepted theories of institutions and governance in the scholarly literature (developed in Chapter 2), the theoretical extensions drawn from the results (discussed in Chapters 5 and 6) are generalisable to other contexts, albeit with a need for further testing and refining. This contribution is discussed in Section 7.2. Similarly, the methodological developments the thesis outlines to map and analyse the institutional context of urban water management is also applicable, and recommended, for use in a variety of contexts and sectors. This is argued in Section 7.4. Conversely, the recommendations for governance processes described in Section 7.3 are more contextually anchored. Thus while these insights align with the international literature (discussed in Section 7.3.2) and may be relevant to other cases, they should be understood with the limited contextual basis of the research in mind. These limitations of the study, along with implications of the findings for current scholarship and suggestions for future research, are discussed further in this chapter.

7.2 EXTENDING THEORY ON ADAPTIVE CAPACITY

7.2.1 Achieving the research aim

This research was framed by the idea of adaptive capacity. This brought to the study an intellectual heritage for understanding system change, and a term providing a meaningful conceptual frame for applying the knowledge generated. Though a term with multiple nuances, adaptive capacity has proved a useful umbrella concept for capturing the multiple processes that occur within complex adaptive systems that lead to their structural or functional change. By reframing adaptive capacity as a dynamic

process within institutional systems, this research promotes a redirection of the scholarship beyond concerns of measurement, indicators and benchmarks. This aligns with Gallopin's (2006) suggestion to focus adaptation studies on the development of general theories of change and transformation. By starting to understand the dynamic interactions within these systems and within their operational environment, and examining empirical cases of urban water management, the study has shed light on what these processes entail when the sector is under stress or readjustment. This has generated the following five empirically based propositions on the collection of processes that lead to adaptation:

- the recognition of feedback from the operating context;
- assessment of feedback on how the current system's structural integrity is affected;
- assessment of the implications of this feedback for the system's functional purpose or objectives;
- determination of what type of adaptation is needed, resilient or transformative; and
- reconfiguration for resilient adaptation, or transitioning to achieve system transformation.

In doing so, this study has expanded the theoretical understanding of adaptive capacity.

7.2.2 Implications

Examination of the various mechanisms at play within each case study to either maintain the current urban water system and its practices, or generate change, have provided a key conclusion about adaptive capacity: that its outcomes are to enable the system to *learn*, *decide* and *act*. These three forms of adaptive capacity differentiate adaptive responses from those that are resilient to those that are transformative. In particular, the ability to collectively assess feedback and decide whether the functional purpose of the system is appropriate to the external operating conditions, and hence inform what form of adaptation is needed; resilient or transformative.

While learning capacity has been well recognised in the literature, and studies of tipping points may provide indicators of system change, decision-making capacity in sustainability scholarship is a significant knowledge gap (Head, 2010; Ostrom, 2010; O'Brien, 2012). This form of adaptive capacity appears critical, not only because it sets direction for future endeavours, but because it is where power issues are particularly prevalent; interests and influences of actors come to the fore, stakes are raised (Fuller, 2010), and there is greater risk of diverse interests side-tracking change processes.

Understanding how decisions are negotiated and come to legitimise new institutional configurations through a change process holds the key to furthering scholarship on utilising adaptive capacity. To understand this decision-making capacity in more detail, scholars may need to look at the political science, organisational change and cognitive psychology disciplines to identify and explain this important form of adaptive capacity.

7.2.3 Critical reflections

While these propositions provided a good fit to explain the processes that led to structural or functional change, or the absence of it, in the case studies, further testing on cases of Crisis and Stabilisation, and in different contexts, cultures and sectors is needed to refine these propositions. However, by distilling adaptive processes into

three forms of capacity – learning, deciding and acting – these research results provide focal areas for future research to test and explore these propositions using a variety of scholarly perspectives to progress theory development.

7.3 RECOMMENDATIONS FOR GOVERNANCE PROCESSES

7.3.1 Achieving the research aim

Taking these forms of learning, deciding and acting capacity further, the study provided empirical insights and extrapolations on what types of institutional conditions would produce these forms of capacity, how they might be characterised for different phases of adaptation, and what governance instruments could be utilised to build or employ these conditions to generate adaptive governance. These ideas are collated in Table 7.1, derived from Publications Three and Four and the literature review discussed in Chapter 2. The results reported in Publication Four determined the different institutional conditions underlying phases of adaptation:

- the connectedness within the system and how it is performing to meet its potential;
- the type of institutional work (maintaining, creating, disruptive) producing the dominant dynamic within the system; and
- the specific institutional instruments (cognitive, normative or regulative) supporting these dynamics.

Publication Four also characterises these phases according to the forms of capacity (learning, deciding and acting) that the above institutional conditions produce. These results are then supplemented with those from Publication Three, which recommended how this knowledge of institutional dynamics could be operationalised through the four clusters of governance activity prescribed in Transition Management. Table 7.1 presents these suggested focal areas for each cluster of governance activities, given the expected institutional conditions that exist in each adaptive phase, and the expected progression of the system through the Adaptive Cycle. For example, given the locked-in institutional conditions present in the Perth case, and the need to break the lock-in and move toward system reorganisation, the governance activities that are needed may include:

- a focus on collective problem framing to establish a need for change, by considering the assumptions underlying cognitive and normative understandings of the problem;
- identifying barriers to change, and strategising how they might be shifted or circumnavigated, using knowledge of the institutional conditions and types of institutional work;
- targeting monitoring activities to assess the performance of the system within its broader operating context (i.e. not only against its specific objectives); and
- developing or mobilising champions and leaders, to innovate alternative solutions and guide the system through crisis and uncertainty.

In addition, the tools and frameworks reviewed in Chapter 2 were added as suggestions for how further details or assessment capability could be added to the dimensions of adaptive governance presented in Table 7.1. For example, a combination of the benchmarking capability of the Adaptive Capacity Wheel and the institutional dynamics mapping method used in this research could be used to generate an understanding of the institutional dimensions of the system in order to

inform governance activities. Or with its emphasis on social learning processes, a modified version of the Management and Transitions Framework could be used to assess what type of learning exists in the system, providing insight into this form of adaptive capacity.

This compilation of the empirical knowledge produced through this research within the theoretical framing of adaptive capacity and applied governance framework of Transitions Management, achieved the aim – *to generate recommendations on how institutional adaptive capacity can be built into governance processes*. Some of the significant empirical insights into adaptive governance processes identified in the case studies are discussed in the following section.

TABLE 7.1 TOOLKIT FOR ADAPTIVE GOVERNANCE

		Lock-in	Crisis	Reorganisation	Stabilisation	Suggested Tools
Institutional conditions	***Connectedness and potential***	High connectedness, optimised performance to deliver outcomes	Rapid disconnection, following ineffective performance and/or inappropriate outcomes	Development/testing of new connections. Sub-optimal performance as new outcomes are identified	Increasing connectedness, continual improvement in performance	**Institutional Dynamics Framework** in combination with **Adaptive Capacity Wheel:** Provides an understanding of institutional adaptive capacity, including dynamic processes existing in the system (Gupta et al., 2010; Bettini et al., forthcoming)
	Dominant Institutional Work	**Maintaining**	**Disruptive**	**Creative**	**Maintaining**	
	Dominant Institutional Instruments	**Normative and regulative:** Institutional stability through entrenched practices and principles	**Cognitive:** Dissonance between normative foundations and emerging cognitive frames. Causes regulative institutions to lose legitimacy	**Cognitive and normative:** New normative associations and related cognitive frames and logics developed	**Regulative and normative:** New cognitive frames are institutionalised in regulations and norms	
Forms of adaptive capacity	***Learning***	**Single loop:** System focused on optimising performance	**Double loop:** Crisis highlights assumptions behind system structures and functional outcomes. System reassesses 'fit' to new operating conditions	**Double + Single loop:** System monitors performance against new objectives, refining objectives and actions to achieve them	**Triple loop:** New objectives, principles and assumptions are formalised in governance arrangements	**Management and Transitions Framework:** Could be adapted to determine types of learning in the system (Pahl-Wostl et al., 2010)
	Deciding	**Day-to-day:** Objectives clearly defined, established logics used to decide actions	**Fundamental:** Values, beliefs, assumptions and first principles no longer hold. Significant decisions to be made about purpose of system	**Complex:** Many interrelated decisions about how best to deliver new outcomes to be made as the system reorganises	**Day-to-day:** System fine tunes performance against new objectives	**Adaptation Action Cycles:** Framework and series of questions for understanding decision-making processes and their outcomes (Park et al., 2012)
	Acting	**Highly entrenched:** Traditional scripts of behaviour and standard operating procedures prescribe actions	**Disparate and conflicting:** Outcomes and objectives unclear, actions become uncoordinated and may conflict	**Learning-by-doing:** Widespread experimentation with new practices to establish best practice	**Narrowing:** The range of activities narrows as the system becomes more efficient	**Transitions Management:** Applied approach for operationalising new governance arrangements (Loorbach, 2010)
Recommendations for governance processes	***Problem framing and visioning***	Focus on the framing of problems at a collective level, to generate recognition of need for change, and develop cognitive and normative basis	Use crisis as an opportunity to reframe problems and promote visionary thinking to inspire change	Collaboratively develop vision, embedding new cognitive and normative principles in new objectives to guide change activities	Listen to feedback and adjust visions and underlying principles through iterative negotiation and collaboration in order to operationalise visions and address issues	**Management & Transitions Framework:** Provides a comprehensive understanding of the operating context of the system (Pahl-Wostl et al., 2010)
	Strategising and implementing*	Develop change agenda and pathways for implementation. Identify barriers to the agenda, strategise how to pressurise them	Promote an all-options-on-the-table approach	Pursue multiple pathways for alternative solutions/practices/approaches. Develop solutions toward new objectives and principles	Pursue the alternative achieving the best performance while allowing shadow alternatives to continue to develop solutions for the future	**Planned Adaption Framework:** Provides a framework for diagnosing barriers to key management processes (Moser and Ekstrom, 2010)
	Monitoring and evaluating	Invest in monitoring system performance within the operating context, to consider the need for change	Invest in information gathering to understand root of the crisis, and how alternatives may perform	Ensure alternative solutions are implemented with sufficient investment in monitoring, so information on performance against traditional solutions and opportunity costs can be gathered	Invest in performance monitoring against specific objectives of the system	Project/Program specific monitoring frameworks and assessment tools
	Change agents*	Identify frontrunners and disincentives preventing their emergence/activity	Mobilise different forms of leadership to navigate crisis	Mobilise horizontal and vertical networks to provide informal systemic connections	Support peer networks to embed change through capacity building initiatives and informal exchanges	**Adaptations as Actions:** Assesses actions of actors to understand how they can contribute to or block change (Eisenack and Stecker, 2012)

* Continually foster informal networks and alternative technologies and approaches. These provide latent acting capacity and contingency solutions ready for the Crisis and Reorganisation phases.

7.3.2 Implications

In addition to contributing to governance scholarship with pragmatic recommendations and tools to supplement Transitions Management, this study has produced unique empirical insights into the informal processes of governance, thereby adding to current governance scholarship.

The cases of Perth and Adelaide revealed that the first key to adaptation was the questioning of underlying cognitive assumptions and normative beliefs. Without this disruptive activity occurring at a collective choice level, no basis or justification for exploring or pursuing any systemic change was generated. Therefore, the activities by which cognitive and normative institutions are disrupted are key to adaptive capacity. These include undermining assumptions and beliefs behind water management practices and disassociating the moral foundations of water management objectives.

In this research, a mechanism for these disrupting activities was found in discourse. Discussion between professionals led to new cognitive frames for water management practice, while public debates contributed to a reconsideration of the values and aspirations for water management. This finding adheres to a predominant assertion in the literature, that social learning to formulate new cognitive and normative understandings is an important adaptive capacity (Keen et al., 2005; Gunderson et al., 2006; Hjorth and Bagheri, 2006; Pahl-Wostl et al., 2007; Ison, 2010).

The results from this study illustrate that such learning can provide the background socio-political capital required for change (Morison and Brown, 2011), but can be more influential if tied to the collective choice level of institutional systems. If normative changes occurring in deliberative, participatory policy development processes are captured in shared visions and objectives, a more tangible outcome of social learning is generated (Sondeijker et al., 2006; Loorbach, 2010).

Global change literature often recognises a shared vision or direction as a success factor for change processes (Olsson et al., 2006; Voß et al., 2006; van der Brugge and van Raak, 2007) This research supports the notion that this can be attributed to the development of shared normative ideas underpinning the vision and its supporting direction, objectives or targets (Bos and Brown, 2012). However, the results suggest that research into how social learning translates into various institutional instruments (cognitive, normative and regulative) will provide greater understanding of how social learning contributes to the adaptive process. This could also help provide more tangible justification for inclusion of social learning mechanisms in various governance activities, by showing, more concretely, how they add value through greater acceptance of, commitment to, and successful implementation of initiatives.

Further to this general insight on social learning, the research uncovered that professional learning is also a key knowledge gap for understanding adaptive governance in resource management regimes. These results are conducive with other studies in that leaders, champions, frontrunners, entrepreneurs and networks are critical for coalescing new concepts into communicable messages, (Biggs et al., 2010; Westley et al., 2011) and elevating cognitive and normative ideas to a collective choice level through discourse (Huitema and Meijerink, 2009). However, this research also suggests two key factors related to the roles of these champions; the need for something to champion and a context that enables them to do so.

The results in Perth showed a situation where champions or frontrunners were not evident. This was attributed to a lack of an accepted and trusted alternative for them to champion, and a conservative professional culture that did not place value on continual improvement through innovation, but rather, improvement through optimisation. In Adelaide, proven technical solutions provided an alternative practice to promote and the reputation of being an innovator was also viewed as a desirable professional identity. These results suggest that more attention needs to be paid to how cognitive change occurs at a disciplinary level, to develop new cognitive frames and understand how a culture of innovation develops. Much work has been done on individual cognitive and normative change in the context of sustainability education, engagement and behaviour change studies. However, the occurrence of these processes within the professional schema is a significant knowledge gap in the urban water literature (Brown et al., 2011). Therefore, while the literature calls for inter and trans-disciplinarity, a greater understanding of the cognitive frames of different disciplines is needed for deeper learning, collaboration *and* changes in professional identities (Martin, 2005).

As well as professional cognitive change, the results from Perth suggest that, if leaders and networks are critical carriers of adaptive capacity, attention needs to be paid to the institutional context in which they emerge. Incentives and disincentives for innovative thinking and action are contained within the compliance mechanisms of formal and informal rules-in-use. Understanding how these encourage or discourage actors to think and work 'outside the box' will be important to ensure champions can emerge and alternative ideas and solutions circulate and develop through professional discourse and networks. Coupling this knowledge of the need for professional and cultural change with organisational change frameworks, such as Jeffrey and Seaton's conceptual model of receptivity (2004) may help understand not only how disciplinary cognitive change occurs but also how change comes to occur at the collective choice level to enable institutionalisation of new ideas of professionalism.

Another related insight was that processes to elevate issues and ideas from operational to collective choice levels and to translate those from the collective choice to the operational, are critical for adaptation to occur. Each of these levels supports the other as the system reconfigures and consistency between cognitive, normative and regulative instruments underpinning these levels of activity are required for this mutual support to be generated. While the disconnection between policy (collective choice) and implementation (operational) is well recognised in the literature (Chanan et al., 2009; Werbeloff and Brown, 2011; Termeer et al., 2012), the current mechanisms for bridging this gap are the activities and strategies of boundary spanning actors (Pahl-Wostl et al., 2007; Huitema and Meijerink, 2009; Morison and Brown, 2011; Westley et al., 2011). These findings suggest that paying closer attention to the cognitive, normative and regulatory instruments employed by these actors to forge connections within and between these levels will show how this support for adaptation is fostered in more depth.

The research also offered insight into the idea that a crisis can open the way for change processes. The literature advises that preparing alternatives to promote and instil when times of crisis destabilise current institutions is a pertinent strategy to turn the crisis into an opportunity (Kingdon, 2003; Folke et al., 2005; Keath and Brown, 2009). Examination of the Perth case illustrates that with enough system lock-in, the recognition or perception of a crisis may be delayed. Subsequently, investment in

developing alternatives is difficult to justify, especially from the public purse or in a corporatised water sector.

The literature also advocates for reflexivity (Kemp and Loorbach, 2006; Gunderson et al., 2007) and monitoring and evaluation to assess feedback to the system and recognise a crisis (Walker et al., 2004). However, this research suggests that not only feedback mechanisms are needed to recognise crises, but also that these assessments need to circulate to generate widely held perceptions of the crisis in order to prompt action by a range of social actors. As a corollary to this finding, disruptive institutional work by actors may manufacture a crisis, by generating the perception that the system's function or structure is dissonant to its context or cognitive and normative foundations. Such a perception, if elevated to a collective choice level, may legitimise the need for change (Fuller, 2010). Thus, while research into understanding tipping points and other feedback mechanisms that inform proactive decisions and planning is needed, understanding the perception of crises in a broad range of social actors may also prove useful.

7.3.3 Critical reflections

Given the paucity of knowledge on institutional dimensions of change in sustainability scholarship, this research has taken an exploratory approach. As such, the scope has been limited to initial insights into the processes of adaptive capacity in practice. Further empirical study and application of various elements of Table 7.1 are needed to test this exploratory work. For example; Are maintaining dynamics really key processes in stabilising governance regimes? Can a crisis phase be avoided by following these strategies and recommendations for governance? Will fostering networks generate the right dynamics and cognitive/normative developments throughout the Adaptive Cycle? How does one employ creative and disruptive work to unlock locked-in systems? While these questions are pertinent to practice, by providing this matrix of adaptive governance and its underlying conceptual framework for understanding different dimensions of institutional dynamics, this research has produced a way to structure adaptive governance knowledge to start exploring these questions in a systematic way, matched to a framework for implementation. It has also generated some key empirical insights into governance for future exploration.

7.4 INSTITUTIONAL CONTEXT MAPPING

7.4.1 Achieving the research aim

As was alluded to in the previous section, in the course of this research a method was developed to map the institutional context of urban water governance, thus meeting the aim – *to empirically map the dynamic institutional context of urban water governance*. Following the literature reviews conducted to date, this framework and supporting method appears to be unique in its ability to capture a number of dynamic dimensions of the institutional system and with its actor-orientated focus, returns relatively applicable results for implementation. This feature may prove useful to supplement the existing tools listed in Table 7.1 by adding temporal and/or agency dimensions to their analytical power. Further, in providing a tool to conceptualise and analyse formal and informal institutions in a dynamic way, this research fills a significant gap in current methodological resources available to generate knowledge of institutional contexts and processes behind resource governance.

7.4.2 Implications

In developing this framework to describe and analyse the dynamic institutional setting of urban water, this research has developed a theoretically grounded but operationalised tool to understand systemic change processes. This methodological development aligns with a broader turn in the global change literature toward diagnostic approaches to analysing sustainability problems (Young, 2008; Moser and Ekstrom, 2010; Ostrom and Cox, 2010; Pahl-Wostl et al., 2010; Ferguson et al., 2012). Scholars argue that diagnostic methods are needed to i) attempt to disaggregate issues and understand interdependencies in complex adaptive systems, ii) provide a way to focus on underlying nature and cause, and iii) develop knowledge to target solutions at leverage points in the system to maximise success rates. Scholars argue the diagnostic method provides a way to address specific problems in ways that are attentive to the connections to and influences of broader contexts and scales (Young et al., 2008; Cox, 2011) and temporal dimensions (Moffatt and Kohler, 2008). By developing and empirically applying a framework capable of capturing the internal workings of the institutional system, its scales of activity and position in cycles of adaptation, this research has generated an analytical tool and theoretical propositions to further this growing research agenda.

7.4.3 Critical reflections

When examining the maintaining institutional activities during the empirical analysis, it could become difficult to distinguish between embedding and enabling work and some creative activities. These types of work produce a similar effect in instilling new concepts and practices. This suggests further empirical application is needed to refine Institutional Work theory, in order to clarify the specific activities occurring within the types of work. Examining the processes behind these institutional activities and their effect on the overall institutional system in more depth is needed to explore how institutionalisation of new rules and understandings occur.

With regard to the mapping method developed, a key area for improvement lies in methodological techniques to access the tacit knowledge where informal institutions exist. The applicability of these results and their acceptance by practitioners indicate a level of success in generating relevant and robust data. However, further work to develop suitable methods for unearthing and capturing the rules-in-use from cognitive psychology and other relevant disciplines will greatly contribute to future research in this area.

7.5 ANSWERING THE RESEARCH QUESTION

By combining the research results and insights with existing scholarly theories, frameworks and tools, this research has produced a toolkit for guiding adaptive governance processes (Table 7.1). This toolkit:

- Enables identification and characterisation of institutional systems to understand where in an adaptive cycle a governance regime is situated;
- Provides an understanding of the adaptive processes underlying the system *and* those it might need to aspire to in order to shift to the next phase of adaptation;
- Recommends how governance processes can be geared to influence or utilise these institutional dynamics, in order to build the appropriate forms of adaptive capacity; and

- Suggests tools capable of generating more detailed and specific knowledge to inform or assess institutional conditions, forms of adaptive capacity, or governance processes.

In doing so, this thesis has provided answers to the overall research question – *How can urban water governance more effectively support institutional adaptive capacity, to enable and advance a shift toward sustainable urban water management?*

The exploratory, empirical research within a well-framed research design resulted in a methodology that is transferable beyond urban water. While this approach allowed generalisations, care should also be taken in finding their relevance beyond the context of democratic systems of government and western culture. Nevertheless, the results indicate that the institutional perspective can offer significant insights into problems of sustainable resource governance. With further empirical application in a variety of cultural and governance contexts, scales and resource sectors, the tools and methods developed herein have potential to produce knowledge on how institutions function over time. By capturing institutional dynamics at a level of abstraction that allows meaningful comparisons across cases, while remaining cognisant of contextual details, this toolkit provides a starting point for understanding and generating institutional adaptive capacity in resource governance regimes.

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CONCLUSION

It is now well recognised, in policy and practice, that the management of fresh water resources face significant challenges in the future. Achieving sustainable use of these resources in an urban context is an economic, social and environmental imperative for intergenerational equity. Our knowledge of how to engineer new technologies to meet future challenges of climate change, population growth and diverse societal needs, is no longer the prime barrier to this pursuit. Understanding the socio-political conditions that underlie how water is governed and subsequently managed is now the key knowledge gap.

This thesis has sought to bridge this gap, by using an institutional perspective to connect theories of social change with empirical examples of urban water management. This approach has yielded preliminary understandings of the processes and instruments behind adaptive capacity. Without developing the capability to be flexible within the urban water management profession and the hydro-social contract with urban communities, alongside adaptable infrastructure, future uncertainty will continue to tie cities to unsuitable water management systems.

This research has revealed that as actors navigate their institutional systems through various maintaining, creating and disrupting activities, they generate change dynamics; working on the cognitive, normative and regulative instruments that support water governance, professional practice and cohesive society. Illuminating the nature of these institutional instruments and targeting institutional work toward certain dynamics, can help the system recognise the need for change in governance processes (learn), determine when a new approach is called for (decide) and plan how to pursue a change agenda (act).

This Learning-Deciding-Acting perspective produced through this research not only poses a new way of understanding adaptive capacity but aligns to key questions of practice – why, when and how. By attending to these pragmatic concerns with theoretical development from empirical insights, this thesis has gone some way toward bridging the research – practice gap between adaptive governance and sustainable urban water management.

APPENDIX A: LIST OF PUBLICATIONS

JOURNAL ARTICLES

- Bettini, Y., Brown, R.R. and de Haan, F.J. (under review). Propositions for a theory of institutional adaptive capacity. *Global Environmental Change.*
- Bettini, Y., Brown, R.R., de Haan, F.J. and Farrelly, M. (forthcoming). Understanding institutional capacity for urban water transitions. *Technological Forecasting and Social Change.* Accepted 4/5/2013.
- Bettini, Y., Brown, R.R. and de Haan, F.J. (2013). Water scarcity and institutional change: lessons in adaptive governance from the drought experience of Perth, Western Australia. *Water Science and Technology,* **67**(10): 2060-2068.

BOOK CHAPTERS

- Bettini, Y., Rijke, J., Farrelly, M. and Brown, R.R. (2013). Connecting levels and disciplines: Connective Capacity of Institutions and Actors Explored. Chapter 7 in Edelenbos J., Bressers, N. and Scholten, P. (eds) *Connective Capacity in Water Governance.* Ashgate Publishing: Farnham, U.K.

CONFERENCE PAPERS (PEER REVIEWED)

- Bettini, Y., Farrelly, M., de Haan, F.J. and Brown, R.R. (2012). Achieving Water Sensitive Cities: Institutions as building blocks of collective action. *7th International Water Sensitive Urban Design Conference,* 21-23 February 2012. Melbourne, Australia.
- Bettini, Y. and Brown, R. (2011). Water crisis and institutional adaptive capacity: Lessons from the Australian Experience. *12th International Conference on Urban Drainage,* 11-16 September 2011. Porto Alegre, Brazil.

INDUSTRY REPORTS

- Bettini, Y. (2012). Adelaide Case Context Report. *Monash Water for Liveability/School of Geography and Environmental Science, Monash University*. September 2012, Melbourne.
- Bettini, Y. (2012). Adelaide Case Study Report. *Monash Water for Liveability/School of Geography and Environmental Science, Monash University*. December 2012, Melbourne.
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APPENDIX B: RESEARCH PROTOCOLS

B.1 PHASE 2: DATA COLLECTION

This phase of the research sought to collect contextual information surrounding the practice of managing water in each city, and a potted history of the way the city responded to the water scarcity of extreme drought conditions, in terms of the practices used and institutional changes that were made.

B.1.1 Participant selection

1. Using key informants who had conducted recent research in each city, a list of a dozen potential participants who were active in each city's water sector during a substantial part of the drought period. This list included people from a wide range of areas in the water sector including local government, state water and planning policy areas, consultancies, water utilities, land developers and peak industry bodies, in order to ensure a broad perspective.
2. In addition, a number of practitioners working at a national scale were identified to provide a broader and sometimes comparative perspective of the water sectors in each city.
3. Participants were contacted via email with a short introductory explanation of the research and the purpose and agenda of the interviews.
4. For those interviewees who responded to this request, a convenient time for an interview was arranged.
5. A second request was sent to potential participants if no response had been forthcoming after a week. In some cases this resulted in a response or a referral to another suitable participant from within their network.

B.1.2 Interview design

1. Interviews were conducted over the telephone from October-November 2010. Duration of interview was an hour on average, ranging from 40 mins to 80 mins.
2. Interviews were semi-structured, in an effort to allow the rich experiential insight of interviewees to emerge by allowing their narratives to flow. An interview guide provided a set of key questions with which to prompt interviewees onto the topic of interest (see Table 1). In the style of (Yin, 2009) two levels of questions were used, first level being the questions asked of participants, and second level questions indicating the information the first level question sought to draw out. This guide was used to help the interviewer steer the interview, while allowing the participants own narrative to be captured.
3. Interviews began with a short overview of the research objectives, an explanation as to the purpose of the interview and how it would contribute to the overall research questions.
4. An icebreaker was used to start conversation flow by asking the participant for a short overview of the various roles they had over the course of their career in the water sector.
5. Then as described above, the general topics of the interview were prompted using the interview protocol. Questions were paraphrased or adjusted to suit the flow of the conversation, and the interviewer only used this when the conversation faltered, and then not in any specified order, trying to match the next topic of

conversation to the interviewee's previous discussion so as to keep the narrative flowing. As such interviews did not always cover all topics. The interviewer was also free to expand conversations if they were felt to be offering or leading to significant insight for the overarching research questions and objectives.

TABLE 1 INTERVIEW GUIDE

First Level Question	Second Level Question
Could you give me three words that describe the X water sector at the moment for you?	Ice breaker
Can you sum up the underlying philosophy or direction for managing water in X at the moment?	Service delivery requirements Paradigm Shared language/concepts
Reflecting back on your time working in the water sector, what would you say the most notable change has been? What was behind that change? How did it come about?	Identify what has changed in the sector What drove the change: Seeking drought as major driver Or other landscape factors How was did this change manifest? Seeking processes, advocacy, policy directions, niches
Have there been some key milestones, events, decisions, people, groups that have been key in shaping the development of the water sector? What effect did they have?	Identify what has shaped the cities approach to water management What influenced the sector and how this happened Linkages between these factors.
Can you think of a particular innovation – a new way of thinking about urban water, new way of doing business, new design principles or technology, or innovative project which you know the story of? How did it originate? How was it implemented?	How changes occur Processes, planning activities, networks Roles, who has to be involved and why. Translation to practice. Linking driver to actions to outcomes
To what extent do you think the rhetoric around urban water management in policy, public debate, legislation etc. is reflected in water management practices? What do you think is the reason behind this gap/match?	Distance between policy and practice Who's involved in policy and practice? What are the relationships like? What links policy to practice?
What do you think is the biggest issue in terms of urban water supply management in X in the future? What do you think it will take to address this? Do you think the sector is capable of doing this in its present state?	Capacity to adapt. Future planning issues and strategies
How do you think X's water sector is placed on a national/international level?	Self-assessment.

B.1.3 Data recording

1. Interviews were recorded and brief notes also taken. Audio recordings were edited to remove parts of non-relevant conversation (such as introductions and the introductory speech of the interviewer) then transcribed verbatim.
2. The interviewer also recorded personal reflections after each interview.
3. Audio files, transcripts and personal reflections were uploaded into NVivo.

B.2 PHASE 2: DATA ANALYSIS

Phase 2 in this research design is concerned with building the contextual understanding of each case city, in particular identifying the drivers of change and the responses in the institutional underpinnings of the urban water sector.

B.2.1 Scoping interviews

1. Interview data transcribed verbatim.
2. All interviews read through, notes taken on key points for each interview, to familiarize and get a sense of common themes across the data set.
3. Interviews theoretically coded using a variation of Multi-level Perspective (Rip and Kemp, 1998; Geels and Schot, 2007) with three levels :
    - Statements on management practices. Coded as 'Practices'
    - Statements on formal rules/regulations/governance arrangements. Coded as 'Rules'
    - Statements identifying an influence on water management practices were coded as 'Landscape.' These could be a wide range of features including events, new technology, concepts or understandings, influential relationships etc.
4. Landscape coding results were extracted within NVivo. A second level of coding applied following axial coding technique applied to begin to conceptualise the data. Through this process, themes were developed that encompassed and described and storylines expressed in the data.
5. Coding themes continually refined, recast or combined throughout the coding process. While many themes may show some connection, themes with large amounts of content are generally left as their own theme, or may be added to with a similar theme that contains small amounts of material. Closely related themes with relatively small amounts of content are combined. This process refines the number of themes to a manageable size.
6. Coding results for each Landscape theme extracted from Nvivo. Coding results examined and a short description of the theme composed and saved within the 'Code Properties' meta-data window of NVivo. A summation of key storylines under each theme is then compiled for the Case Context Report. Both opposing and contradicting views were described. Interrelation between themes was also described where this relationship was reflected in the data.

B.2.2 Secondary sources

Secondary sources we used in the following ways throughout the analysis of Phase 2 data. Citations are fully reference in the Case Context Reports.

- Firstly, in constructing the background narrative on the history of urban water management in the city, secondary sources were drawn on to build upon and cross-check the information provided by participants. These sources included published historical research, background research reports and government policy documents.
- In documenting the management practices employed to cope with the effects of the drought, secondary sources were consulted to clarify details and verify dates given by the interviewees. Sources included predominantly government policy

documents, official media releases, media articles and website content of relevant organisations.

- In describing the formal institutional setting, secondary sources were used to clarify and expand descriptions from interviewees, and to ensure all relevant organisations were included. These sources included legislation and department and agencies' websites.
- In the construction of the themed narratives under the Landscape level coding, secondary sources were drawn on extensively to both elaborate and validate the interviewee's commentaries, and to explore inconsistencies, conflicts and contradictions in their accounts. A wide range of sources was consulted including published articles and publically available research and consultancy reports, government policy documents, media articles, official websites and communications material such as fact sheets.

B.2.3 Data reporting

The narratives constructed in the analysis were documented in a Case Context Report. Quotes from interviewees were used to supplement the narratives presented in these Case Context Reports, and also to introduce the voices of the interviewees themselves to the data reporting. This document provided a reference for the deeper analysis of the case study in subsequent phases of the research design. The report included the following commentary:

Water Management Practices

A brief overview of the evolution of the city's urban water management system, focusing on water supply strategies and including the recent history of water management practices used to respond to the drought-related water shortages.

Using scholarly research to supplement the historical details contained in the 'Practices' coding results from interviews, a brief summary of the city's water supply practices from time of settlement to current were derived. This commentary expanded in detail for the period of recent history, to list the succession of management practices employed deal with the water scarcity and some contextual information surrounding them, by using the rich commentary provided in the coded interview data.

Formal Institutional Setting

A brief description of the formal institutional arrangements in place for managing the city's water was provided, focusing on the roles and responsibilities of the key departments and agencies. Any commentary from interviewees related to these arrangements was included.

Using contemporary analysis of water governance arrangements in Australia and internationally, the formal institutional setting was broadly categorized and a brief description of its key features presented. Each of the key organisations involved in water management in the city was listed with a brief summary of their key roles and responsibilities. This information was drawn mainly from the websites of these organisations and relevant legislation.

Further commentary from the 'Rules' coded interview data was also included to add to this understanding of the formal institutional setting. In particular the nuances in how these organisations work together to conduct management practices.

Landscape Influences

A narrative surrounding each of the landscape themes identified in the analysis were constructed. A short initial conjecture from the researcher as to why this factor may be important to the study of the city's institutional adaptive capacity was included to test these initial thoughts with case study actors through the member checking process.

Constant contrast and comparison between the storylines contained in coded interview data and the secondary sources were an integral part of the writing up of these sections. The researcher's written material was constantly reviewed and rewritten in an iterative writing/research process. Beginning with the construction of a narrative of each theme based on the interview data; this was then tested through a review of secondary sources. The narrative was adjusted or rewritten to provide a fuller or richer account in light of this information. Where there was contradicting or conflicting evidence in interviewee's accounts, secondary sources were consulted for clarification. If secondary sources could not be found to provide such clarification, or the accounts of interviewees were difficult or inappropriate to clarify (e.g. individual perspectives), then both views were presented the narrative. These conflicting or contradicting accounts provided important anomalies that offered opportunities for deeper research and understanding, and therefore were documented in these reports for further investigation in subsequent research phases.

B.2.4 Validation processes

Internal and external validation techniques were used throughout the data collection and analysis process and included, in sequential order:

1. Interviewer corroboration: The semi-structured format of the interviews allowed the interviewer to introduce perspectives and accounts from previous interviews to provoke discussion through collaboration, clarification or conflict with the interviewee. Such additional information or alternative perspectives were in this way included in the interview data.
2. Member Checking: This technique was employed in two ways. Firstly, the Case Context Report compiled following Phase 2 analysis was sent to key informers for feedback. Secondly, during Phase 3 of the research, preliminary insights on 'Practices' and 'Landscape' were included as an 'ice-breaker' discussion topic for the workshops. This generated a focus group style discussion to provide a validation of these contextual results.
3. Peer debriefing: Throughout the research process, various formal and informal peer-debriefing sessions were conducted with the researcher and her supervisor, with other research colleagues, and with key informers from each city. This helped to bring clarity and to strengthen the narratives presented by the researcher.

B.3 PHASE 3: DATA COLLECTION

B.3.1 Workshops

These workshops sought to identify some of the mechanisms and dynamics of institutional change, by seeking the informal institutions that influence the practice of water management. The research anticipated these influences would be found in the experiences and tacit knowledge of urban water professionals, and the workshops were thus designed to identify and map some of these influences.

Participant selection

1. Using key contacts, potential participants from a wide range of roles and organisations were identified as being able to contribute to the research through their professional experiences and activities, and potential willingness to be involved.
2. An email invitation was distributed using contact details provided by key informants or through publically available lists, describing:

    - The aims of the workshop and what type of information it is seeking to collect
    - The qualities of participants being sought and what they might expect to gain from participating.
    - Details of the different workshops and their different focus topics (supply & sewerage, drainage and waterways, urban planning)
    - How the workshop would contributed to the overall research project
    - A brief workshop agenda with key questions participants will be asked to consider

The email also invited contacts to circulate invitation to relevant networks and colleagues where invitee thought it may be appropriate.

Workshop design

The workshop was limited to 2 hours over afternoon/morning tea, with refreshments provided, to try and make it attractive and achievable for participants to attend. The agenda was structured as follows:

1. Introductions – participants were asked to introduce themselves by identifying what they saw their role as an individual in the water sector of their city is (i.e. not what their role in their organisation is). This was an attempt to get participant to think beyond of their participation beyond as representative of their organisation.
2. An introductory presentation was given which included:

    - Framing of the urban water management problem as a governance problem, with institutions the structures that underlie governance.
    - Definitions of institutions and justification why the research project specifically targets informal institutions.
    - How the research hopes to contribute to urban water management pragmatically.
    - Ground rules to create safe environment for participants to share their experiences.

3. A brief presentation on the results of Phase 2 was then presented for feedback through an open discussion.
4. Exercise One: Identifying Influences (Individual reflection)

    - Participants were asked to reflect on what influences their work in both positive and negative ways, and record these as a statement on separate colour-coded post-it notes (Blue = positive influence, Pink = Negative influence)

5. A short explanation of Ostrom's (1998) action situation was presented as a way to organize data. This explanation focused on describing outer working rules of this framework, as these represent the part of the conceptual framework the participant's influences were being used to expand and explain. A tangible

example relevant to the workshop audience was used to make this abstract model a little closer to their experiences.

6. Exercise Two: Mapping Influences (Group activity)
    - Participants were asked to stick their post-it notes on a whiteboard around a diagram of the action situation; connecting them to the components(s) they thought these influences acted upon. They were invited to duplicate post-its if they saw an influence connected to more than one component.
    - The connections were discussed one-on-one with participants if they seemed to be struggling to map their influences.
7. Refreshment Break. Participants were asked to read over the whiteboard to get a sense of others participants' contributions. During the break, the researcher picked out reoccurring influences to use as discussion points for the next exercise.
8. Exercise Three: Linking Influences (Focus group)
    - Using common influences identified from the whiteboard, discussion was prompted on how this influence was connected to the component of the action situation participants had identified.
    - The researcher then expanded discussion to identify how the 'influence' may link to other components of the action situation.
    - The above line of discussion was continued with as many influences as the time allowed, encouraging the participants to identify the influences and linkages they thought important to discuss. The researcher also prompted discussions toward positive influences, as the discussion tended towards the negative influences and linkages.

Data Recording

1. Feedback on the Phase 2 results was recorded and notes taken.
2. Participants recorded their individual reflections on post-in notes, which were collected and transcribed after the workshop.
3. The group discussions were audio recorded, and the researcher also attempted to capture key points on the whiteboard with arrows and explanatory text. The researcher continually offered interpretations of the discussion as these points were documented checking if the participants were happy that this represented what had been said.
4. The whiteboard used to map and individual reflections against the action situation was photographed in high resolution to ensure the details of the post-it notes could be read.
5. The researcher also documented personal reflections following the workshops.
6. All this material was uploaded into an NVivo project.

B.3.2 Interviews

These interviews aimed to further explore the results of the workshops with key informants who had been involved in past change processes, and thus would have experience of institutional change, and be able to identify some of the mechanisms and dynamics, prompted by the workshop outcomes.

Selection of Participants

Practitioners recognised as champions, leaders, or part of a network that were actively involved in past or current initiatives to prompt change were identified by key informants and using the snowball technique during interviews. They included people

in executive level positions in water utilities, local government, state government and government agencies, and some who had retired from the industry. This provided an opportunity to internally validate these findings with a different set of participants from those attending the workshop, with a broad and strategic overview of how the urban water sector functioned.

Interview Design

Interviews were unstructured, with preliminary insights from the workshops, illustrated in the concept maps, used as talking points. This allowed interviewers perspectives to flow to corroborate, elaborated or dispute these insights. Interviews were between 45 – 60 mins.

Data Recording

Notes were taken to record the further insights. The research also recorded personal reflections after each interview. Notes and reflections were uploaded into an NVivo project.

B.4 PHASE 3: DATA ANALYSIS

B.4.1 Workshop Data

1. Post-it notes were transcribed and organised according to 'rules-in-use' participants associated their experience with. Observations/discussions which were documented in workshops were also included.
2. The whiteboard picture was then transcribed into concept mapping program (Cmap Tools)
3. This map was organised using principles of concept mapping:
    - Organise map around central focus questions of 'What are the influences on the action situation?'
    - Identify 'concepts' – place text in boxes.
    - Determine the relationships between concepts – describe in a line joining these concepts.
    - Identify 'propositions' (strings of concepts and relationships – colour coded in maps) which help to answer the focus question: *'What are the influences on achieving the potential outcomes of the action situation.'*
4. Using these maps, Post-it note statements and audio recordings of workshops, a discussion of each 'proposition,' for each topic area (Supply & Sewerage, Drainage and Waterway Health) was documented.
5. These discussions were ordered according to action situation components (related to Actors, Positions, Actions, Information, Cost/Benefits, Control, and Outcomes).

B.4.2 Interview Data

6. Interview notes were organised according to themes that emerged in the conversation.

B.4.3 Analysis

7. Raw and interpreted workshop data (From Steps 1 and 4) and Phase 2 interview notes (Step 6) were then coded according to Institutional Work categories (creating, maintaining or disrupting). A decision tree was used to guide this analysis, reproduced in Box 1.

BOX 1. INSTITUTIONAL WORK ANALYSIS: DECISION TREE TO GUIDE CODING

Does it indicate some sort of action or activity?

What actor is conducting this activity? What are they doing?

- Rule reconstruction, identity change, changing boundaries? CODE AS CREATING
- Supporting, repairing, or recreating compliance mechanisms? – CODE AS MAINTAINING
- Attacking, undermining compliance mechanisms? – CODE AS DISRUPTING

8. A query was run in NVivo to extract coding for each type of Institutional Work. [These reports are saved as 'Results' in NVivo].
9. For each report, each participant's quote was examined and the insights into the institutional instruments underlying each piece of coded text were documented using annotations in NVivo.
10. A summary commentary of each type of Institutional Work (creating, maintaining, disrupting) was compiled according to these insights [Saved as Memo's in NVivo].
11. All these commentaries were reviewed, and the predominant themes or domains where this institutional work was occurring in the water sector were listed (e.g. governance arrangements, information flow, professional capacity). [Note, this step was conducted with supervisor.]
12. The concept maps from workshops were then examined and combined into a consolidated map for each city. Configurations – or concepts and relationships - that linked to form a particular domain were identified. These configurations were highlighted using different colours.
13. Using the data above, a description of the institutional working occurring (at operational and collective choice) within each domain was compiled (categories and what effect it had on the urban water sector described. Participant quotes were used to highlight key findings.
14. For each domain, construct a matrix was constructed using the institutional work categories and differentiating between work occurring at operational levels and collective-choice. A short description of the Institutional Work identified for each area of the matrix was compiled.

B.4.4 Data Reporting

Results

15. Present generalized concept map, with coloured highlights to illustrate the origins of the domains.
16. Provide a matrix of institutional work categories for each theme. Using a 'traffic light' rating system, rate all the areas of the matrix according to the significant influence (green), negligible influence (red) or possible influence (orange) of this type of institutional work occurring.
17. Aggregate these results into summary matrix of Domains by Institutional Work, For example, if operational level is rated red, and collective-choice green, aggregated rating is orange. If operational is orange and collective-choice green or red (and vice versa), aggregated colour is green or red as the case may be.
18. Expand institutional work descriptions for each domain, with matrix table (step 14) as the introductory summary for each section.

Discussion

19. Aggregate the results into summary matrix of Analysis Levels and Institutional Work. Tally the colours for each area of the matrix from each theme, and choose the predominant colour. Provide a discussion of each of these areas of the matrix.

B.4.5 Validation Processes

A number of internal and external validation processes were used to ensure the results of the Phase 2 analysis were robust:

- Preliminary insights from workshops were used to structure discussions in interviews, representing an external peer review validation. This also helped to enrich the data from the workshops.
- Steps 11 and 12 above represent an internal validation process, where the domains that emerged from the concept map analysis and institutional work analysis were closely aligned (or not).
- In step 11, the themes identified from the institutional work analysis were produced in discussion between student and supervisor.
- The final Case Report documenting the research findings from Phase 2 was sent to key informants for peer review.
- A workshop was held to discuss the results with practitioners in Perth.

B.5 PHASE 4: DATA ANALYSIS

1. Identify areas of similarity and difference for cases using the institutional dynamics traffic light assessment tables (Step 16 of Phase 3 Analysis protocol).
2. Examine the consolidated concept maps for each city (from Step 12 of Phase 3 Analysis protocol), identifying configurations of rules-in-use and dynamics which underlie the similarities and differences observed in Step 1. Extract these visual configurations into diagrams.
3. Code all data in NVivo files to types of Institutional Work (maintaining, creating, disrupting) and to the level of specific activities of Work (eg policing, routinising etc.).
4. Code the data identified in Step 3 to Levels of Institutional activity (Operational or Collective Choice).
5. Tabulate results of coding to show types of cognitive, normative and regulative Institutional Work activities at operational and collective choice levels.
6. Using the coded material from Steps 3 – 5, construct an explanation for each configuration identified in Step 2.
7. Drawing on all available data, these explanations were elaborated and explanations cross-checked.
8. The results of the two cases were then compared to the prescriptions of the Adaptive Cycle, to position them as cases of Lock-in and Reorganization.
9. Narratives describing how these configurations connected to the management practices, governance changes and other manifestations of system change identified through the research were then documented, drawing on all the available research data and comparing the similarities and differences of the two case studies to iteratively raise questions from the data, and provide explanations.
10. Explanations of the processes behind each city's drought response were then mapped against the Adaptive Cycle, drawing on the narratives constructed in Step 9. This produced the 5 Step propositions on the process of adaptive capacity.

11. Propositions were distilled into their key activities (Learning, Deciding, Acting), and descriptions of the institutional work and instruments underlying these forms of capacity were then identified in the narratives from Step 9.
12. Drawing on the theoretical framing of the research, explanations of the possible institutional work, instruments and forms of adaptive capacity within the Crisis and Stabilization phases of the Adaptive Cycle were extrapolated.

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APPENDIX C: CASE CONTEXT REPORTS

C.1 Adelaide Case Context Report

Adelaide

Case Context Report

September 2012

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Preface

This report forms part of a PhD project entitled 'Processes and Pathways to Water Sensitive Cities.' The research seeks to provide an answer to the question *"How can urban water governance regimes more effectively support institutional adaptive capacity to enable and expedite a shift toward sustainable urban water practices?"* Adelaide, along with Brisbane and Perth, provide unique case to study this research question, providing an opportunity to explore how urban water institutions adapt following their exposure to over a decade of drought in the 2000's.

This report presents the urban water context of the city of Adelaide. The first section of this report provides a commentary recounting the succession of management responses Adelaide implemented to deal with increasing water scarcity. The second section presents a description of the urban water institutional setting in Adelaide. The final section of the report presents storylines that describe landscape and underlying influences on the practice of water management.

The report was compiled based data from semi-structured interviews conducted with Adelaide urban water managers from State and Local Government, SA Water, industry bodies, consultancies, other government authorities and departments involved in urban water issues, and research organisations. Interviews were conducted in October – November 2010, and June 2011, and were transcribed and coded to identify key broad 'landscape' influences on urban water management responses to drought over the last decade. Commentary representing the narratives of interviewee' accounts were then constructed by the researcher. Secondary sources of evidence were used to enrich, corroborate, and clarify these narratives, and to identify the structure of the city's urban water institutional setting. These sources are listed in the References section and include government policies, legislation and reports, academic articles, media releases and articles, research reports, and websites. The insights and ideas presented in this report were tested, discussed and further elaborated during two focus groups conducted in Adelaide. Key informants also provided feedback on the draft of this report.

This report will provide the basis for analysing and understanding the mechanisms and dynamics of institutional change occurring in Adelaide, by providing the contextual information to inform phase two and three of the research: i) the exploration of the interplay between landscape influences, institutional setting and subsequent water management practices within the Adelaide case study, and ii) between this case and the Brisbane and Perth case studies. These phases of the research will be documented in subsequent reports.

All views and thoughts expressed remain those of the author, except those in text boxes, which are direct quotes from interviewees.

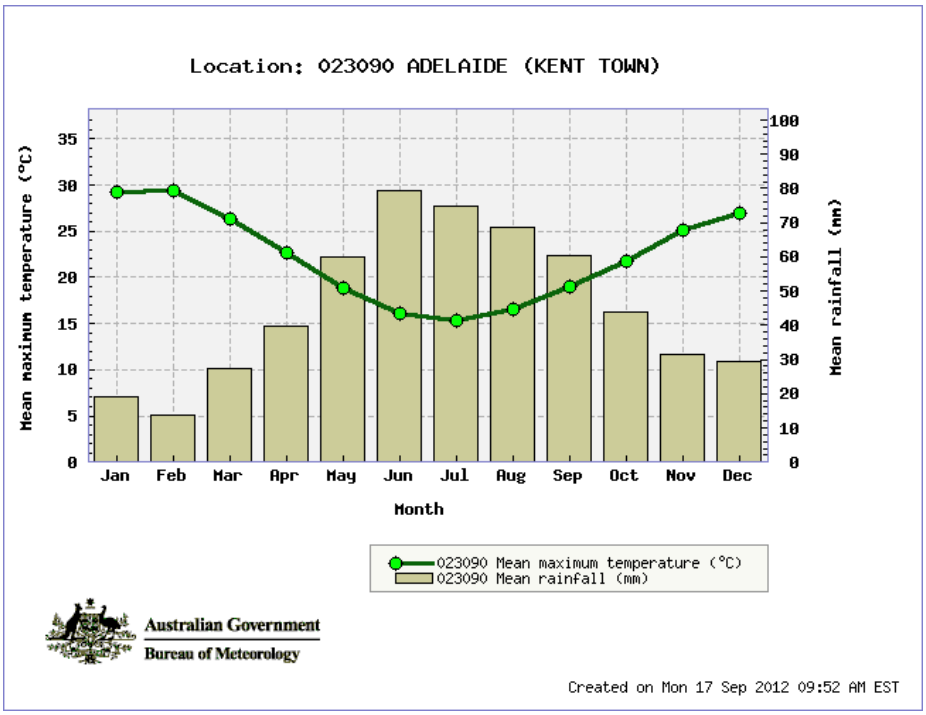
Background

Adelaide is a city of 1.2 million people[2], stretching 90km north-south along the eastern coastline of the Gulf of St Vincent, and spreading 20km east to the Mt Lofty Ranges[3]. Prior to European settlement, these Adelaide Plains were characterised by heath and mangroves along the coastline, grassland and low shrubs extending to Mallee Box woodland and other low and open woodland species toward the Mt Lofty Ranges.[4] With open vegetation and a predominance of clay soils, the regions waterways tended naturally towards high turbidity.

With a warm Mediterranean climate, summer rainfall is light and infrequent through the summer months,[5] South Australia is the driest of Australia's states and territories[6].

Source: Mapsof.net[1]

Figure 1: Mean Monthly Maximum Temperature and Rainfall for Adelaide[7]



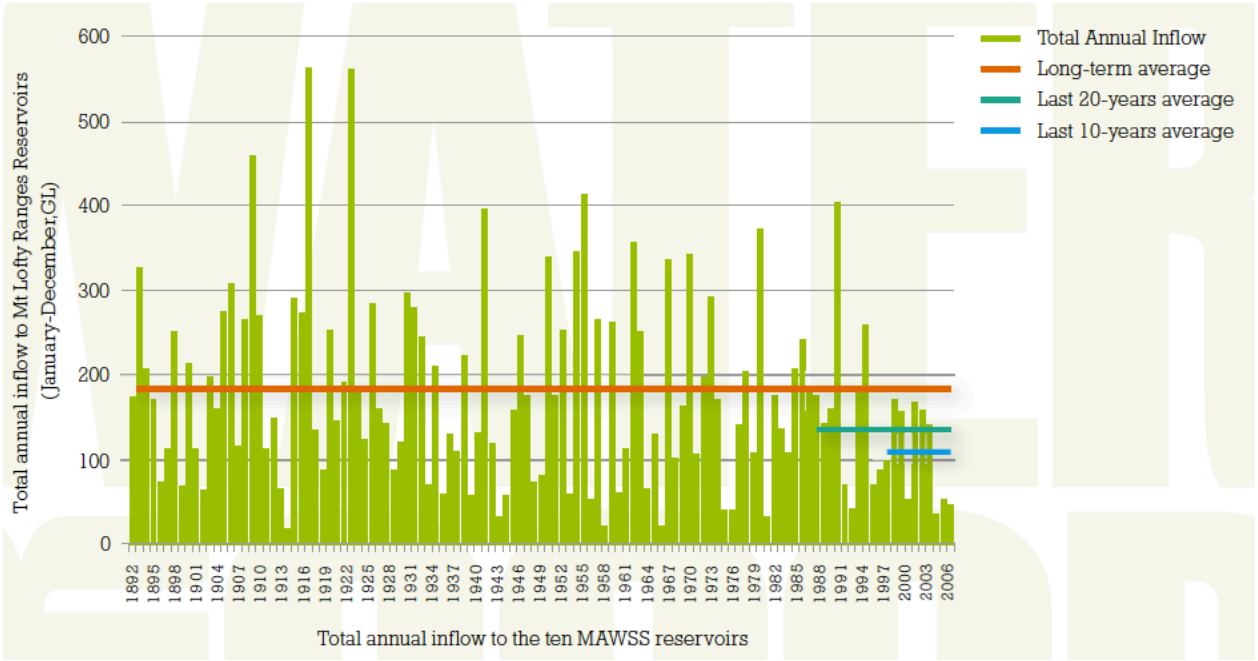
Since its European settlement in 1836[8], water supply has been at the forefront of Adelaideans' consciousness. The young city relied heavily on the River Torrens for water,[9] and as the city grew the river became stressed from extraction, modification, land-use change and pollution[9, 10]. Beginning with Thorndon Park Reservoir in 1861, the city's first reticulated water scheme[11], Adelaide's water engineers have met the challenging task of supplying clean, reliable water in a water scarce landscape. This task included dealing with significant water quality issues[10, 12], and water filtration and disinfection have long been features of Adelaide's water supply system[13].

Management Practices:

Managing Water under drought 2006-2009.

Like much of the south-eastern part of the Australian continent, Adelaide's climate began to shift to drier conditions in the late 1990's – early 2000's. During the late winter and early spring of 2006, South Australia recorded its driest period since records began in 1900.[14] The next three years until late 2009, the city received below average rainfall, and inflows to the city's water supply dams subsequently reduced (see Figure 2).

Figure 2: Annual inflows to the Mt Lofty Ranges reservoirs 1892 - 2006.[15]



In addition to this tradition reticulated supply system from the nearby Mt Lofty Ranges dams, Adelaide has, since 1955, drawn water supplies from the River Murray.[9] This supplies up to 80% of drinking water to the city,[15] and with the health of the Murray-Darling river system in serious dire straights during the drought, Adelaide's water security was under serious threat.

Inline with the water management industry across the country, Adelaide developed a discourse around 'drought-proofing' the state's water supplies through diversification of water sources[16]. Demand management strategies such as media information campaigns, permanent water saving measures and temporary water restrictions were employed to try and slow the draw-down of existing supplies. Recent legislative change to require rainwater tanks on new developments also helped to decrease demands. Additional storage capacity was also secured in the Murray-Darling river system to increase security of Adelaide's supplies. In 2007 the decision to build a 'rain-independent' desalination plant was announced[17], and in 2009 a further decision was made to increase the capacity of the plant to 100 GL/yr[15], enough to supply about half of Adelaide's current water demands[17].

Being such a dry state, Adelaide has had to be innovative when it came to securing its water supplies. Large schemes to recycle wastewater for fit-for-purpose use in horticulture and viticulture existed prior to the drought, constituting about 30% reuse of the city's wastewater. However an innovative niche in stormwater recycling via managed aquifer recharge had also been developed prior to the peak of the drought, within a local government. The City of Salisbury had been developing stormwater harvesting and treatment systems, first as a means of maintaining the health of the area's wetlands, and later, by developing aquifer injection technology, for watering public open space. As water resources became

scarer, the City of Salisbury recognised it had a significant asset in these stormwater reuse systems, and expanded their activities to begin supplying water for non-potable use to industry, agriculture, and within new housing estates.

As a more strategic response to the dry conditions, in 2008 the South Australian Government established an independent Commissioner for Water Security. This role provided coordination of water management efforts at a whole-of-government level, developing a long-term action plan to secure water supplies to 2050. This plan, *Water for Good* was released in 2010, and integrates a number of measures including infrastructure planning, policy development, water sector reforms, and community engagement in water management. Finally, in 2010 a State Government Department for Water was formed to take carriage of water policy and provide a focal point for water management activities, in collaboration with other relevant departments and agencies. In July 2012, this Department was amalgamated into the Department of Environment, Water and Natural Resources.

Formal Institutional Arrangements:

The formalised governance arrangements for urban water management in Adelaide.

The key organisations in urban water management and their roles and responsibilities with relation to water are described below:

- **Minister for Water and Minister for Planning**, have certain powers of delegation and approval/decision, to manage water or other activities relating to its management (such as land-use planning and development), on behalf of the people of South Australia.
- **The Department for Environment, Water and Natural Resources**, created in July 2012, is responsible for conservation, protection and management of natural resources, including water, addressing climate change, regulation of the water industry and provision or management of water, sewerage and stormwater services, facilities and schemes.
- **SA Water** is the State Government owned Corporation responsible for the provision of water supply and wastewater services.
- **Essential Services Commission of South Australia** is a State Government agency and independent regulator of water pricing, industry licencing and consumer protection.
- **Environmental Protection Authority (SA)** is a State Government authority responsible for the protection of water quality, and the control of pollution and waste, through the licencing and regulation of human activities that impact on the environment.
- **Adelaide and Mt Lofty Ranges Natural Resources Management Board** is a statutory authority with responsibility to plan for the management of natural resources in a holistic integrated way, through a regional NRM plan.
- **Local Governments** are responsible for local flood management, and land use planning and development approvals.
- **Department of Planning, Transport and Infrastructure** delivers the land use planning system to control the physical development of the State. This includes setting the land use planning policy framework, and long-term directions for planning and development, such as those set out in *The 30 year plan for Greater Adelaide.*
- **Land Developers,** both private and government owned, have an integral role in designing and implementing water management infrastructure often in close collaboration with the SA Water, and Local Government.

A new *Water Industry Act 2012* will open the water industry in SA for third party service providers, and will come into full effect from 1 January 2013.

Landscape Factors:

Broad trends, features, events and characteristics that influence practice.

These following sections describe the factors emerged from the interview data as significant influences on Adelaide's urban water sector. They represent broad landscape trends, features and events, or underlying characteristics that were not evident in the formal institutional arrangements described in the previous section. They were identified in the accounts of interviewees as having a significant influence on the practice of water management in the Adelaide context.

Environment

As in other Australian cities during this time, the drought was recognised as the main driver behind water management issues in Adelaide. However it was noted that the full impacts of the drought were felt in Adelaide over a shorter periods, and it was suggested that this intensified the response of the city.

'When the eastern states were experiencing drought for the last ten years, it didn't affect South Australia until the last few years…So drought, once it reached South Australia it did raise a lot of awareness.'

Water quality issues were also highlighted by interviewees as an important connection between Adelaide's environment and water management. River Murray water, which makes up most of the city's supply, has high turbidity and salinity[18], while the remaining surface supplies run-off populated catchments which include some intensive agriculture. The water supply in Adelaide has a history of various forms of treatment,[18] while the city's history records many public debates surrounding drinking water quality and the health of it aquatic environments.[10]

'The main issue back then has been Adelaide's water supply quality because we've got open catchments and a lot of colloidal clay material, typically our run-off is very murky, and that combined with River Murray water which has got a high suspended load fraction...'

Some interviewees also noted that flooding problems in the city had driven the development and uptake of water sensitive urban design solutions in the past. These had been recognised as a way to hold back and treat the first flush of stormwater, in order to reduce volume and pollution loads entering Adelaide's coastal environments.

'…flooding has always been an issue. The stormwater management system wasn't particularly great; and when you get combinations of heavy rain and king tides you tend to get flooding, so it was part of the then engineer's rationale to slow down and detain for at least a period water in major rain events. So that would be early exposure to water sensitive urban design.

Environment-Water Connections

Throughout the interviews the knowledge of and engagement in integrated water management by the Adelaide community was highlighted in a number of ways. Foremost it was recognised that the significant engagement work conducted by the Catchment Management Boards (now Natural Resource Management Boards) had been building water management literacy within the Adelaide community since their establishment in the 1990's. Complimentary to this is the city's identity being closely tied with its beaches,[19] and significant recreation activities in these costal environs make Adelaideans' highly conscious of the catchment-to-coast effects of water flows. Another significant environmental

'The water quality of Adelaide's beaches is fairly poor after a stormwater or rain event… people have seen discharges of polluted water out to the Gulf. So that's raised community awareness.'

'Water restrictions was always linked to the health of the Murray.'

connection in community consciousness is the high reliance of the city on water from the River Murray. This has driven many activities in the past concerned with improving the health of this iconic river, including the South Australia Government taking the position of advocate for the River in political debates on the management of the Murray-Darling Basin[20].

'…people in that area are very much environmentally conscious so they look at everything council does.'

'You were only three months off the water level dropping so much that there'd be so much acid sulphate soil…so you could end up with a situation instead of having too much salinity at the pumps at Murray Bridge, actually having sulphuric acid-related water. And regardless of the environmental impacts, it was close to a catastrophe, and I don't think that message really has penetrated enough.'

More specifically through the drought, this underlying appreciation of water management and catchment/coastal health connections meant that the community recognised the multiple values of some alternative supply solutions. In particular, the benefits of harvesting and treating stormwater in terms of reducing high pollutant loads to the oceans and securing fit-for-purpose water for keeping public open space green. This appreciation seeded public pressure to find new and innovative ways of managing water resources, and resulted in political will to implement these novel solutions.

With such a high level of awareness in the Adelaide community, some interviewees noted that expectation management was a key job, to make sure the community understood all the rationale behind descisions on water management and supply. And despite understanding integrated water management principles, some interviewess noted that an apreciation of the complexity of the task is still not acknowledged in the general community.

Realisation of Water Scarcity

'Apparently there was this kind of standout meeting between CEOs of key departments …and the fact that we were in serious trouble… escalated it politically and it wasn't probably until the real implementation of water restrictions got more publicly recognised as an ongoing issue.'

'Over the last two, three years, councils have reduced their water use for parks and reserves, so community have seen those dry up…a lot of trees have died as well so, again, it's very visual… so awareness is very much out there.'

'I think there was heightened awareness in government and a process had been initiated and then the community weren't that concerned or didn't know; then they had a year of water restrictions and thought, "Oh it's only a year, not going to be a problem," and then a second year, that probably drove a concern.'

Although, with a high reliance on the River Murray, the residents of Adelaide were aware of the threat of dwindling water supplies, a number of interviewees recalled that a 'crisis' type trigger was still needed to bring water scarcity into public debate. Growing water supply threats were raised at a high level of Government, and a number of initiatives were put in place to address water scarcity. Some interviewees believed that the public saw Government taking action and did not rate water supplies as a concern. However, after the second year of tight water restrictions, there was a rise in community anger over the issue. This rising concern was reinforced by visual clues in the environment such as drying parklands and dying vegetation. Water price rises also promoted the community to begin to ask questions about whether their water resources were being managed in the best way they could be.

Communicating Water Issues

A number of participants discussed the role of the media in water debates. They noted how the driver for the media is to present themselves at the forefront of the public debate. As such, their portrayal of water issues was often highly simplified and proposing 'silver bullet' solutions to communicate to their readership. This created a lot of misinformation about water issues, and bias toward particular solutions in public opinion, and required water management organisations to put effort into expectation management. In addition, portrayals of Government activities in the media were often not positive, and some participants were frustrated that, despite putting effort into communications, stories about initiatives to deal with the crisis were not picked up. However, participants also noted that the media attention did drive better resourcing, albeit of the 'popular' alternative solution.

'There's been a fair bit of interest, politically and publically about stormwater management…; and every time it rains and people see stuff running out to sea there's a lot of media about wasting this water, building this big de-sal plant, etcetera.'

'The media is just after sensational stories and so it just seems to be that they're just well whose fault this is, is it government's fault…'

Some participants also noted problems caused by different 'experts' in the industry stating opposing positions on certain issues. These mixed messages created confusion for the general public, and generated some distrust in the science, organisations or individuals of water management.

'What has happened is there are comments made by people who have not had sufficient experience in it.'

'You have old school thinking still influencing the public debate.'

One participant also noted problems communicating to the public when the drought breaks, as attention is diverted to other issues. Post-drought the only water information people become receptive to is their water bill, and this makes it difficult to provide justification for the rising water prices, as people no longer see the resource as scare.

'During the drought people would listen; out of the drought when the water's there and no restrictions, it's much, much harder to get those messages across. Yeah. They just see a bill.'

Hydro-Social Contract

(The Hydro-social contract refers to the informal expectations of Adelaide's citizen's around the provision and use of water.)

Community water literacy, the realisation that water supplies were becoming low, and recognition of this in communications and media, has generated debate about the provision of water supplies. While there have been some polarised views as to what the 'best' options and solutions may be (see discussion in Communicating Water Issues above), many interviewees noted the Adelaide community were, by and large, pushing for the consideration of a range of options over longer-term planning horizons, largely driven by concerns over the costs and impacts of the desalination solution, and the health implications for the River Murray. It was noted that the past and present work of Natural Resource Management Boards have helped to create the informed and engaged community which is needed for this type of healthy public debate.

'…the community continue to be really concerned about looking at the best options in terms of all solutions, not just what's the easiest thing to do. 'During the most recent state election it was one of the main issues, which of the main two parties would do the most stormwater harvesting and which would do the least de-sal and that sort of thing, and who would do the best things for Murray.'

However, some interviewees highlighted a concern that debate had focused on water scarcity, and there is now a need to discuss the community's value propositions for water as a resource. Particularly, to

determine their willingness to pay for different solutions (see next section on Economics for further discussion). Thus while a public debate to how to secure Adelaide's water future in times of drought has been had to a large extent and incorporated other values such as costal and river health, this was outside a policy process to set value propositions for water to the Adelaide community and city, and the subsequent long-term aspirations and objectives for water management under different future conditions. The re-negotiation of Adelaide's Hydro-social contract is therefore yet to occur.

Economics

'It's a comprehensive case that's it's cleaner than reservoir water and it's cheaper than drinking water.'
'It's not proved up to the point comparable to more traditional water supply and potable water supply options.'
I think policy, in this field, tends to focus on elements of economics. And the problem is that some of the other bits are very hard to value. And that makes it difficult.'

'You're asking people to use a product which they perceive to be of a lesser standard therefore they expect to pay less, whereas the actual costs might be more. So that's a bit of an issue.'

'To do some of these other things we do have to take a more risk-accepting perspective. And we also have to think about how we might recover money for those, how we might charge in different ways. So for the people in the business, it's a lot for them.'

'I think we are putting a very fundamental economics view to it and we don't recognise that it is a natural resource in a natural system.'

There were some opposing views on the viability of some alternative water supply solutions from an economic point of view. Some participants recognised these solutions as providing a cost-effective solution to water scarcity, while others were of the view that the business case for these solutions was still not clear, in particular in terms of appropriate scales for solutions. However from a cost/benefit perspective, the interviewees all held the view that it was difficult to assign monetary value to the benefits beyond supply services some alternative solutions provided, and that this was making the decision-making process and justification of actions difficult. This issue was coming to the fore in public perceptions of water management and pricing. With the Adelaide community interested in water supply solutions, but their willingness to pay not necessarily informed by detailed costs/benefits analyses, participants noted that justify solutions against community perceptions was problematic.

Overall, the increasing complexity of the new economics of water management, and the lack of information on some aspects of this, is creating a lack of confidence in the ability to make robust, defensible decisions within the industry. At the same time, water resources are seen as critical to the development of the State, and there is significant political pressure to support the State's economic development with sound decisions around provision of water infrastructure and services.

Some participants also expressed a concern with the emphasis on establishing water markets, as they believed there was a moral issue in viewing water as a commodity rather than an essential service and fundamental natural resource.

Water Policy Developments

We always had the Department of Water, Land and Biodiversity Conversation…providing advice and dealing with policy around water policy, but there probably wasn't much of a focus on urban water.'
'…there was a bit of a policy void in this area, which is why SA Water have picked up a lot of that…'

The drought has bought urban water management onto the policy agenda, not only to address water scarcity, but bringing into focus the governance arrangements for urban water. Previously, participants noted there had been an urban water policy gap, which SA Water often took on, despite it being beyond their remit as a corporate entity.

With the influence of the Murray-Darling Basin politics prevalent in South Australia's management of water resources,

the national debate around the health of the River Murray highlighted, for South Australian bureaucrats, deficiencies in the governance arrangements for water resources management in their own State system. With Adelaide's location at the end of the Murray-Darling system, their political bargaining power with other States is dependent on them 'having their own ship in order.' As a result of these environmental and political drivers, development of water policy has been high on the agenda in South Australia in recent years, and resulted in the development of the long-term plan for water security, *Water for Good.*[15] Participants believe this plan has provided the beginnings of a shared direction and cross-agency impetus to work toward better urban water management. Initially, however, the focus has been on clarifying the roles and responsibilities for urban water management with the creation of a dedicated urban water policy arm and the development of the *Water Industry Act 2012.*

'Water for Good plan… gave a direction and in that plan was some cross-agency work that had to go on and that is going on…'

'[shared direction], it's the process of being developed. The stormwater strategy will probably be the start of that articulation…'

There was some confidence that further work on expanding the policy agenda beyond water scarcity to set out an integrated approach to water management is now possible, following the momentum of efforts in the sector spurned by the drought. However, a number of participants emphasised the need for policy outcomes to be clearly articulated from the start for it to create a successful basis for engaging across government and in the broader community. This suggests that the outcomes and objectives for water management have not been clearly articulated. Some interviewees also expressed disappointment in the 'no potable re-use' position the Government has taken. While recognising the community is not yet ready for this idea, they felt it limited the scope of achieving true integrated and in some instances efficient urban water management. Some interviewees noted that this influence of public opinion on Governments could sometimes result in sub-optimal policy positions and decisions.

'There is goodwill outside government that can be harnessed…it's just making sure that we are working towards the same kind of direction which is the challenge.'
'The key challenges: integrated water management and what it means and what it's going to look like.'

'There is a risk that popular pressure actually drives bad policy.'

Interviewees noted an unconstructive influence on furthering the *Water for Good* plan was the recent budget cuts. With no dedicated funding assigned to implement the plan, these cuts are driving departments and agencies to limit activities to core business only. As such, recommendations to integrate water sensitive urban design into the State's land-use planning system have stalled, as the Department for Planning, Transport and Infrastructure do not consider water management activities part of their core responsibilities to deliver on.

'And particularly when times get tough like they have again over the last three years, and the accountants in the departments say 'oh, well, why are you looking at those …when it's not our business'

Another issue in furthering integrated water policy links to Adelaide's reliance on the Murray River. With a plan for the integrated use of the river's water resources still under development and highly contested at the Federal Government level, there are limitations on how far plans can progress on integrated water management for Adelaide.

'Just to get that clear direction out there for everybody to work towards and for the community to understand that this is what is needed and…well because we're affected by the Murray-Darling, then… we're still waiting for that…'

Leadership

Interviewees noted a number of different sources of leadership for water issues throughout the course of the drought. Predominantly, the work and influence of a network of

'…in Adelaide a lot of things are driven by industry champions
'There are many others that are in key positions that do things that get noticed.'

industry champions were often highlighted. The positions, strategies, and relationships between these individuals helped to coordinate activities for greater influence and to raise water on the political agenda. Sometimes this involved putting their reputations on the line to back a new idea, approach or solution and allow it to breakthrough.

'…seeing how things have worked so far, I would say if there are industry champions in key government positions and are able to drive it, champion it, outside of a crisis…I really can't see how else it would happen because it's a fact of life if it's not a crisis the government won't respond…'

'Significantly Cabinet…was more engaged in water policy issues, publicly it was more of a political issue therefore agencies and CEOs would draw into it, being a priority issue.'

'I clearly remember him saying, "The rule book is there to work through to give you guidance, and there's a rule to be broken, a rule to be amended, put it up for legislation review".'

Participants noted that much of the leadership activity around water in the past had occurred from the 'bottom up,' individuals and organisations working in an operations type context (see also Niche Activity section on page 177). However, once the water scarcity situation became a crisis, there was political will to intervene with more strategic actions with legislative backing. However, the network of champions and the past work that had been done looking at alternative water supply solutions were in a position to influence this 'top-down' intervention. One participant noted that having a relatively stable Government with only two water Ministers in the recent past had assisted in building the relationships and trust needed to enable such and influence. Other, interviewees noted that the heightened political attention drove more collaboration at the agency level, as water was considered an issue for a number of other policy portfolios.

One interviewee also indicated being particularly influenced by the thinking of one former politician, who recognised the limitations of legislation and encouraged bureaucrats to look beyond these frameworks of public administration, if and where necessary.

Benchmarking

'They do have some stuff that defines who does what, where the money's coming from, got support systems with it as well, so all in all, a more mature framework I guess.'

'If you then say what are the people here thinking about, the answer is they've been totally influenced by what's going on in the eastern states.'

'…but you look at Victoria, South-east Queensland and even New South Wales, well, ten years now, nearly ten years, it's been in place and Adelaide, South Australia could have learnt from that a long time ago…'

An observation across all the participants revealed many comments that could be seen as a benchmarking exercise against what is happening in other Australian States and capital cities. This was prevalent around the extent of Adelaide's implementation of water sensitive urban design, but also familiarity with legislative frameworks and policy tools other State Governments had used to support the implementation of these solutions. Adelaide practitioners seem to therefore be actively seeking information on what tools and methods have worked in other cities, along with the technical and economic information and knowledge on alternative systems. In addition, this benchmarking seems to provide a self-assessment of performance, and is often cited as a reason to drive water reforms, to 'catch-up' to other States.

Niche Activity

Adelaide is recognised as a leader in stormwater harvesting internationally, however interviewees gave other examples across the city of different types and scales of experimental water supply systems, mostly related to recycling and reuse. Interviewees noted that a key reason for these innovative projects getting off the ground was the injection of funding from the Federal Government; however a number also mentioned there was significant policy development or interest on many of these alternative approaches.

'To tell you the truth the only reason a lot of these stormwater projects have got up is because the feds have thrown some significant dollars at it.'

The significance of the work done by Salisbury City Council is that it became a true 'demonstration' project. Not only did it achieve successful outcomes with an innovative solution, but the learnings and results were promoted widely and used to feed information and knowledge into the development of guidelines and regulations. The success of the project and the solid science behind it also prompted other local councils and land-use developers to advocate for the mainstreaming of the technology through the change if relevant Codes of Practice.

'… all of a sudden this was getting very popular, a number of councils wanted to do it…a lot of the developers and operators actually came to government and said we want this whole thing smoothed out. So I've actually started work on that to rewrite the Code of Practice.'

There were some divergent views over the success of some of the projects, and some interviewees noted even some approaches that have proved successful are not necessarily widely adopted. However, there did appear to be a culture of experimentation within large parts of the Adelaide water industry.

'And there were some failures, which were good learning projects.'

Professional Capacity

Along with the lack of focus on urban water policy, some interviewees suggested there was also a lack of policy expertise within the Adelaide water sector, believing that in the past the predominant mindset of policy-making had been environmental protection and not necessarily management of water for societal benefit. Other interviewees were mindful of the lack of water expertise within the new urban water policy arm of Government. However, some saw a role for themselves as bridging this policy-science gap by developing relationships with the new policy group to position themselves to inform the policy process with water expertise.

'…there was a lot of scientists and a lot of people that knew legislation, what you could and couldn't do…the challenge is getting away from the pure mindset of environmental protection towards maximising benefit of the value of water for different purposes and situation….and ensuring that science supports policy development and not the other way around.'

Many interviewees noted, with urban water management now needing to meet other needs beyond supply, sewerage and flood mitigation, the skills set to achieve integrated water management has expanded. Sometimes this can be bought in by engaging with other profession (e.g. landscape architects and urban planners). However some skills have also become an integral part of professional practice, such as stakeholder engagement and participatory engagement to bring other professionals on board or engage with communities to establish the needs and expectations for water management that should be met. Some interviewees noted

'In the scientific training and engineering training, they have to go to start giving people the basics of management or business training, how to deal with people, how to see the bigger picture.'

'A lot of the old timers, traditionalists, are [about] to retire; and of course the new generation... appear to be less risk-averse…they will move around and bring their ideas from elsewhere …and they will be more receptive to new ideas…and they will look for ways to do it that utilises the best technology. Just need a few old timers around to make sure that the risks, the right risk is covered off.'

'…traditionally you would reward the good engineer; you'd move him or her up the ladder and forget about how good they were at managing. So we have to work on having recognition of what I would call their value as a technical expert, and recognition of others who are good at managing.'

this changing requirement of the profession is not necessarily embraced by the workforce. Keeping the right balance of professional capacity with the changing profession was raised by a number of interviewees; from how to reserve a place for traditional knowledge, preserve corporate knowledge, to how to equip professionals with the right skills in training and education and how performance and promotion in the profession might need to be changed.

One interviewee noted that this change in workforce structure had occurred within SA Water in the 1990's, with the workforce's tertiary education base expanding from the engineering professions. This was driven largely but the corporatisation of the organisation, which led to the outsourcing of a lot of the technical operations and maintenance. Subsequently, the organization's focus moved toward stakeholder and contract management, and customer service delivery, and so have built up a variety of stakeholder engagement skills.

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Perth

Case Context Report

May 2011

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Preface

This report forms part of a PhD project entitled 'Processes and Pathways to Water Sensitive Cities.' The research seeks to provide an answer to the question *"How can urban water governance regimes more effectively support institutional adaptive capacity to enable and expedite a shift toward sustainable urban water practices?"*

The report presents the urban water context of the city of Perth, WA, which is being used as a case to study the research question. A combination of prolonged drought, diversification of supplies within a centralised infrastructure system, and a complex and dated formal legislative framework, make Perth a unique case to explore how urban water institutions adapt to enable new practices more suited to changed conditions.

The report was compiled based data from semi-structured interviews conducted with Perth urban water managers from State and Local Government, the water utility, industry bodies, government authorities and research organisations in October – November 2010. The transcripts from these interviews were coded using an open coding technique to identify key landscape influences, the urban water institutional setting, and management responses surrounding Perth's experience of drought. Commentary representing the compiled narratives from interviewee' accounts was then constructed by the researcher. Secondary sources of evidence were used to enrich, corroborate, and clarify this representation of the interview data. These are listed in the References section and include government policies, legislation and reports, articles published in academic journals, media releases, media articles, research and consultants' reports, and websites. The commentary was also corroborated using primary data from interviews with water sector leaders at the national level from peak bodies, industry associations leading research institutes and Federal Government agencies.

The first section of this report provides a commentary recounting the succession of management responses Perth implemented to deal with increasing water scarcity from mid 1970 to the present day. The second section presents a description of the urban water institutional setting in Perth and some of its functional features. The final section of the report presents storylines around general themes that describe landscape and underlying influences on the practice of water management.

The insights and ideas presented in this report were tested, discussed and further elaborated during three industry workshops and ten interviews that formed the second phase of the research, conducted in April 2011. Key informants also provided feedback on the draft of this reports. However all views and thoughts expressed remain those of the author, except those in text boxes, which are direct quotes from interviewees.

This report will provide the basis for analysing and understanding the second phase of the research project, which seeks to identify the mechanisms and dynamics of institutional change occurring in Perth, being driven by the landscape factors and occurring through interplay between the water management practices and institutional setting reported herein. It also provides the contextual information to inform cross-case comparisons that will be conducted in the final phase of the research.

Executive Summary

Three interconnected layers of analysis are used to build the contextual setting of urban water management in Perth. 'Management Practices' describe the actions that have been taken to supply water to Perth, the 'Formal Institutional Arrangements' are those rules and structures that determine the way water is governed, and 'Landscape Factors' of broad or underlying influence on the way these previous layers operate and interact.

MANAGEMENT PRACTICES

While successfully surviving three decades of significant water scarcity, Perth's response to secure water for supply has been reliant on greater extraction of groundwater. Desalination and demand management are now providing significant new sources of water, however the extensive ground water resources have permeated the urban water management subconscious to create a 'source' focused mindset. While looking to embrace 'Integrated Urban Water Management,' Perth's water sector is implementing it only in supply sources management. Integration of water services for multiple outcomes, of the urban water cycle with the total water cycle and other dimensions of integration entailed in this new management paradigm, are not evident in Perth. This limited interpretation of what 'best-practice' urban water management involves is effecting the cohesive operation of the water sector, thus its efficiency and effective performance, and the sustainability of water resources management broadly. Perth's situation illustrates a 'cognitive lock-in' that perpetuates practices and their underlying institutions. If not balanced with an ability to respond to changes in operating context, this situation could lead to inapt management practices in the future.

FORMAL INSTITUTIONAL ARRANGEMENTS

Perth's formal institutional arrangements distribute roles and responsibilities for urban water management, corporatize service delivery and centralise control. This model is characteristic of the hierarchically structured and operationally marketised governance modes that dominate the provision of societal services in many countries. In the Perth context, legacies of historic arrangements, the politicisation of water and the mechanisms for inter-agency collaboration animate these formal institutional arrangements, the names, roles, responsibilities and rules statically documented on paper, offering a more dynamic understanding of how the system functions.

LANDSCAPE FACTORS

A variety of influencing factors emerged from the data analysis, and their effects on the two previous layers of analysis are summarised under general themes below.

ENVIRONMENT: The management of Perth's water supply is largely defined by the geological features of its environment, its soils and groundwater systems. However the changing climate is beginning to have a profound impact on Perth's urban water management practices and leading to significant shifts in approach.

ENVIRONMENTAL CONNECTION: There were mixed views on the extent of the Perth community's connection and engagement with water management issues. There was a strong view that without a crisis it was difficult to get the community engaged in issues more complex than saving water to secure human supplies. The Perth community's environmental connection may not be generating sufficient socio-political drive to collectively pursue more sustainable trajectories.

REALISATION OF RESOURCE SCARCITY: The Perth community's acknowledgement and acceptance of their water supply situation seems to have been delayed by protective strategies of government, and a lack of interest and information on the issue in public discourse. A residual cultural expectation that high quality water is readily available at low cost for universal use still exists.

HYRDO-SOCIAL CONTRACT: This term encompasses the expectations of citizens surrounding the provision and use of water (as touched on above). Practioners feel constrained by the performance criteria they are judged by under this 'contract' which are based on social norms and community

expectations that may no longer be realistic. On the other hand, rather than working toward shifting these unrealistic expectations, water managers employ strategies to meet these demands, and avoid controversy, by opting for potentially less suitable options. This sets water managers, and by-proxy governments, up for future failure, as the community's unrealistic criteria for judging performance remain unchanged. This suggests a need for greater levels of community engagement to renegotiate the hydro-social contract.

ECONOMIC DEVELOPMENT: Development pressures resulting from the WA's favourable economic climate and the resulting development focus of Government priorities are significant underlying influences on current water management practices. Interviewees talked of the prevalence of economic concerns in their day-to-day work, and suggested that this was leading to solutions that were potentially locking-in future users to inappropriate infrastructure. Innovative solutions with proven performance and benefits are viewed as too hard to mainstream, as the challenges they pose to underlying philosophies and acceptance criteria delay implementation, which is seen as unfavourable.

WATER POLICY DEVELOPMENT: The ability of government policy to guide and streamline water management activities toward desired outcomes appears to be ineffective in some aspects of water management in Perth. This leaves water managers unable to manage the resource in conjunction with other managers under common strategic objectives and frameworks. Without this alignment of activities inefficiencies can eventuate, particularly the ability to achieve of multiple outcomes. Attempts to look beyond current needs and address future challenges collectively are also compromised.

LEADERSHIP: A lack of leadership is widely recognised in Perth, not only a result of difficulties in garnering political support of 'wicked' water issues, but also due to a deficiency in external championing of these issues, and a disconnection of efforts to strategically lever windows of opportunity when they arise.

PROFESSIONAL CAPACITY: Changing workforce demographics, 'cognitive-lock in,' wariness of some new science and technology, and carried over organisational cultures expose some critical factors influencing management practices. Organisations and individuals are the actors whose decisions and practices interpret, shape and eventually alter the formal institutions of urban water management. Thus the background training, attitude and approach to problem solving ingrained in the practice and cognitive norms of these professionals underpins adaptation processes. This insight highlights a need for greater support of professional capacity building and initiatives that can bridge organisational boundaries and silos.

NICHE ACTIVITIES: Development of niches are known in the literature as one of the main pathways by which practice changes are fostered and eventually taken up as mainstream practice, altering formal institutions in the process. It appears that there are niche activities operating in Perth, but they may need support to form the 'critical mass' needed to instigate change processes. These niches could therefore been as important platform to accelerate change initiatives.

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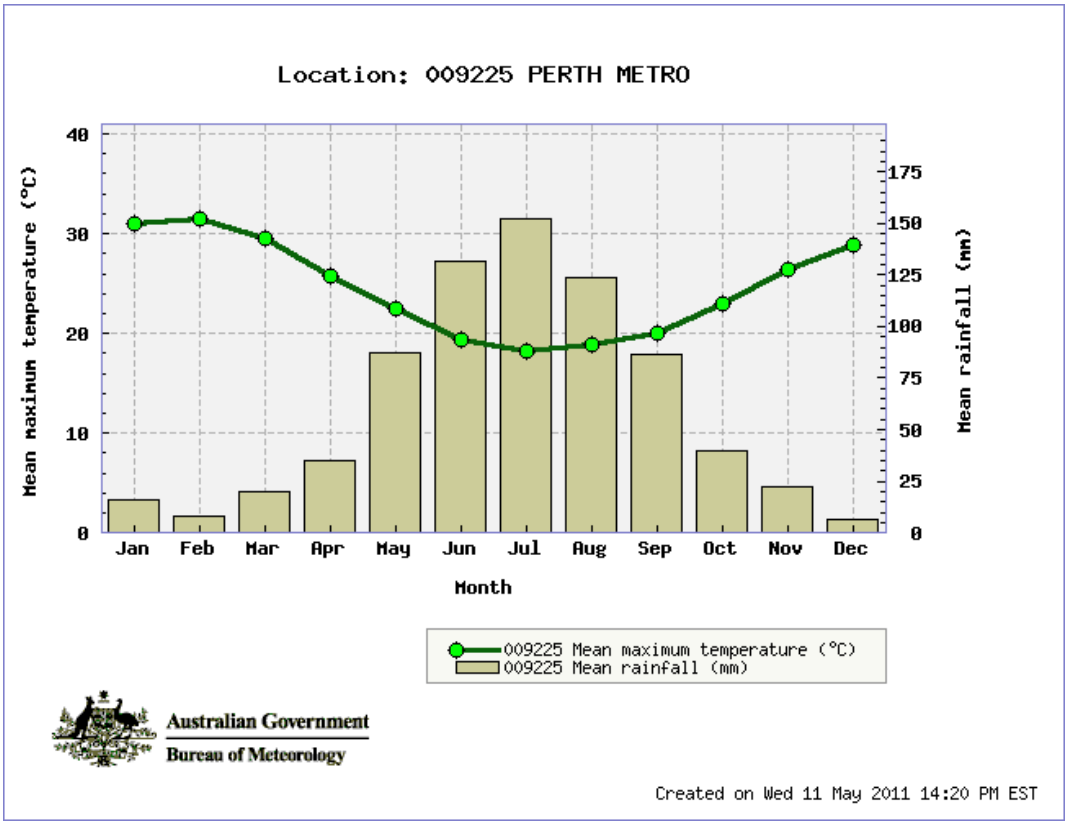
Background

Perth is a city of 1.6 million people[3], inhabiting a long strip of the Swan Coastal Plain in south-western Australia. The city lines the Swan- Canning and Serpentine-Murray river systems as they reach the Indian Ocean, and spreads itself along a 90km strip of the coastline, extending east 50km toward the Darling Scarp. The sandy porous soils were once dotted with freshwater wetlands fed by the extensive shallow groundwater. Many of these wetlands were drained and filled as Perth grew from its original settlement in 1829 as Swan River Colony.

Source: mapsof.net[1]

The climate of south-western Australia is characterised as Mediterranean, with winter receiving the majority of the rain, and long hot, dry summers with an mean maximum daytime temperature of over 30°C[3].

Figure 1: Mean Average Monthly Temperature and Rainfall for Perth



Development of Perth's water supply system followed a similar pathway as other Australian capital cities, with the focus switching from securing a reliable water supply to draining and sewering the urbanising landscape to cope with flooding and public health issues[4, 5].

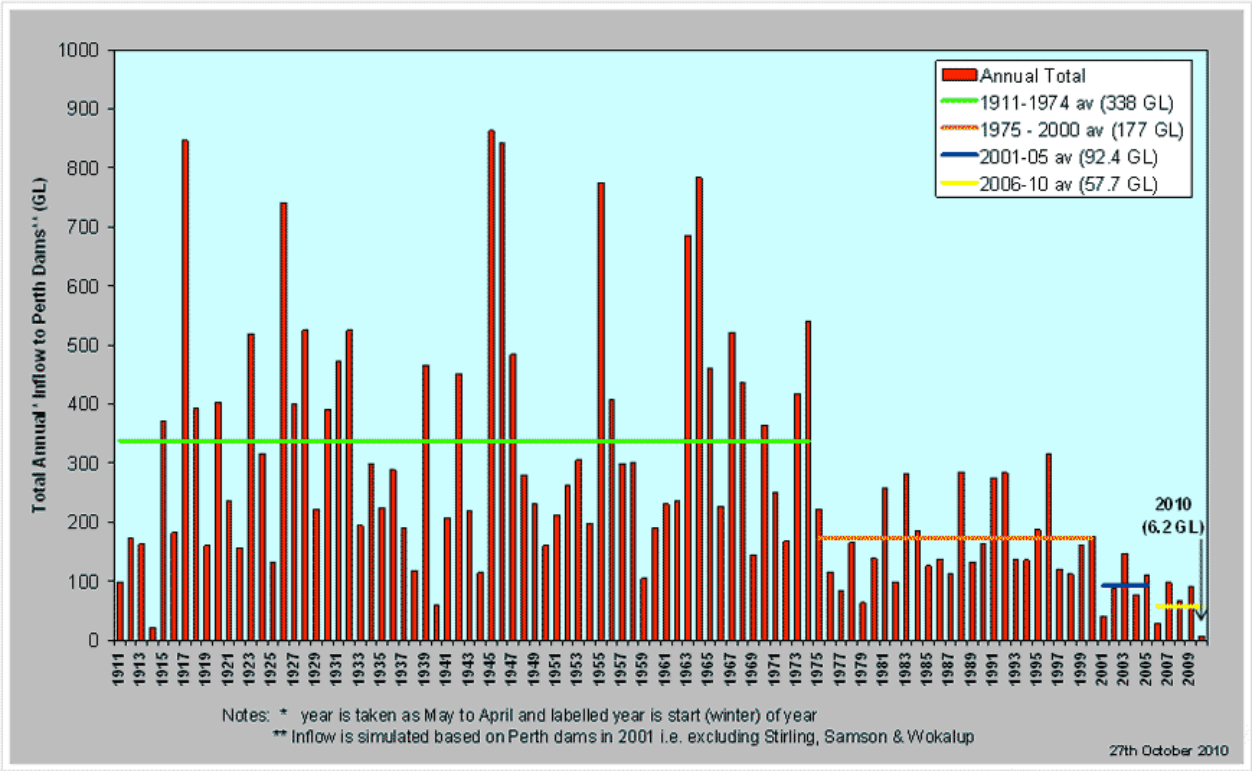
When the coastal lakes on the Swan Coastal Plain quickly proved unable to meet the needs of the first colonisers of the Swan River Colony, they turned to the shallow groundwater[6] systems. Thus began a legacy of free private access to shallow groundwater through back yard bores which extends through to the present day. Large-scale engineering works eventually bought water from the Darling Ranges, and in 1880 the vast artesian groundwater system was tapped to supplement the surface water scheme[6], and the amount of Perth's water supplied through groundwater has been increasing ever since. This combined surface water and groundwater is known locally as the Integrated Water Supply System (IWSS).

Management Practices:

Managing Water under drought 1975 - 2011

Since the mid 1970's Perth's winters have become drier. The city's water supplies have become increasingly under stress as inflows into dams have declined, and monitoring of groundwater systems is showing decline in the main aquifers used to supply the city[7].

Figure 2: Impact on Water Availability - WA Reduced Inflows to Dams.



Source: Water Corporation, 2011.[2]

In the 1980's and 1990's the decreasing surface water stores were replaced by increased extraction from the shallow, superficial aquifers, and in 1998 this was extended to the deep aquifers[7]. However the practice of borrowing from the regions extensive groundwater systems in tough years, to be recharged again in plentiful years, is becoming risky business, with sustainable yield predictions not promising a return to plentiful years anytime soon[7]. The focus of urban water managers since the early 1990's has been heavily dominated by supply security concerns[8]; how to supply Perth's growing population when surface inflows continue to reduce, and the subsequent increasing reliance on groundwater coupled with the decreasing rainfall recharge is creating stress on these systems[7].

The year 2001 featured in many interviews as the tipping point to Perth's water crisis. Dams reached record lows and conditions signalled a possible step change toward much drier climatic conditions (see Figure 2). Decision makers realised that past data was no longer an appropriate source of information to plan future water supplies, and new sources of water needed to be identified and developed. A new approach '*Security through Diversity*' was adopted by the water utility[9], which represented a change in the way water supply services would be planned and delivered. As a result Perth broke new ground in 2006 when it switched on the country's first major desalination plant[10]. This technological supply option has now been employed by most other major Australian capital cities, and the benefits of 'drought independent' sources of water are now lauded in the broader Australian water sector. A second desalination plant is due to be commissioned in late 2011, which will bring the proportion of Perth's water supply by desalination to 30%[11]. A recycling project as part of an industrial precinct, the Kwinana Water Reclamation Plant was also developed to reduce demand for scheme water for industrial use by treating wastewater to a standard suitable for local industries. This plant came online in 2004, producing 6 GL of water per annum, equivalent to about 2% of the total scheme water use in Perth[12].

Demand management strategies were also employed early in the drought, with water restrictions introduced over summer in 1971 and 1976[6], while the first pay-for-use water rates structure in Australia was introduced in 1978, and a permanent daytime sprinkler ban was introduced in 1994[13]. Reducing water consumption was a key element of the *Security through Diversity Strategy*, with seasonal two-day-a-week sprinkler rosters introduced in 2001, and reduced to one day in 2010, along with a total sprinkler ban over the 2010 winter. However many interviewees and others[13, 14] agree that Perth residents were spared the tougher restrictions implemented in other capital cities.

'We're not going to be able to meet our future demands on supply alone. We have to lessen demand; that is the most important thing. So there's not enough room to build a desal plant if it's not going to be able to keep up with demand so we have to do a lot more recycling and we have to reduce consumption.'

During this time groundwater extraction and augmenting of surface supplies continued with new bores, dams and other infrastructure upgrades. However with all the cheap sources of water developed, and desalination a costly option, more water needed to be found. *Water Forever*, a 50 year plan produced by the water utility in 2009 following extensive public consultation, proposed a 'portfolio' of water options with a greater focus on reducing demand through reducing water use and wastewater recycling[15]. This strategy showed a significant departure from the traditional approach to water management, acknowledging that relying on new source development would no longer be adequate, and that savings from demand management were a major and viable source of water.

Some of the new strategies now being investigated or employed across the Perth water sector to secure water supplies include:

- Wastewater recycling from treatment plants for Managed Aquifer Recharge (MAR), with trials currently being conducted by the CSIRO[16].
- Catchment thinning to increase run-off to dams, with a 12 year trial in the Wungong Catchment underway since 2005[17]
- A number of residential developments demonstrating various water sensitive urban design, fit-for-purpose, third pipe and other water saving measures[18].
- Water trading through savings generated by investment in upgrading agricultural irrigation infrastructure.

'I don't think any pipe, stormwater, grey water, rainwater tanks, all that sort of stuff are really going to assist at all in providing an alternative source.'

While these represent a shift away from the traditional methods used to secure water supplies in Perth, such as infrastructure upgrades and groundwater source development, they are still largely novel add-ons to those former traditional methods, along with a growing emphasis on demand management, and could not yet be considered mainstream practice.

'It's very much about water source, alternative water you know, water for parks and public open space, and looking at groundwater and all those sorts of things, which is really good but the water source, and looking at the total water cycle as a whole, they still haven't got that.'

'I don't think there's a full commitment to total water cycle approach yet because they don't, people don't understand it, there's not enough widespread understanding, people still don't understand the value of it.'

While most of the interviewees adopt the language of Integrated Urban Water Management (IUWM), their interpretation of this concept was largely compartmentalised, with water supply, sewerage, drainage and waterway health largely viewed and discussed as separated activities. This is not surprising, given the interviewees also discussed how current institutional arrangements silo these management areas. However the compartmentalisation also appeared to be at a conceptual level. Many narratives showed an interesting contradiction in viewing the porous soils and perceived storage capacity issues as barriers to integrating stormwater into the supply system, while valuing these features of permeability and natural subterranean storage capacity for current MAR trials using wastewater, and overall in the Integrated Water Supply System itself. Such a separation of water sources is contrary to the scholarly concept of IUWM which emphasises that water resources need to be viewed as a 'total water cycle' in order to recognise the different values (often non-monetary) and variety of needs from a diverse range of users

(often non-human) that make up this complex resource system. Management of the resource can then be optimised through water services which deliver multifunctional outcomes and minimise collective impacts to all users.[19] As Mitchell notes in her 2006 study[19], the new IUWM paradigm has been pursued in Australia, but there is *'still room for greater integration of the water supply, stormwater, and wastewater components of the urban water cycle.'* This division appears to be a present conceptualisation of urban water management in Perth, based on this analysis of interviewee's narratives and corroborated by other research conducted in Perth.[20, 21]

While successfully surviving three decades of significant water scarcity, Perth's response to secure water for supply has been heavily reliant on greater extraction of groundwater throughout this period. Desalination and demand management have providing significant new sources of water, and various novel approaches are now being explored as alternative water sources or means of supplementing supply. However inconsistencies in the interpretation of and application of IUWM will likely have some baring on Perth's institutional adaptive capacity; given the shared meanings derived from these underlying management paradigms are some of the key informal institutions which form the foundation of the overall institutional setting.

Formal Institutional Arrangements:

Formally recognised rules and structures, and how they operate in practice.

Like most Australian cities, Perth's urban water governance arrangements can be characterised as hierarchical and corporatized. The key organisations in urban water management and their roles and responsibilities are described below:

- **The Water Corporation**, a government owned corporation, responsible for supply, sewerage and drainage services across most of the state.
- **Economic Regulation Authority**, licences and monitor compliance of the Water Corporation, and may conduct inquiries referred to it by the State Government.
- **The Department of Water**, created in 2006, is responsible for the overall management of water resources in the state, and its key responsibilities include water monitoring, allocation and licencing, policy for regulation and future planning, identification and assessment of new sources, and providing information and assistance to water users and government.
- **The Environmental Protection Authority** also plays a role in water regulation through its State Protection Policies, and responsibility to conduct Environmental Impact Assessments on major new source developments. It also has a role to provide strategic advice to Government.
- **Local Governments** are responsible for local drainage provision (in conjunction with Water Corporation, who manage the city's main drains) through local drainage infrastructure, and land use planning, approvals and management.
- **The Department of Planning** sets the land use planning policy framework through which this aspect of urban water management is governed, and most of the Departments and Agencies mentioned above have a referral role in the assessment and approval of new developments.
- **Land developers**, both private and government owned, have an integral role in designing and implementing water management infrastructure often in close collaboration with the Water Corporation, Local Government and Department of Water.
- **The Swan River Trust** is a government agency and caretaker of the Swan-Canning River system and foreshore (known as the Riverpark). It has a policy role in developing a river protection strategy and associated management plan, and a facilitation role to work closely with local governments and other relevant agencies to coordinate activities under these strategies and plans, such as implement on-ground management interventions, commenting on proposed land use developments and plans, and providing strategic advice to Government.

Most of these Departments and Agencies act on behalf of Government, and are answerable to the Ministers for Water, Environment and/or Planning. These Ministers also have certain powers of delegation and approval/decision, to manage water or other activities relating to its management, on behalf of the people of Western Australia.

'…both of them would point the finger at the other one and say "Oh they won't let that happen." And yet he'd get them in the room and they'd both say "Well you know, isn't this you that's stopping this?" And then they'd say "No, not us, isn't it you?".'

The urban water sector in Perth, like other Australian cities, has undergone major structural change since the mid 1990's driven largely by Council of Australian Government (CoAG) agreements. These reforms sought to introduce greater efficiency, transparency and accountability in public monopolies like the existing water authorities of the time, by dividing the service provision, policy and planning, regulation and monitoring responsibilities into separate organisations, and making room for greater competition in the sector. Some interviewees agreed that this was a sensible move given the conflict of interest in having all of these roles in the one organisation. Others felt the small scale of Perth's water sector meant competition would always be limited, and the model with all water management responsibility resting in a single organisation would produce greater efficiencies. However most interviewees agreed that the current formal institutional arrangements were functional in most aspects of water management, albeit requiring greater efforts of coordination across agencies, and some aspects of remnant cultures from past organisations occasionally having a negative impact.

One offshoot of the reforms was that ultimate responsibility, and hence power for water management, was transferred to a Minister, rather than a more independent bureaucrat or board of management. As a result Governments have gained greater influence over water management decisions. The relationship between public opinion and political decisions is well known, particularly in times of crisis[22], and can present a significant influence over the way urban water management is conducted. This has been visible in other Australian capital cities, most notably recent public debate and subsequent political decisions on water recycling in South-East Queensland. Thus these reforms has led to increasingly politicisation of water management, and has been widely criticised in recent years as State Governments step in to 'solve' the water crisis. This analysis has certainly come across examples of this in Perth, which are discussed in later sections.

'In the past we could impose restrictions; now it's up to the minister, so it takes that away from us. So that's a bit of a concern and then it becomes a political decision rather than a service delivery decision.'

'… and Brisbane, the classic case is the Premier decided to go ahead with indirect potable re-use of water but then the next Premier decided to put it on ice because she was nervous about the next election. So… there's a lot of pressure on management of the utilities to dance to the tune of the government.'

Following on from the discussion in the previous section regarding compartmentalisation of the urban water cycle, this appears to be reflected in this formal institutional framework, as suggested by interviewees. The clear separation of roles for supply and sewerage services, custodian of water resources, and custodian of waterways, results in the separate management of these aspects of the urban water cycle. While there are collaborative efforts to align management approaches and activities, the commentary from interviewees suggests there is still a need for effort in this area. One clear illustration of this problem is drainage management, being as it is the main interface between urban water cycle management and waterway health protection. With infrastructure ownership widely distributed and responsibilities left open to interpretation in the legislation and regulatory arrangements, drainage management is a largely disassociated role in these institutional arrangements. The result is many frustratingly grey areas of responsibility in activities were drainage management is a consideration, and a lack of action to resolve these issues.

'[W]e do the drains, we do the pipes, we do the treatment…it mainly deals with licensing…it does…planning, it does…water management.'

'The argument is that's all very well but it's not good enough for the future. Waterways management requires that we re-engineer the drainage system to deliver flood mitigation and ecosystem health.'

Perth's distributed governance model of roles and responsibilities with centralised, politicised control illustrates the intricacies of how formal institutions function in reality. Nuances in this operational context including the politics surrounding water issues and the mechanisms for inter-organisational collaboration, provide some of the ingredients of institutional change.

Landscape Factors:

Broad trends, features, events and characteristics that influence practice.

The following sections describe the factors that emerged from the interview data as having a significant influence on the practice of water management in the Perth context. Similar storylines from interviewee's accounts were grouped and the specific factors or influences emerged from this collation. Each section describes these themes, presents a collated commentary from the interview data highlighting the impression of these factors and influences on water management, then closes with a short summary commentary.

Environment

This theme covers the biophysical features that have an influence over how water is managed in Perth's environs, and some of the impacts and influences directly related to these biophysical features and events.

Many interviewees used the metaphor of Perth as a big sandy bathtub to describe Perth's environment of sandy porous soils and large groundwater reserves. The sandy costal plain on which Perth is built largely determines how water interacts with the landscape, and thus how to manage its movement and storage.

'The good thing about Perth sitting on top of a big sort of sandy bathtub is that we don't need conveyance to take the water to places….we can just poke it into the ground near the treatment plant or in the bore field…then abstract it at any point we want.'

The quickly draining soils can make surface water storage difficult, while their inability to retain soil moisture creates a need for large amounts of irrigation over the summer months, when no rain falls and Perth's residents need to keep their valued green spaces alive. Fortunately, the extensive groundwater systems fed by these porous soils provides an ample storage and conveyance system, allowing supply managers to withdraw water almost anywhere in metropolitan Perth when it is needed, and residents to sink private bores to meet their garden watering needs. Ironically, the shallow groundwater systems also create flooding problems in low-lying areas when the rains do come in winter. With high demand for land development and little high ground left to build on, flooding issues were prevalent in the interviewee's narratives, along with securing ample water supplies. The task of managing water in Perth appears to be finding a balance between the low natural surface water availability in summer and excess availability in winter, and the seasonally opposite needs of Perth residents for ample water in summer and staying dry in winter. The 'big sandy bathtub' compensates for this somewhat by providing collection and storage services through its soils and aquifers.

Balancing this water demand and supply will become a trickier prospect than coping with these seasonal extremes if the climate of South Western Australia continues the drying trend it has been experiencing over the last three decades[23]. The decreased rainfall has caused marked decreases in inflow to surface water supplies[7, 24], and complex interactions between long-term rainfall reductions, their seasonal variations, land use changes and greater extraction for public water supply are leaving both confined ('fossil water') and unconfined (shallow) aquifers showing overall declines in levels, or susceptible to further rainfall decreases[25 7] or intrusion from salty marine water. Indeed with the 2010 winter producing only 11GL of inflow[26] (in comparison to an average of 150GL), and restrictions on groundwater abstraction to manage the sustainability of these water sources[26], interviewees narratives suggest that supplying Perth with water is becoming an increasingly complex balancing act between the state of the biophysical systems, capabilities of infrastructure systems, and supply demand. With very few exceptions, interviewees spoke of the warming climatic conditions as the predominant environmental factor shaping the management of Perth's water resources.

Another environmental feature of Perth's environment a number of interviewees mentioned in relation to water management issues were algal blooms. Driven by high nutrient loads, high temperatures, and in some events large freshwater inflows from cyclonic activity further north, the Swan and Canning rivers can provide optimal conditions for toxic algal blooms[27]. One particular incident in early 2000 was

recalled by a number of interviewees as a catalyst for more attention being paid to water quality issues. While algal blooms were discussed in relation to community connectedness with their waterways (see following section), it also revealed something of the way water practioners themselves view the water environs they directly and indirectly manage. Interviewees spoke somewhat of the connections between the surface water bodies and shallow aquifer systems that supply them, but predominantly in terms of water quantity issues. There were few mentions of the connections between these two systems in terms of water quality, and while the need to protect the quality of these shallow aquifer systems for water supply is recognised in regulation, the same attention does not seem to extend to protecting water quality in these aquifers for the health of the receiving water body, the Swan - Canning River system. While more research would need to be done to understand this anomaly in perceptions of water quality issues, it does corroborate the inconsistent application of total water cycle management principles discussed in previous sections.

'…people are starting to realise that the water quality issues, the water quality issues they're actually really starting to affect the Swan and Canning Rivers and to do, if you start managing the water at source you can solve, you can increase ground water recharge, but you can also, it also helps with managing the water quality.'

Management of Perth's water supply is largely defined by the geological features of its environment, its soils and groundwater systems. However the changing climate is beginning to have a profound impact on Perth's urban water management practices and leading to significant shifts in approach.

Environmental Connection

This theme describes some of the ways the Perth community connect to the natural elements of their surroundings, particularly in regard to the part they play in supplying water. The theme captures the values the general community place on their water sources, and their understanding of the implications of having these sources as part of their supply.

Perth residents have a strong affiliation with their waterways. The Swan River is an icon of the city, often referred to as the jewel in its crown. Citizens of Perth look to the Swan as not only a scenic backdrop to the city and a recreational playground, but connect the quality of its water to these values and the health of the river and its surrounding flora and fauna[28]. Some interviewees believed that there is public acknowledgement that Perth's natural ground and surface water resources need to be protected, however many interviewees also held the view that Perth citizens are complacent and unengaged on issues of water supply. This is supported by work by Ruth Morgan[13], who describes the 'disassociation with domesticity' of environmental problems and subsequent abdication of responsibility, particularly with regard to water use, in her study of the impacts of water restrictions on Perth's citizens in the 1970's. This community attitude may appear to be changing as a result of the current water crisis, with the Water Corporations 'Target 60' demand management campaign achieving its targeted saving a month ahead of schedule[29]. The community also appear to be taking an informed interest in the situation, with over 200 responses to a recent article on the state of Perth's dams[30] attracting over 200 online comments ranging from debate on a Kimberly-Perth pipeline to querying why recycling isn't considered a significant water supply option[31] So while there are mixed views regarding the communities connection with their water supply sources, there does appear to be a rising engagement

'I really don't think that the public actually feel at risk of having water [scarcity].

'The fact is we don't have enough water to give you two days a week, you're down to one day a week and so on. So people are aware that this is becoming an important issue'

'There's no doubt that the water scarcity in Perth and the potential scarcity is accelerating people's interest in trying to save water.'

'Where people can look out [at] our river from the city and then can see the dolphins jumping and you can catch a 40-pound Mulloway right at the city door, then they go "What's the problem?".'

with water supply issues, translating into water saving behaviour. Many interviewees observed that it was difficult to get the community on board unless a crisis such as floods and algal blooms forced a wider acceptance of a problem. The current season being the driest on record appears to be providing such a crisis.

'We've got such a pathetic non-active stay inside our own homes community here... they just don't want to get out there and change things. You come to Perth just to live the quiet life.'

With regard to public opinion forming an 'active' pressure on government and decision-makers in the form of advocacy or lobbying activities, there appears to be little evidence of this type of public engagement on water issues. While the Perth community certainly value their waterways, and may be willing to make some personal sacrifices to improve the health of these natural assets[28], there does not appear to be a strong acknowledgement that personal water use is detracting from the overall water balance. In assessing the communities 'willingness to pay' for an improved Swan River and its environs, respondents of a survey were given the scenario that a healthier river may require personal sacrifices like decreasing their lawn space and paying more for environmentally fertilisers[28]. While the respondents were in favour of these sacrifices, they may not necessarily connect with the real sacrifice behind this scenario, a trade-off between personal water use (and not just through decreasing the amount of lawn they need to water) and providing for environmental water needs. Indeed the limited public outcry surrounding the death of six Swan River dolphins in 2009 was noted by some interviewees as evidence of the lack of community concern for intrinsic, non-human centred connections between water and environmental health. While autopsies revealed a culmination of environmental stressors lead to the dolphin deaths[32], the finding that a less-than-healthy aquatic habitat is creating enough stress to result in mortality of such an iconic species, did not seem to raise the issue of water quality in the Swan Canning River, or the sustainability of water management in the broader urban environment, in public discourse. The willingness of the Perth community to be active advocates for their aquatic environments by both conserving water to make more available to the natural environment, and to campaign for water issues or take an active interest and involvement in water management, therefore appears to be limited.

'I mean we had seven or eight dead dolphins in the Swan River. It maybe hit page 3 once or twice.'

The issue of community engagement with natural ecosystems and linkages to values, aspirations and motivations for behaviour change is a large and complex scholarship, and the commentary presented above in no way sets out to provide a definite description of the wider Perth community's connection to their environment. What is relevant for this research is the influence of this connection and awareness on the practice of urban water management. Many of the interviewees lamented that without a crisis it was difficult to get the community engaged in water management issues more complex than saving water to secure human supplies. It therefore would appear that the community's connection with their environments and their understanding of water issues, the basic ingredients of public opinion, may not be generating sufficient socio-political drive to actively influence water management decisions and collectively pursue more sustainable trajectories. However more research focused on the area of community participation would need to be conducted to confirm this inference.

Realisation of Resource Scarcity

This theme explores community acknowledgement of water scarcity, and some of the possible reasons behinds these sentiments.

'So nobody's actually felt the pressure for water restrictions.'

The majority of interviewees believed the realisation that water is a scarcer resource in Perth came quite late to the Perth community. It was suggested that the hidden nature of the groundwater resource and the relatively cheap cost of water throughout this time has buffered Perth residents from this

reality. Thus while people may have acknowledged water scarcity, it did not impact on them in terms of the water available to them or its cost, and so a true comprehension of the issue did not occur.

A small number of interviewees noted another factor that shielded the Perth community from the true water situation were its politicians, not wanting to upset the voting public with water restrictions. While there is little way to verify these sentiments with sources on the public record, other factors point to potentially substantiating these views. Ccomparable

'And the Minister just said, I remember hearing a while ago... "I don't ever want our people over here on water restrictions so just keep building de-sal plants''.'

sentiments expressed across interviews and in other sources[13] that Perth residents were not subject to water restrictions at the severity of their eastern state counterparts, and the a statement in the then Premier's introduction to the *State Water Plan 2007*[33] that '[t]oday, Perth is the only major capital city in Australia where people can use sprinklers through summer..., could suggest that political interventions have been a factor. In any case, there appears to be a combination of influences that have sheltered the Perth community from the realisation that water was becoming a scare resource.

'It's going to be a really hard summer and I think hopefully this might actually be a summer where people start feeling that pinch...'

There was a general consensus throughout the interviews that the introduction of sprinkler bans in 2001 began to raise awareness of the water supply situation, and the decreased watering regime introduced for the 2010 season has not created large amounts of backlash, suggesting a greater level of apprehension in the community. Indeed some interviewees thought that the 2010-11 season may represent the crisis or tipping point where the restrictions, prevalence of water in the media and public discourse, and price rises beginning to affect individuals might bring water management from community consciousness to greater levels of awareness and subsequent increases in water saving behaviours.

'There's always something in the paper... so it's really becoming quite topical and people are saying "Oh, it's been a dry winter this winter... and what are you going to do about your garden; are you still growing your veggies?".'

The media has a well know role in informing public opinion, and interviewees commented that the media certainly raised water issues, but the messages were more sensationalised rather than to prompt informed debate. However people noted that a recent media story had raised the issue of inadequate resourcing to the Swan River Trust, and that this type of media attention had potential to deepen the debate and generate discussion around solutions, rather than who is to blame for a particular problem. This kind of coverage promised to produce a credible and useful role for the media in public water discourse.

'[The] media has a big role of course. There's often a headline about the latest water issue, water crisis and so on and so forth.'

These findings suggest the Perth community's acknowledgement and acceptance of their water supply situation seems to have been delayed by protective strategies of government, and a lack of interest and information on the issue in public discourse, perhaps stemming from some of the characteristics discussed under the previous section, 'Environmental Connection.'

Hydro-Social Contract

This theme describes the expectations of Perth citizens surrounding the provision and use of water.

The interviewees often mentioned perceived community expectations around the supply of water to them. The idea of a hydro-social contract has been coined to encapsulate the implicit and undocumented 'agreements' between citizens and governments about how water should be managed. These normative understandings often underlie people's attitudes

'I do know that they do think that there's some things they should never run out of and the government should always supply them with plentiful water.'

and behaviours, use of water, and create social norms around the supply and use of water. Interviewee's expressions of the way these social norms influence water management decisions showed there is a strong sense of this hydro-social contract in the Perth context. The discussion below identifies the elements of the contract that were evident in the interviewee's narratives.

Access to water

The long history of cheap and relatively unrestricted water available to Perth citizens, even through 30 years of drought, has left a lasting legacy in the public's attitude to water supply provision[13]. Interviewees strongly felt that the public believe water will always be available, and government is responsible for ensuring this happens. Failure to supply ample water at low cost is therefore viewed as a failure of government. One interviewee also pointed out that the resources boom, bringing wealth to the state's economy and individuals alike, has added to this attitude by producing an expectation that wants and needs can be easily and quickly satisfied.

'The resources boom has produced this generation of materialistic people who are used to having whatever they want when they want.'

'Our Premier's come out and said, "Whatever happens, we won't have total sprinkler bans." So, that doesn't help change people's thinking at all.'

Many interviews spoke of the difficulty in dealing with this attitude as water becomes more appropriately valued, because cheap and ample supply is the performance criteria the community uses to judge government, and successive governments have bowed to this rather than trying to educate the community on the true cost of water.

Use of water

Similarly, there is an expectation that having water to supply English style gardens, large lawns and private swimming pools in a Mediterranean climate is not unreasonable. While this social norm has probably come under question more in recent years with more frequent water restrictions and the increased regulation of groundwater extractions, large green gardens and lawns are a part of Perth's identity and will alter slowly. Given the important role these green spaces play in building a sense of pride and achievement in citizens[13], interviewees were grappling with questions of how to manage these cultural aspects of the changing water availability regimes.

Sources of water

'But we can also treat 30 gigalitres of water from one of our wastewater treatment plants to potable water. But people still won't drink it. But if we inject back in to the Gnangara Mound, they will drink it, they just won't know they are…It's not that efficient because you're actually doing some engineering that you probably wouldn't…So that's sort of, that's what we would call innovation…'

As one interviewee noted, Western Australians have been using fit-for-purpose water supply strategies for the history of its settlement, private groundwater bores being used from early on to supply garden watering. However many interviewees noted the 'yuck' factor which arises around the water recycling debates, suggesting in their attitude to water, Western Australian's still judge suitability by the source of the water, not the quality of the water and its intended use. This is no different to the wider Australian community, and can be gleaned from public discourse around the topic of wastewater recycling across the country. This aspect of the hydro-social contract seems to indicate that the Perth community expect high standards of water quality for all water supplied to them. However the costs of delivering this are not being made explicit, the prime example being the Managed Aquifer Recharge trials currently being carried out. These treat recycled effluent to a tertiary standard and then pump the resulting drinking quality water back into the aquifers, mixing with lower quality groundwater and to be extracted again in the future. A more logical choice would be to add this high quality water directly back into the supply system. While there are complicated and conflicting arguments as to which option is the most cost effective, many interviewees suggested adding this water to the supply system as 'groundwater' was an easier prospect than managing the backlash that would come if treated effluent were added to Perth's water supply sources. Thus these community attitudes to different water sources, regardless of quality or intended use, are having significant influence of water management decisions, and one could argue, leading to the less-than-optimal solution being implemented.

These perceptions and handling of the hydro-social contract expressed by water managers' show an interesting dynamic influencing urban water management. On one hand practioners feel constrained by the performance criteria they are judged by, being based as they are on long held social norms and community expectations that may no longer be realistic. On the other, rather than working toward shifting these unrealistic expectations and 'negotiating' a more appropriate hydro-social contract, water managers employ strategies to meet these demands and avoid controversy, by opting for potentially less efficient options. In doing so, they are perpetuating the current and seemingly out-dated hydro-social contract. This sets water managers, and by-proxy governments, up for future failure, as the community's unrealistic criteria for judging performance remain unchanged. This is suggestive of a need for greater levels of community engagement so that the hydro-social contract can be renegotiated to meet changing conditions.

Economic Development

This theme describes some of the economic drivers of water management in Perth, and the influences these bring to bear on water management practices.

The majority of interviewees saw Western Australia's economic situation as the second most significant driver of water management, beyond the changing climatic conditions. This is because the Western Australian Government are placing a high priority on economic development in the wake of the rising prices and demand for ore and metals propelling the State's large mining industry into a high profit period. Thus much of the focus in the water management sector which emerged from interviewees accounts is how to service the growing land development needs for water services to houses to accommodate the growing population influx following the mining boom and the jobs it creates. Any option or initiative seen to add to the cost of a block, even in the name of saving water and reducing demand on this infrastructure, is seen as a disincentive to development, which is against the Government's priorities.

'The new taglines for the department, it's to manage the water to facilitate state development.'

'It's not managing the water to achieve environmental, social, economic, you know, sustainability objectives, it's to manage the water source so that we can achieve the development that we need.'

Our current water supply is very cheap and so it's very difficult for… these alternative schemes stack up.

A number of interviewees mentioned this development imperative was resulting in a race to keep up with development, at the cost of environmental and other concerns. In this climate there is little time afforded to assess the suitability or sustainability of traditional water service provision, or test and develop more efficient methods to try and reduce strain on water resources and infrastructure. A number of interviewees mentioned demonstration projects such as the Kwinana Industrial Recycling plant, which recycles sewerage for industrial water use, had been implemented, but raised a number of issues for traditional water management approaches. In particular supply and demand dynamics changed as on-going commitment is needed from consumers to use the water proved just as important as a commitment from suppliers to produce reliable supplies. Such new considerations and how to incorporate them into management practices or indeed governance arrangements around water supply and use are afforded little time to be worked through in a climate where water managers are encouraged to practice speed and efficiency in order to keep up with demand. As such some interviewees noted the downside of trying to capitalise on the State's favourable economic situation. Such a reactive approach may result in infrastructure legacies that

'So they know they can roll it out in a certain way whereas if we actually challenge them and say no, you need to do this infrastructure differently, it would set up a whole number of different processes and people not knowing how to actually get there and it would prolong that.'

'The state government just went ahead and announced that before they had done any work on all this sort of stuff. And then they go "Holy crap! We haven't got water for these people!".'

'…they just haven't managed the changes well at all and so they're all trying to play catch-up now

lock-in certain water management practices which turn out to be problematic in the not-too-distant future, given the predicted climate effects on water availability.

A couple of interviewees suggest this may change, with large infrastructure investments and aging infrastructure starting to produce a capital constrained environment which will begin to drive innovation out of an economic necessity. Others suggested the proposed Federal carbon tax adding to the cost of traditional, centralised water conveyance systems may also drive innovation. A number of interviewees expressed disappointment that the scarce water availability had not been viewed as a real constraint to development in Perth from the outset of the development boom, and used as a similar driver to produce more strategic planning and experimentation earlier.

The development pressure resulting from the WA's favourable economic climate is a significant underlying influence on current water management practices. Interviewees talked of the prevalence of economic concerns in many aspects of their day-to-day work, and suggested that this was leading to solutions that were not forward-looking, potentially locking-in future users to inappropriate infrastructure. The speed of development and its high ranking in the priorities of Government also leaves little time to ensure water servicing solutions were well planned. Innovative solutions with proven performance and benefits are viewed as too hard to mainstream as the challenges they pose to current underlying philosophies and acceptance criteria delay implementation that is seen as unfavourable. This situation raises some interesting issues for how urban water institutions evolve when priorities at the top of a power hierarchy prioritise a singular objective, potentially overlooking medium to long-term planning.

Water Policy Developments

This theme describes some of policy features identified during the interviews, and their influence on Perth's water sector.

'They still haven't changed fundamentally their policy of single pipe in-single pipe out.... So there hasn't been any major change in the delivery philosophy, just the source…capital upgrade and new source development is still the major engineering response.'…

'…we still don't have that big picture attended to though.'

As discussed in the previous section the underlying driver for water policy is the state's economic development. A small number of interviewees observed that the policy direction filtering through from this priority setting is focused on water allocation and development of sources, rather than the more holistic management of water resources advocated in IUWM including waterway health, social amenity, intergenerational equity and limits to the natural resource[34]. Thus despite the 'Security through Diversity' approach recently taken in water supply planning efforts such as *Water Forever*[15] and the *State Water Plan 2007*[33], and sustainably thinking promoted in policy on other water resources issues such as the *State Waterways Initiative*[35] and *Towards a water sensitive city: The urban drainage initiative – Phase 2*[36], only partial integration of the planning and management of the urban water cycle into the total water cycle is evident. This is not unique to Perth, as other commentators have assessed and questioned the extent to which IUWM has been implemented successfully in Australia[19, 20, 37] and internationally[38].

'I think there's the beginnings here in Perth of recognition at water planning and land use planning have to go hand in hand, and that's been happening at the political level; it's happening at the state government department level.'

One strength many interviewees noted in terms of policy development in Perth's water sector, was the recent work to integrate land use and water planning. The resulting policy document *Better Urban Water Management*[39] was seen as a successful joint effort of a number of departments and agencies to inject consideration for water supply and use into land planning and development approval processes, and considerable capacity building efforts have been conducted to promote and facilitate the uptake of this policy.

The overall consensus stemming from most interviews on the topic of water policy as a whole was that there was a lack of policy to direct and guide water management practices. Some expressed this as a lack of strategic or visionary policy to provide direction. The recent large-scale schemes that have been proposed by politicians and the mining industry and the significant media attention they have attracted[40], could be seen as evidence of this lack of shared vision documented in policy, as these efforts seeks to create visions outside of traditional policy making processes. Other interviewees described situations where new developments or proposals would uncover process gaps, which no agency seemed willing to take responsibility for resolving, leaving uncertainties in decision or approval processes and creating time and transaction costs.

'[t]here's a bit of a policy vacuum too, there's not strong leadership, not strong vision, there's not really visionary policy development.'

The ability of government policy to guide and streamline water management activities toward desired outcomes appears to be ineffective in some aspects of water management in Perth. This leaves water managers unable to manage the resource in conjunction with other managers under common strategic objectives and frameworks, aligning activities and delivering efficiencies through achievement of multiple outcomes. This also hampers attempts to look beyond current needs and address future challenges collectively.

Leadership

This theme identifies the sources of leadership and some of the its threats in Perth's water sector.

There was corroboration across interviewees accounts that lack of leadership was the predominant reason Perth's urban water sector is struggling to address many of its urban water issues. Many interviewees saw this role resting with state government, and in particular the Water Minister's delegate, the Department of Water. This expectation, while making sense, has left a void in leadership due to a number of circumstances that came out of the collection of interviews.

Firstly, the Water Corporation has been so successful at supplying Perth with ample water that other priorities in the political portfolio have taken precedent. While water supply became a political issue, once the desalination plant was commissioned and a few average winters raised inflows, a number of interviewees suggested Government believed the water problem to be solved, and it fell off the agenda. However, a wider acceptance of the water scarcity is beginning to politicise of water, as politicians see opportunities to attract growing community attention and win voter credibility[41]. Many would argue that is it the role of Departments and Agencies to keep important issues on the political agenda, or at least prompt and capitalise on the opportunity to do so when they arise.

'[t]he Department of Water is still an embryonic organisation, they're still building capacity. Because in a way... they're only less than a few years old.'

'And that's been a major step I think in the way in which water planning is being managed within Western Australia.'

Herein lies a second leadership issue identified by interviewees, that the Department of Water, as a new organisation with some deficiencies in its own capacity, has experienced difficultly building relationships with a succession of Ministers in its short five year life. This leaves the Department's ability to negotiate the political space in which Government operates seriously curtailed. Interviewees saw the Department's formation as a positive development in the formal institutional arrangements, providing a single point of contact for water resources planning and management. In reality they have perhaps suffered from the informal institutional nuances, in addition to having high expectations to satisfy.

These perspectives from the interviews relate to political leadership, but there are other empirical cases and scholarly work, which identify many other forms of leadership which can play a role in leading change in the form of networks of champions.[42, 43] A number of interviewees from within the government agencies saw the leadership void as a lack of credible and willing leaders from outside the

system, such as commissioners, industry associations, and scientific figures, able to agitate and pressurise pertinent issues, which can then lever political leadership.

Another barrier to leadership offered identified in interviewee's accounts was the of a risk averse culture within the sector, due in part to its corporatisation. A number of interviewees noted that, where power and motivation for Government to intervene in water management is strong, bureacrats and other public figures are unwilling to 'going out on a limb' to promote or implement new approaches and ideas; in other words to champion innovations. Recent instances of senior bureacrats being investigated by the Crime and Corruption Commission, but subsequently cleared of any wrong-doing, were given as examples of barriers to leading challenges to conventional approaches.

'No-one will make the first step because they might get over the, no-one's going to go over the trench because they're going to, the machine guns are going to mow you down.'

A lack of leadership is widely recognised in Perth, not only a result of difficulties in garnering political support of 'wicked' water issues, but also due to a deficiency in external championing of these issues, and a disconnection of efforts to strategically lever windows of opportunity when they arise. These questions of who should lead change initiatives and how to develop and connect leadership efforts represent key missing pieces in the puzzle of Perth's change trajectory.

Professional Capacity

This theme highlights some of the views regarding professional practice in Perth's urban water sector.

'But we also have really good engineers; we have engineers that can put anything you put their mind to, but sometimes they don't want to. "This is what I've been doing for 50 years"; and it's how they think it needs to be done; "and we won't change".'

'They don't believe that, you know, they can learn from over East very well.'

A number of insights arose around the general theme of professional capacity. A general concern permeated a number of the interviews in relation to the changing workforce in the urban water sector. Many interviewees noted the workforce has a large proportion of engineers who are reaching retirement age, and it is increasingly difficult to attract new candidates due to the more attractive remuneration being offered in the mining industry. However some interviewees saw this 'changing of the guard' as a positive development. While engineering expertise was seen as a strength of Perth's urban water sector which had served well in the past, it was also viewed as a barrier to generating innovative approaches to new problems. With the majority of professionals with the same background holding similar problem framing and solving approaches, it was difficult to generate new ideas and ways of thinking beyond these long held, tried and tested cognitive norms.

'I think we were too much precautionary principle approach you know, and you'd find reason to say no rather than find a reason to do something,'

Similarly, another observation that came through many interviews was the aversion to professional knowledge, science and technology imported from settings outside Perth. The rationale behind this scepticism is that Perth has a very different biophysical environment. Many interviewees expressed frustration that the general reaction to potential solutions developed in other contexts was 'Oh no, that won't work here because of x, y and z…' rather than "Oh, that could work if we changed x, y and z…'

The final insight into professional capacity that arose was legacies from past structural changes in the sector. Many interviewees could trace the lineage of organisations back through past organisations in terms of where people had been drawn from to form the new organisation or internal division. Being a relatively small sector, many organisational cultures carried over into the new organisations. It also appears that while expertise was used to determine who should move where during these restructures, other important skills and capacity to enable these new collectives to fill the role they had been given may not have been given enough consideration.

Other research in the area of sustainable water management[42] has recognised the need for bridging organisations to help build capacity in professionals and to span organisational boundaries by providing a safe space to learn and collaborate on issues. The New WAter Ways program was formed with backing from key Departments and Agencies to fill this role, but due to its own capacity issues is struggling to achieve these aims.

Through these small insights from interviewee's accounts it would seem changing workforce demographics, 'cognitive-lock in,' wariness of some new science and technology, and carried over organisational culture are features of the water sector in Perth and critical components of the capacity of the urban water institution to adapt. After all, these organisations, divisions and individuals will be the actors whose decisions and practices interpret, shape and eventually alter the formal institutions of urban water management. Thus the background training, attitude and approach to problem solving in the practice and cognitive norms of these professionals and groups are the informal institutions that underpin the current urban water institutional setting, and look to be instrumental in its ability to evolve. This insight highlights a need for greater support of professional capacity building and initiatives that can bridge organisational boundaries and silos.

Niche Activity

This theme describes some of the past and present niche water management activities in Perth, and where they sit in the history and current practice of urban water management.

'If you go back to the early 1990s, you probably had some four or five people that were quite influential… they probably got water sensitive urban design on the agenda. Then they all went off on their own ways, and you didn't have any champions left.'

The Water Sensitive Urban Design movement was born in Perth, driven largely by water quality and drainage issues and is recognised as one of the most significant changes in how urban water management is practiced in its recent history. However it was not as influential in WA as in the eastern states. It was suggested that because the key champions moved on, to other states, fields and/or out of government, the ability to institutionalise the approach was lost. However renewed efforts are emerging though the release and capacity building work behind the policy *Better Urban Water Management*[39]. Interviewees observed that this niche activity is raising water quality issues, but more significantly providing a driver to integrate land use and water planning, particularly at the State Department and policy level.

'Now we've evolved that conversation, or are starting to evolve that conversation into a much broader, deeper, more meaningful one about water quality management more generally and that course of means drainage, urban drainage.'

As of the end of 2010, a new niche is consolidating around the governance of urban drainage. This area has been an issue of contention in Perth for a long time, and a number of reports and reviews have been conducted in an attempt to resolve the grey areas around who is responsible for managing urban water quality[44-46]. There has not yet been concerted action to address this issue, perhaps because flooding and hence drainage have not been great threats in recent years of low rainfall, water quality issues in the Swan and Canning rivers are not highly visible thus there has been no 'crisis' impetus for Government to step in and fix the situation, and due to the disconnection between drainage and water supply issues stemming from the misinterpretation of IUWM. Drainage is now being picked up by local government elected members through their involvement in a policy forum run by the Swan River Trust. The Western Australian Local Government Association (WALGA) has produced a draft plan[46] on behalf of these members, proposing governance arrangements and investment in activities to improve urban drainage issues across jurisdictions and statutory responsibilities. A number of interviewees mentioned that development of this plan, carried out with extensive engagement of the agencies and departments involved, has generated some momentum. Whether and how this niche activity will escalate remains to be seen. It does seem to promise a step toward a more comprehensive interpretation of IUWM in framing Perth's approach to urban water management.

'Risk drives profit in private industry. So they see the pay-offs of risk taking. They therefore tend to be excited by new ideas and actively seeking to innovate.'

Another significant area of niche activity is that of state and private land developers. Driven by the necessity of finding water supplies for their new developments and the desire to capitalise on the 'green' niche in the housing market, novel approaches to water supply and management from lot to regional scales are being built into land development. In the process of seeking approvals for these, they are also questioning the suitability and legitimacy of performance measures and approval criteria embedded in institutional frameworks. As such these niches are challenging current conventions and driving change, given the Government priority to facilitate development.

Development of niches are known in the literature as one of the main pathways by which practice changes are fostered and eventually taken up as mainstream practice, altering formal institutions in the process. It appears that there are niche activities operating in Perth, but they may need support to form the 'critical mass' needed to instigate change processes. These niches could therefore been as important platform to accelerate change initiatives.

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APPENDIX D: CASE CONTEXT REPORTS

Adelaide Case Study Report

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Executive Summary

Background

This report forms part of a PhD research project on 'Processes and Pathways to Water Sensitive Cities.' The research asks, 'How can urban water governance regimes support institutional adaptive capacity to enable and expedite a shift toward sustainable urban water management?' By identifying the interplay between informal institutions (shared meanings and understandings, norms, conventions and interactions) and formal institutions (documented rules and regulations), the research provides an understanding of the socio-political dynamics underlying urban water management practice. Describing these dynamics reveals how institutions change overtime, and how this capacity to adapt might be used strategically to enable transitions toward Water Sensitive Cities.

This report presents the case study of the Adelaide urban water sector[i], providing an institutional analysis of how the sector responded to the 'Millennium drought'[ii]. By identifying the management assumptions, beliefs, cross-sectoral relationships and other informal institutional conditions that underpinned professional practice change and subsequent governance reform, this research provides insight into the 'institutional black box' of urban water management.

Results

The threat to Adelaide's water security posed by drought highlighted new value propositions for water that challenged normative assumptions underlying water use and management. This triggered a re-evaluation of the objectives for water management. The Adelaide community engaged in debate around the normative foundations of urban water management (How much water should we take from the River Murray? What is a water source? What is acceptable use of water?). Public opinions filtered through various avenues to the water industry and Government, affecting a rethink of problem frames and decision logics underlying management and governance arrangements of urban water. Such discussion, debate and reflection on current practices opened the space for alternative solutions to be considered, multiple outcomes recognised and the structure and function of the sector to be reconfigured to accommodate these. While decentralised solutions appear to be becoming a mainstream component of Adelaide's urban water system, policy work to clarify a new direction and document new cognitive and normative understandings of water management have many issues yet to resolve before a transformation of the urban water governance setting is truly achieved. However, using an institutional perspective to examine the cognitive, normative and regulative institutional change dynamics embedded in this commentary of Adelaide's drought response, the research revealed the following key insights into institutional change processes:

- That re-evaluation of cognitive and normative understandings (problem frames and world-views) provides recognition of the need for change, and also sustain momentum during change processes
- That connecting new value propositions (norms) and problem frames (cognitive understandings) with potential solutions *and* a consideration of the governance (regulative) implications of these new approaches, are critical components of change processes
- That socio-political capital within the community is essential to a re-think of the value propositions for water, to define new and relevant management outcomes, and to generate the political support required for change. This particular capacity in the institutional setting needs to be built up overtime

[i] The management of water to supply a city's metropolitan area loosely defines the boundary of the case study. The urban water sector encompasses the actors (individuals, groups or organisations) with a role in collecting, distributing, using, valuing, treating and disposing of water.

[ii] The Millennium drought, as it has popularly come to be known, was a period of below average rainfall which began in mid 1970 in the west of the continent, and the late 1990's in the east. The eastern states experienced a return to 'average' conditions in 2009/2010, but the west has remained dry.

- Similarly, capacity for collaboration within the urban water sector needs to be supported, so that when the need arises, trust and working relationships can be drawn on to generate robust and broadly accepted outcomes, to efficiently resource implementation, and to help deal with uncertainty
- That informal networks are key to change processes because their activities connect various elements and influences to coalesce change

With creative dynamics at the collective choice level, and maintaining dynamics to embed change across inter-intra organisational relations, strategic support, professional capacity and belief and cognitive frame domains, this analysis points to a capacity in Adelaide's urban water sector to take on board lessons learned during the drought by reconfiguring management and governance arrangements. This represents not only resilience in the water management system, but reflexivity and capacities inbuilt into the institutional setting to recognise and adapt to future challenges and changes.

Next Steps

This report identifies the institutional dynamics behind Adelaide's response to drought conditions. It has revealed key dynamics that can generate the need for change, facilitate the formation of new common goals, and support collective action to achieve them. Moreover, the research identifies the types of activities and strategies that generate these dynamics. A further comparative analysis of Perth and Adelaide is expected to provide greater insight into these ingredients of change, needed within the institutional setting, to instil the capacity for more responsive institutional adaptation over time.

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1. Introduction

Contemporary urban water systems have been centralised to deliver optimised water supply, sewerage and drainage services, based on historic water availability. These systems are becoming 'locked-in' to these delivery objectives and cannot easily accommodate a growing diversity of water services (e.g. recreation, waterway health), water sources (e.g. recycled water), and in variable operational conditions (e.g. droughts and floods, population growth). The socio-technical context of water systems call for integrated management of water; matching water sources to fit-for-purpose uses while considering and minimising adverse, distributed impacts and maximising resource efficiency. A legacy of traditional optimised systems, separated infrastructure and governance arrangements cannot adjust to this level of integration. As such, scholars, practitioners and governments across the globe are recognising the need for fundamental change to water resources management; from technology, system design, operational practices and governance arrangements; to the underlying assumptions, beliefs and attitudes that determine how water is valued and utilised in society. To ensure water management is adaptable and meeting societal needs in the face of uncertain future conditions, all these dimensions of urban water management will need to be regularly reconsidered, operating parameters adjusted, and underlying assumptions and objectives reviewed. Understanding the institutions that underpin physical water systems, professional practice and governance arrangements is key to enabling such adaptive change processes.

Institutions are often defined as formally documented rules and regulations. However, the way actors[iii] interpret, act on and implement these guiding structures is as much responsible for what is observed in practices as what is written on paper. Thus, it is the socially constructed understandings, norms, and cognitive frames that shape interactions in society, allowing individuals, groups and organisations to act cooperatively. In the urban water context, these informal institutions determine the management paradigms and professional practices of water management. To explore how these social structures facilitate collective action, this PhD research aims to identify the institutional dynamics that result from the interplay between formal rules and informal social constructs, and the way actors interpret, enact and enforce these 'rules-in-use.' Understanding how underlying institutions allow the urban water sector to function collectively will provide insight on how these socio-technical systems can respond to feedback from the operating environment, adjust management outcomes and objectives accordingly, and guide activities to achieve them. Such ability will ensure urban water systems can be reconfigured to meet future water management challenges, anticipating and accommodating changes in social, environmental and economic conditions in a more proactive manner.

This PhD research uses the urban water sectors of Perth and Adelaide as multiple cases to explore institutional adjustments and the dynamics behind them. Each city had been subject to prolonged drought just prior to the study period (2009-2012). This offered the opportunity to examine the institutional dynamics that underpinned and/or enabled the significant adjustments to water management practices driven by the drought. This report presents the analysis for the Adelaide case study. It describes the contemporary state of play in Adelaide's urban water institutional setting, highlighting the institutional dynamics present as the city responded to water scarcity. The report reveals key dynamics that enabled Adelaide to adapt its water management system, including the physical infrastructure, management philosophies, cognitive frames, normative constructs and legislation and regulation.

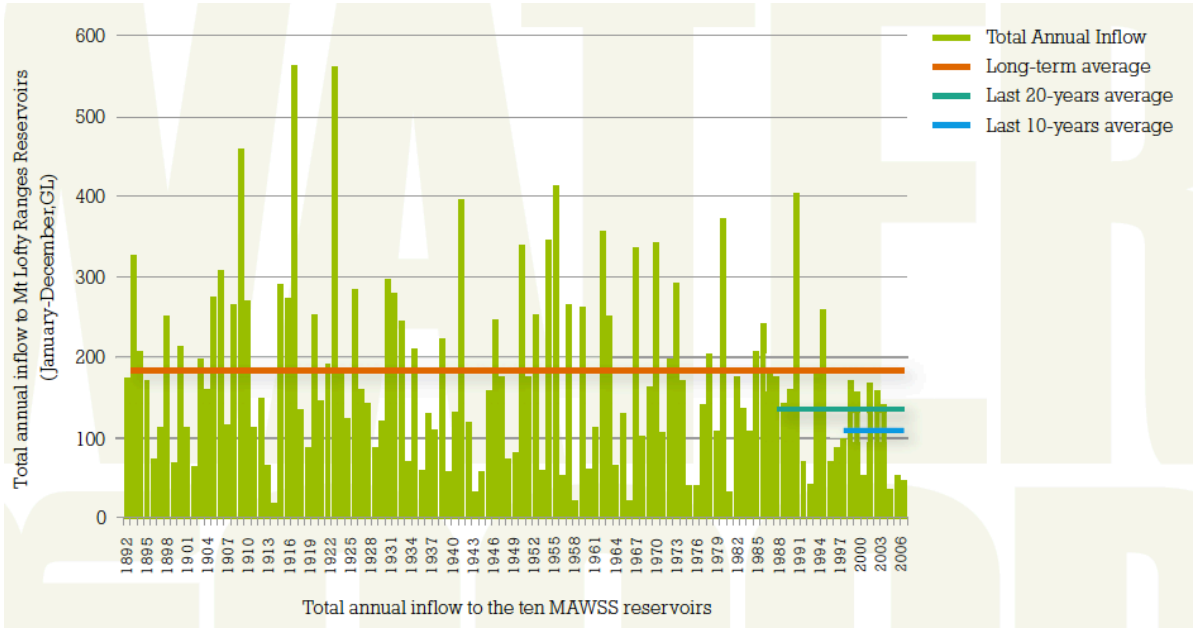
[iii] In this study, the term actor describes any individual, group, or organisation whose activities directly or indirectly influence water management.

2. Background

Adelaide is a city of 1.2 million people[1], stretching approximately 90km north-south along the eastern coastline of the Gulf of St Vincent, and spreading approximately 20km east to the Mt Lofty Ranges.[2] With a warm Mediterranean climate, summer rainfall is light and infrequent[3], making South Australia the driest of Australia's states and territories.[4] Thus since its European settlement in 1836[5], water supply has been at the forefront of Adelaideans' consciousness. The young city relied heavily on the River Torrens for water[6], and as the city grew the river became stressed from extraction, modification, land-use change and pollution.[6, 7] Beginning in 1861 with the city's first reticulated water scheme[8] at Thorndon Park Reservoir, Adelaide's water engineers have met the challenging task of supplying clean, reliable water in a water scarce landscape. This task included dealing with significant water quality issues,[7, 9] and water filtration and disinfection have long been features of Adelaide's water supply system.[10]

Like much of the southeastern part of the Australian continent, Adelaide's climate began to shift to drier conditions in the late 1990s – early 2000s. During the late winter and early spring of 2006, South Australia recorded its driest period since records began in 1900[11] (see Figure 1). The next three years the city received below average rainfall, and inflows to the city's water supply dams continued to reduce.

Figure 1: Annual inflows to the Mt Lofty Ranges reservoirs 1892 - 2006.



(Office of Water Security, 2010[12])

In addition to the reticulated supply system drawn from the Mt Lofty Ranges dams, since 1955 Adelaide has drawn water supplies from the River Murray.[6] This source can at times supply up to 80% of the city's drinking.[12] With the health of the Murray-Darling river system in dire straits during the drought, Adelaide's water security was under serious threat.

In line with the water management industry across the country, Adelaide developed a discourse around 'drought-proofing' the state's water supplies through diversification of water sources.[13] Demand management strategies such as media information campaigns, permanent water saving measures and temporary water restrictions were employed to try and slow the drawdown of existing supplies. Legislative change to require rainwater tanks on new developments also helped to decrease demand. Additional storage capacity was secured in the Murray-Darling river system to increase the security of Adelaide's supplies quickly. In 2007 the decision to build a 'rain-independent' desalination plant was announced as a longer term drought-proofing measure.[14] In 2009 a further decision was made to increase

the capacity of the desalination plant to supply approximately half of Adelaide's current water demands.[14]

Being such a dry state, Adelaide has a history of initiative when it came to securing water supplies. Prior to the drought, large schemes to recycle wastewater for fit-for-purpose use in horticulture and viticulture existed, recycling approximately 30% of the city's wastewater[12]. A pioneering niche in stormwater recycling using managed aquifer recharge had also been developed prior to the peak of the drought. The City of Salisbury had been developing stormwater harvesting and treatment systems, first as a means of maintaining the health of the area's wetlands, and later, by developing aquifer injection technology, for watering public open space. As water resources became scarer, the City of Salisbury recognised it had a significant asset in these stormwater reuse systems. They expanded their activities to begin supplying water for non-potable use to industry, agriculture, and within new residential housing estates.

As a more strategic response to the dry conditions, in 2008 the South Australian Government established an independent Commissioner for Water Security. This role joined water management efforts at a whole-of-government level by developing a long-term action plan to secure water supplies to 2050. *Water for Good* was released in 2010 and integrates a number of measures including infrastructure planning, policy development, legislative reforms, and community engagement in water management. In 2010 a State Government Department for Water was formed to take carriage of water policy and provide a focal point for integration of water management activities, in collaboration with other relevant departments and agencies. In July 2012, this Department was amalgamated into the Department of Environment, Water and Natural Resources.[iv]

The key organisations in urban water management and their roles and responsibilities with relation to water are described below:

- **Minister for Water and Minister for Planning**, have certain powers of delegation and approval/decision to manage water or other activities relating to its management (such as land-use planning and development), on behalf of the people of South Australia.
- **The Department for Environment, Water and Natural Resources**, created in July 2012, is responsible for conservation, protection and management of natural resources addressing climate change, and regulation of the water industry.
- **SA Water** is the State Government owned Corporation responsible for the provision of water supply and wastewater services.
- **Essential Services Commission of South Australia** is a State Government agency and independent regulator of water pricing, industry licensing and consumer protection.
- **Environmental Protection Authority (SA)** is a State Government authority responsible for the protection of water quality and the control of pollution and waste, through the licensing and regulation of human activities that impact on the environment.
- **Adelaide and Mt Lofty Ranges Natural Resources Management Board** is a statutory authority with responsibility to plan for the management of natural resources in a holistic integrated way, through a regional NRM plan. This includes management of soil, water, coastal environments and biodiversity.
- **Local Governments** are responsible for local flood management, and land use planning and development approvals, and for the management of the local natural environment.
- **Department of Planning, Transport and Infrastructure** delivers the land use planning system to control the physical development of the State. This includes setting the land use planning policy framework, and long-term directions for planning and development, such as those set out in *The 30 year plan for Greater Adelaide*.

[iv] As this research was conducted prior to the new Department being formed, the previous entity (the Department for Water) is referred to in the research results.

- **Land Developers,** both private and government owned, have an integral role in designing and implementing water management infrastructure often in close collaboration with SA Water, and relevant local governments.

A new *Water Industry Act 2012* will open the water industry in SA to third party service providers, and will come into full effect from 1 January 2013.

These formal institutional arrangements are animated by informal institutions; the beliefs and cognitive frames that underlie actors' interpretations, actions and sanctioning of the formal rules. Therefore, in order to gain a more functional understanding of the urban water institutional setting, the research sought to identify the informal institutions, explore the interplay between these and the formal arrangements, and the implications for how these dynamics came to shape the urban water sector's response to the drought.

3. Research Approach

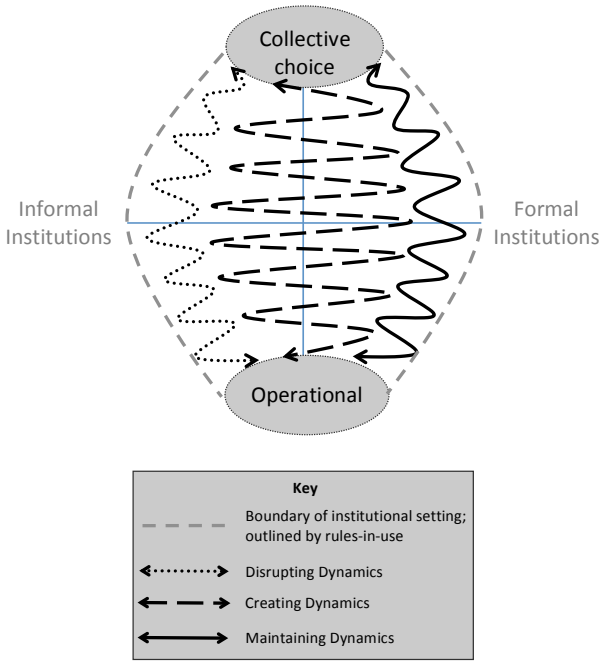
To help the reader interpret the results presented, this section provides a quick guide on the theoretical grounds of the research. Further information on the research design, methods, and analysis framework used to interpret the data can be found in Appendix A and B.

Conceptualising institutional dynamics

To provide a framework for understanding the institutional setting and its dynamics, two institutional scholarships were drawn together in a conceptual framework; The Institutional Analysis and Development Framework[15], and Institutional Work Theory.[16] The key concepts of these scholarships are defined below to aid the reader in understanding the results presented herein.

Rules-in-use are both the rules and regulations, and the social conventions that shape the way people interact, and the actions they decide to take. These formal and information institutions bound the institutional setting of the urban water sector by guiding behaviour and actions through various forms of sanctions and rewards. **Institutional work** is a type of activity an actor carries out which can influence on the rules-in-use. There are three types of activities; **Maintaining** activities enforce or conform to current rules-in-use, **Creating** activities generate new rules-in-use, by questioning the assumptions and conventions behind current rules-in-use, and **Disrupting** activities explicitly challenge current rules-in-use or undermine their legitimacy. If significant institutional work is being carried out, i.e. if these types of activities are aggregated and connected across the sector, it generates dynamics within the institutional setting that maintain, create and/or disrupt the rules-in-use. There are two levels of the institutional setting that these dynamics can take effect on. The **Operational level** is focused on the day-to-day delivery of water services, so the institutional dynamics at this level are affecting rules and regulations governing water management, and practitioners' interpretations of these. Water service providers and resource managers predominantly conducted institutional work at this level. The **Collective choice level** is a level of the institutional setting where the day-to-day rules are monitored, evaluated and changed. This process must be conducted jointly by stakeholders, as the new rules-in-use must be understood and shared collectively in order for them to become legitimised. In the urban water context, activity at this level of the institutional setting would be carried out by executive management within organisations, policy makers, regulators and other broader stakeholders. These key concepts are illustrated as a conceptual model of the urban water institutional setting in Figure 2.

Figure 2: Conceptual model of institutional dynamic



The different scales of institutional activities are presented on the y axis, bounded by the rules-in-use on a continuum from formal to informal institutions (x axis). The three different forms of institutional work mediate between these levels, generating interplay between operational and collective choice levels and altering rules-in-use. Maintaining activities enforce and conform to formalised rules and regulations, and so tend to rely on these rules-in-use. In contrast, disrupting activities seek to challenge and undermine formal institutions, and so rely on informal rules-in-use beyond the sanctions imposed by formal rules. Creating activities mediate between these two, questioning formal rules with insights from disruptive activities, but, rather than challenging these directly, using passive strategies of mimicry, advocacy and education to 'bend' the formal rules to accommodate and eventually legitimise these new ideas. For more information on the different strategies used in creating, disrupting and maintaining institutional work, see Appendix B: Analytical Lenses on page 235.

Using these concepts and conceptual model, an understanding of the dynamic processes within the urban water institutional setting, and the origins and processes of institutional changes occurring as a result, can be identified, described, and understood.

Research Methods

This research identified the institutional dynamics underpinning Adelaide's urban water sector by drawing on people's experiences of working within the sector. The tacit knowledge practitioners develop through experience and interaction underlies how they interpret and navigate the formal institutions. This knowledge includes the informal institutions that animate the rules on paper through interpretation and choice of action, guiding and shaping the way the urban water sector operates, and what eventuates in practice.

Focus groups provided a way to access and understand this experiential knowledge; by providing practitioners with the time and space to reflect on their tacit understandings, identify the more informal rules-in-use bounding their activities, and discuss the influence of these on their day-to-day decisions and actions. These discussions revealed the informal institutions guiding their practices, and the interplay between these and the formal rules and regulations. In this way, a more comprehensive picture of the rules-in-use underpinning professional water management practice was produced. This information was captured in whiteboard maps, individual reflections and audio recordings of discussions and follow-up interviews.

From this data, the research aimed to i) identify the rules-in-use guiding the urban water sector, ii) determine the types of dynamics these rules were creating and the extent of their influence on the institutional setting, and iii) map the connections between these dynamic influences to illustrate their contribution to Adelaide's drought response. These results are presented in Table 1, Table 2 and Figure 3 respectively in the following section. For more details on the methods used to achieve these three research objectives, see Appendix A.

4. Results Summary

This section presents the key results of the analysis. The detail behind these summary findings can be found in Appendix C.

The analysis revealed a number of domains in the institutional setting where activities are generating institutional dynamics (see Table 1). These domains therefore represent key areas of Adelaide's institutional setting where rules-in-use are being used, created or challenged, resulting in adjustment, or preservation, of water management practices and formal institutions.

Table 1: Domains of institutional activity identified in Adelaide

Domain	Description
Governance setting	Regulation, legislation, levies, policies and other formalised incentives and disincentives that shape the industries operational environment.
Policy Direction	The purpose water management fills in society, articulated and communicated in a policy agenda subscribed to across Government.
Inter & intra organisational relations	The relationships and working culture of organisations across the urban water sector.
Strategic support	Managerial support for reinterpretation of roles and responsibilities, and networks of frontrunners to disseminate and champion innovations.
Discourse	Public debates and public perceptions of water management, as understood by practitioners. Professional discussions on the beliefs, cognitive frames, professional identities and other assumptions underlying the current water management paradigm.
Information and feedbacks	Information on system performance, opportunities, emerging issues and pressures from the broader contextual environment the urban water industry is situated in.
Space for innovation and learning:	The culture of learning and experimentation across the sector, and the supporting structures provided by organisations and individuals for such activities.
Professional Capacity	Skills, capabilities and technical knowledge resources for performing water management, and for deriving innovative approaches to this task.
Beliefs and cognitive frames	Shared views, perspectives, problem frames and other intuitive understandings that underlie actors thinking and approaches to urban water management.

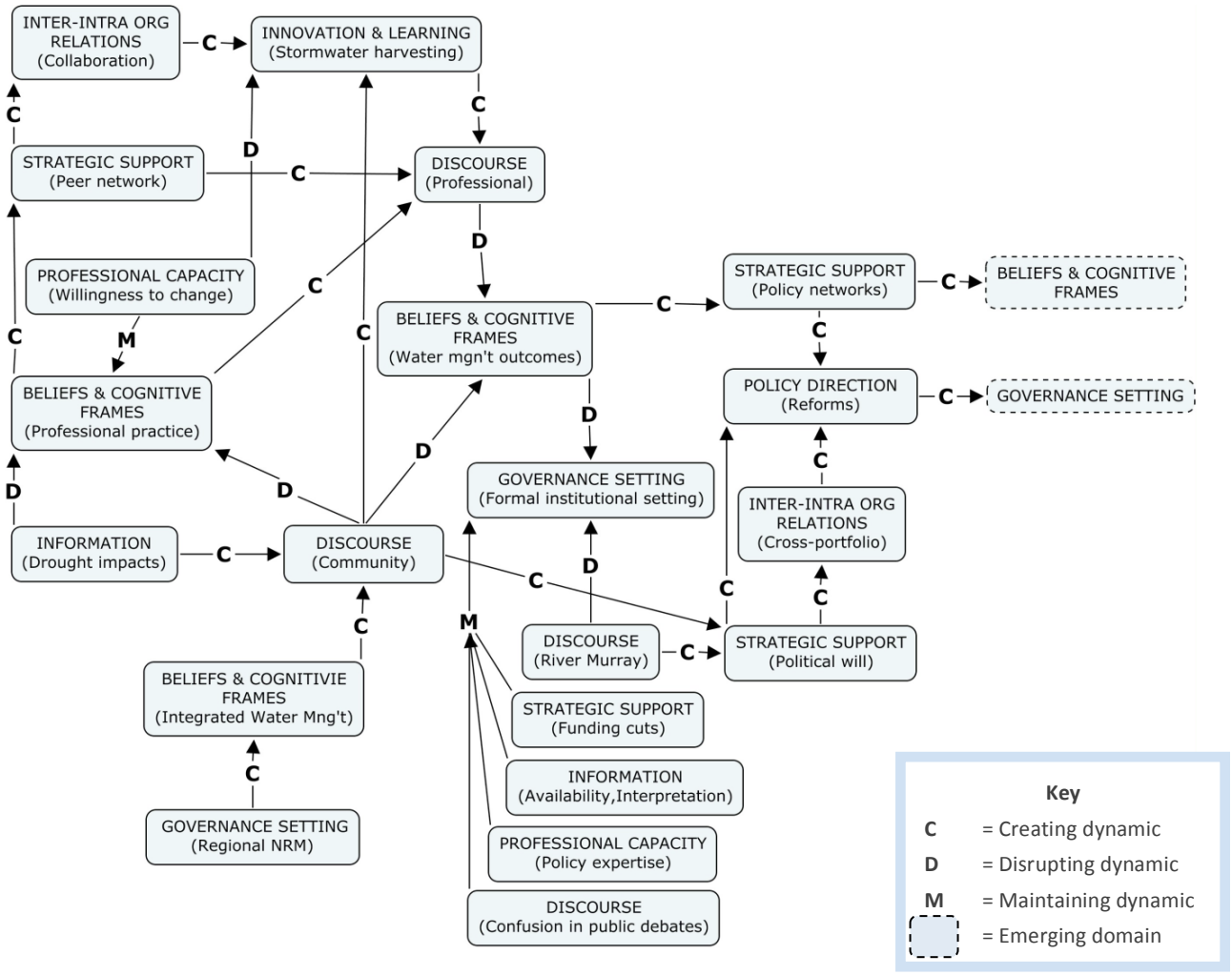
Assessment of the rules-in-use within these domains revealed the types of dynamics (maintaining, creating, disrupting) that are generating institutional adjustments. A significant rating (●) was given where the institutional work being conducted within a domain was having a notable effect on water management practices and/or formal rules and regulations. A limited rating (◐) indicates that there is some institutional work of this type, but it is not producing dynamics that are having a substantial effect on the rules-in-use. An insignificant rating (○) suggests that while this type of institutional work may exist, it is currently generating negligible dynamics on the institutional setting.

Table 2: Assessment of institutional work within domains.

Institutional domains	Creative work	Disruptive work	Maintaining work
Governance setting	●	◐	◐
Policy direction	◐	○	○
Inter & intra-organisational relations	●	○	◐
Strategic support	●	◐	◐
Discourse	◐	◐	○
Information	●	○	○
Innovation and learning	●	○	○
Professional capacity	●	○	◐
Beliefs and cognitive frames	●	○	◐

Concept mapping of the significant and limited dynamics identified in Table 2 provided a picture linking these influences, showing how different configurations of institutional work within and between different domains generated the key change dynamics leading to Adelaide's institutional changes driven by the drought (see Figure 3). These key configurations are described in the Discussion section.

Figure 3: Institutional Dynamics identified in Adelaide

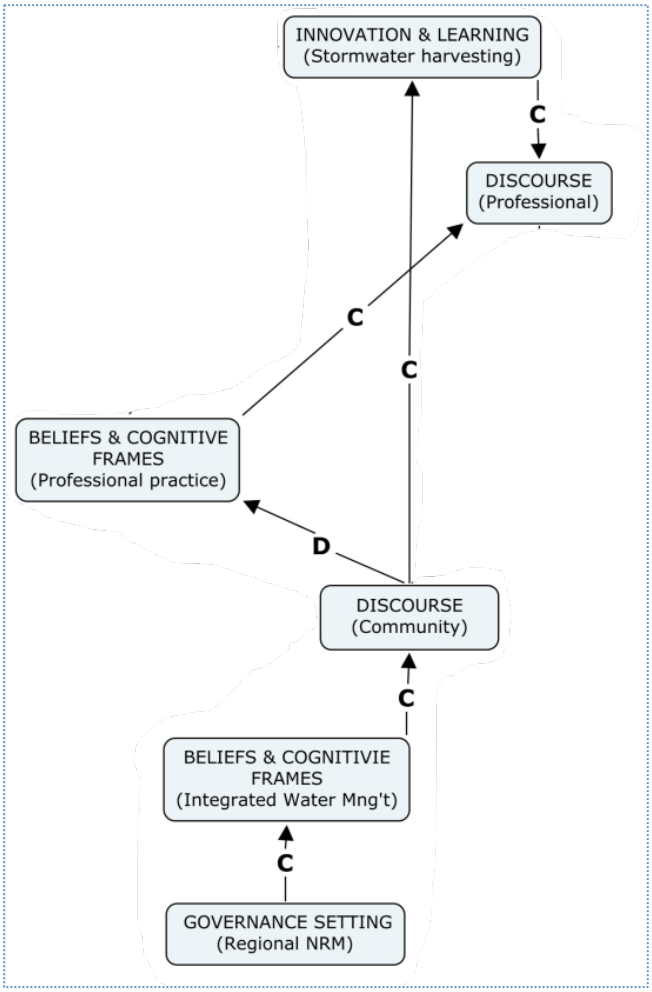


5. Discussion

This section discusses the key dynamics that generated changes to Adelaide's water management practices, and eventually, formal institutional setting.

While the following commentary to describe key configurations of dynamics within Adelaide's urban water institutional setting is presented in a somewhat chronological narrative, it is important to note that these dynamics and their influences are difficult to bound in a particular sequence of events or time periods. The sequence of dynamics discussed below is simplified and described linearly to help the reader develop an understanding of the dynamics the research identified. This understanding should be accompanied with the knowledge that this is an account of a complex, adaptive system that, in reality, does not operate in a linear process.

Configurations of dynamics



Legacy of engagement

Prior to the drought, governance arrangements played a crucial role in developing community water literacy. The establishment of regionally based water management authorities (Water Management Boards) with a remit to involve communities in the long-term planning of water resources management provided formal avenues for community engagement. This activity built the Adelaide community's awareness of water management issues and the socio-political capital for their involvement in water management. The total catchment management approach of the Water Management Boards also created integrated knowledge of water issues in the community, encompassing not only water supply concerns, but water quality issues connected to land management practices, and impacts on waterway and coastal health. This avenue and capacity for the broader community to engage in urban water planning and management drove a focus on drainage management; being the most visible issue that connected land management, waterway and coastal health.

Figure 4. Legacy of engagement rules-in-use configuration

Integrated thinking and problem framing

Integrated thinking in professional practice around flood protection, wetland health and public open space management originally drove experimentation around stormwater harvesting. Once water became a scarce resource, these systems were reconfigured to provide fit-for-purpose supplies. Collaboration around these experiments to monitor supply and environmental performance, and with regulators their success and provided an initial business case to promote the approach as a possible solution to water scarcity to lobby for greater support. The links between new values for water and peer networks

gathering around solution development to meet subsequent management outcomes began to highlight the governance implications of these new approaches. Shifts in the normative perceptions of water sources (e.g. stormwater, aquifer storages, and recycled water) had implications for traditional roles and responsibilities of departments and agencies. In addition, the political debates surrounding the River Murray put an impetus on the SA Government to have good urban water governance arrangements, as it provided them with a stronger bargaining position in negotiations over water rights for Adelaide's supplies.

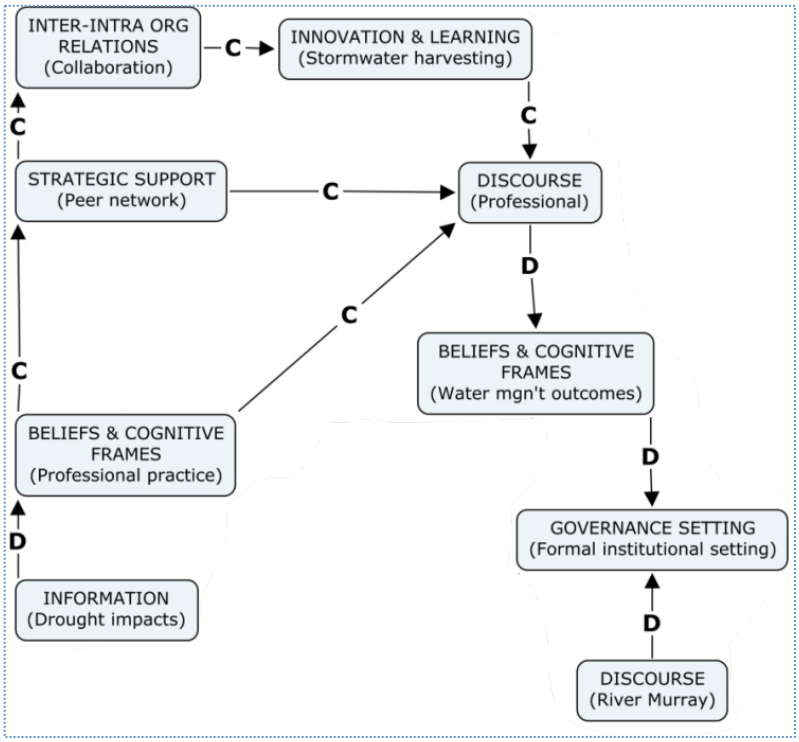


Figure 5. Integrated thinking and problem framing rules-in-use configuration

Community engagement

Following the second summer of water restrictions, the community began to question whether enough was being done in the Government's response to the growing water scarcity. Water management decisions were being publically questioned, and this growing public debate supported an emerging professional discourse questioning and challenging traditional problem frames and moral objectives for urban water resources management. The stormwater harvesting solutions that had been experimented with matched newly articulated problem frames and objectives emerging from this discourse. Because of the public interest in the problem, these narratives were elevated into discussions at the governance level (collective choice level), as differentiated from management level discussions of water supply provision (operational level). This elevation generated significant political will for urban water management reforms.

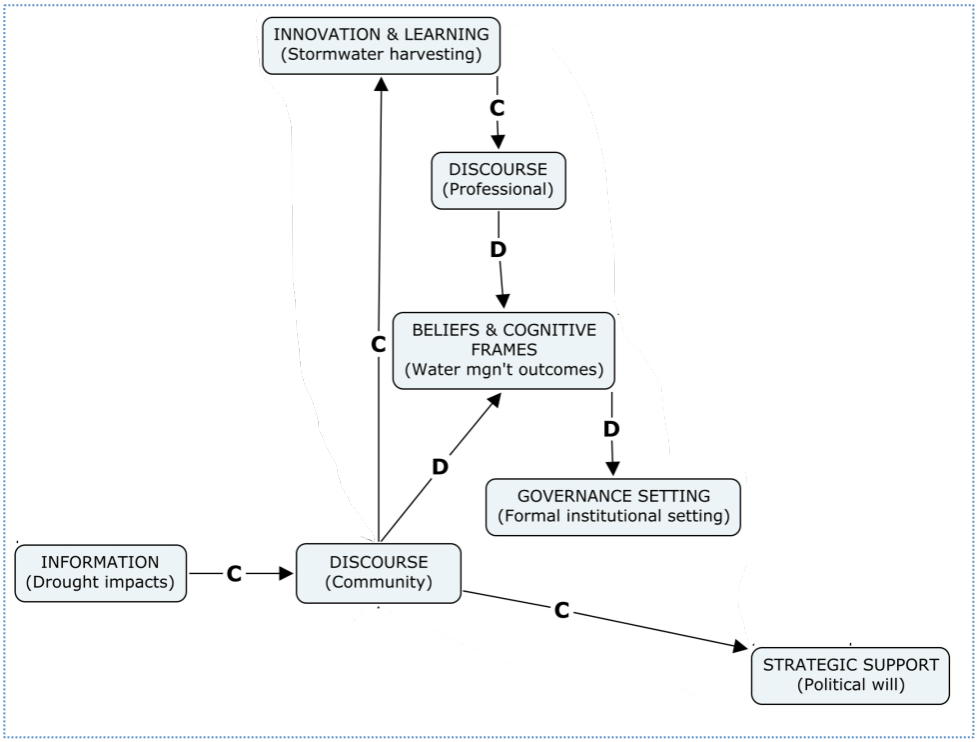


Figure 6. Community engagement rules-in-use configuration

Coalescing momentum

Peer networks and industry champions played an important role in 'connecting the dots' between the different activities within the institutional dynamics. Considering the external feedback to the water management system from the drought conditions, reflecting on the implications of this feedback for management practices and underlying assumptions and world views, collectively theorising these implications, matching new problem frames with solutions, and creating concise narratives to communicate this information were some of the important connections they facilitated. These activities highlighted the dissonance between professional practice, new environmental conditions, governance arrangements, and community expectations for water management. By connecting environmental feedback, experimentation and professional and public discourse, these influences coalesced to question and challenge the viability of governance arrangements for urban water management. This elevated the problems to the collective choice level so that concerted, collaborative activity could occur.

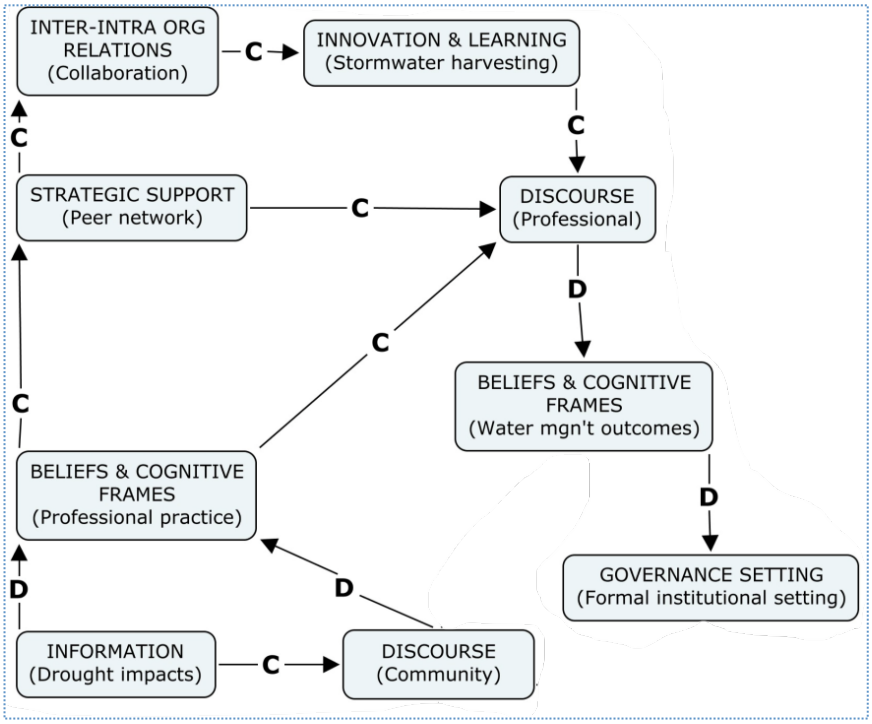


Figure 7. Coalescing momentum rules-in-use configuration

Collaborative, whole-of-government response

Initial governance changes included the establishment of the State Government Department for Water to lead water policy development and governance reforms, and the appointment of the Commissioner for Water Security to conduct a whole-of-government process to integrate initiatives aimed at achieving water security. These governance structures, other collaborative forums to address the water security problem, and the political expediency of the problem, drove cross-portfolio collaboration and generated high levels of managerial support. This situation produced the freedom to discuss & debate water governance issues in professional discourse, the ability to question assumptions and views underlying traditional practices and arrangements, and opened up space to reconfigure governance structures through fundamental, formalised reforms.

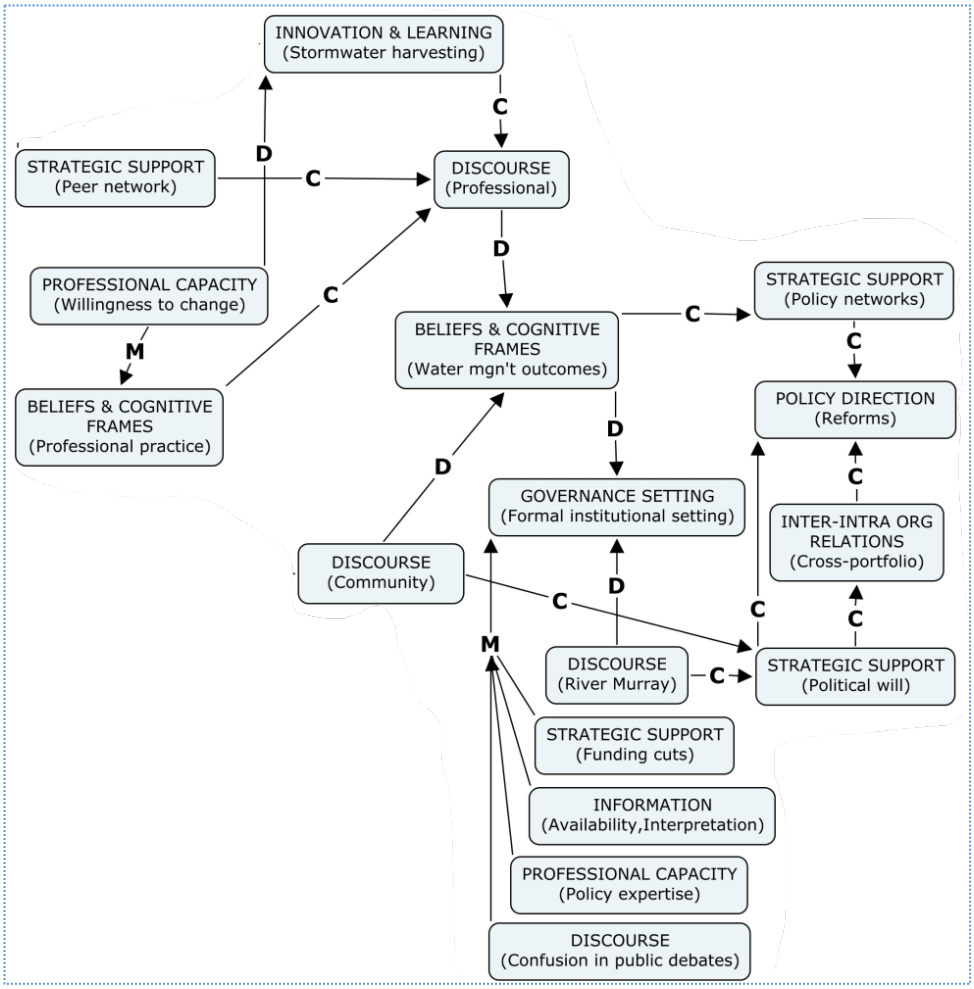


Figure 8. Collaborative government rules-in-use configuration

Maintaining momentum

With the creation of the Department for Water, a policy network developed to address the issues and challenges raised by the drought at the operational level. Continued pressure from public debate and growing relationships with industry champions is sustaining some momentum for reform, despite the breaking of the drought detracting from the urgency of the problem. Likewise, the practice of benchmarking SA against other states that was prevalent in the narratives of participants is helping to drive improved performance. However, contradiction in expert opinion within public debate is creating some mistrust of the science behind water management, and has potential to affect public support for activities, thus have a maintaining influence. Other potential maintaining influences include the discrediting of new solutions and management philosophies by some actors unwilling to change, the limited policy expertise to integrate social and economic aspects of water management alongside environmental protection, and reduction of budgets in State Government departments, reducing their capacity to progress reforms.

These key configurations of dynamics within the institutional setting have been identified as having a significant influence in Adelaide's drought response. It is too early to conclude that the reconfiguration of city's institutional setting represents an adaptive for transformative change. However, this analysis looks in greater depth at the institutional work being conducted by actors, revealing the actions being taken to maintain current practice, and those disrupting the status quo and creating new rules-in-use. These are discussed in the following sections and provide insight into what ingredients might be needed to overcome inertia in the urban water institutional settings, and inform strategies to guide and direct systemic change processes.

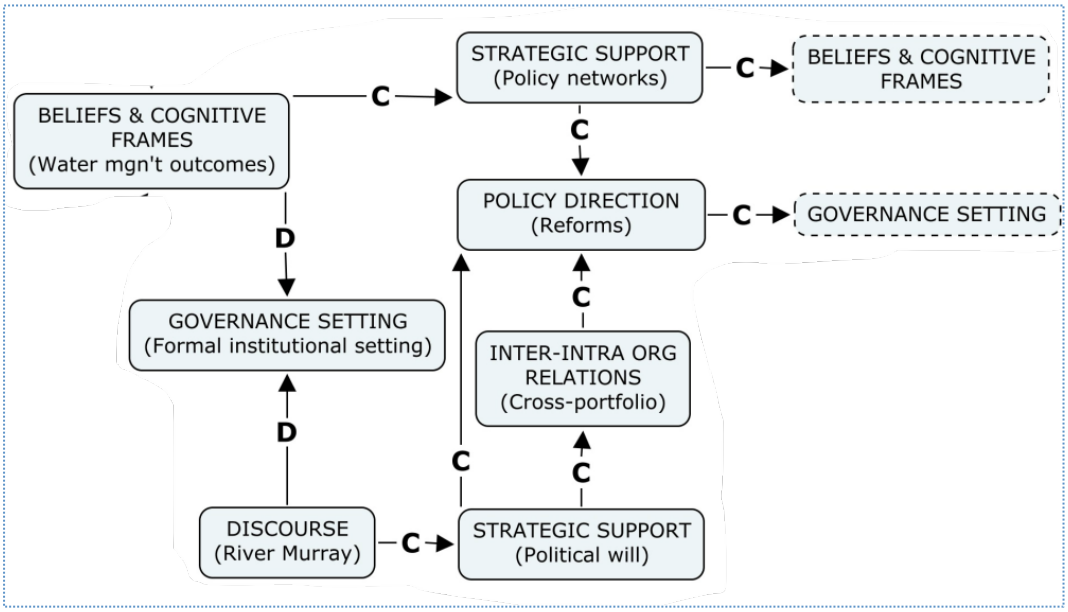


Figure 9. Maintaining momentum rules-in-use configuration

Institutional work

The institutional work identified in this study reveals something of the interplay between the formal institutions providing stability and certainty for water management practice, and the mechanisms of change to deal with the prevailing drought conditions. Adelaide's institutional dynamics were dominated by creative work at the time of this study. This prevalence suggests the drought crisis had destabilised the institutional setting, and actors were in the process of generating new rules-in-use more suited to the altered operating conditions. This assertion is supported by the nature of the maintaining dynamics identified. For, while some maintaining activities deter change, others seek to embed new ideas, practices and norms, to generate certainty through new, shared, rules-in-use, and restabilise the institutional setting. The activities of actors that drive this interplay are discussed below. Some activities might be conducted purposefully, and therefore could be described as strategies rather than activities. However some activities are conducted without knowledge or intention of their influence on the institutional setting. Therefore, these forms of institutional work are referred to as activities. Understanding how to turn these activities into more strategic interventions, or strategies, is the practical output this research aims to eventually operationalise.

Creating work

There was a wide range of activities creating new rules-in-use across most domains of the institutional setting. Significantly, activities in beliefs and cognitive frames, information, innovation and learning and strategic support domains appear to mutually reinforce each other. One of the common threads in these dynamics is the presence of activities focused on cognitive and normative institutions; the cognitive frames and processes and normative assumptions and beliefs, at both operational and collective choice. Such activities indicate reflexivity occurring across the sector as practitioners' surface, question and assess the foundational principles and purpose of urban water management. These activities included:

- Theorising work to make sense of the changing operational environment resulting from the drought, and the implications of these new conditions for water management
- Educating work to spread information and narratives explaining what these implications meant for the industry, generating momentum for change
- Changing normative associations between practices and the new views of the world instilled in these narratives

- Peer networks gathering around these new ideas to develop suitable solutions and communicate them, drawing information and examples from the creative work conducted in the innovation and learning and information domains to support the new narratives
- New professional and organisational identities being constructed around the new framing of the problem and solutions.
- Public debate and discourse supporting broader recognition and development of cognitive and normative shifts, and generating other strategic support mechanisms in the form of political will
- Political will, in turn sanctioning creative activities in the governance and policy domains, and encouraging creative collective choice activities in the inter-intra organisational and professional capacity domains.

Disrupting work

Disruptive dynamics were only identified in three domains; governance, strategic support and discourse. Moreover, these results suggest that Adelaide's urban water sector has moved on to resolve challenges through creative work to generate new rules-in-use and maintenance work to embed these adjustments. Nevertheless, some key disruptive influences were still prevalent. Within the governance and strategic support domains, disruptive activity at the operational level to undermine regulative institutional features by reinterpreting decision logics behind the approval processes, thereby disconnecting sanctions and rewards that encourage traditional practices, were identified. Common disruptive influences across the governance, strategic support and discourse domains occurred at the collective choice level, including:

- Disassociation of moral foundations of water management, due to Adelaide's position in the national debate of the River Murray, which prompted the Government to examine the framing of water management problems and the assumptions underlying the configuration of governance arrangements
- Normative roles in water management, and gaps in responsibility coming to the fore in tensions over ideas and professional identities, particularly around stormwater harvesting and direct potable reuse of recycled water
- Through public questions and comments regarding the approaches being taken to urban water management, the community challenged the moral foundations of water management, requiring urban water managers to go back to first principles in order to justify their decisions to these 'non-experts'
- Confusion in public debate through misinterpretation and contradiction in 'expert opinion' polarising views and turning water management into a political issue

These disruptive activities focus on the cognitive and normative spheres of rules-in-use, and drive and facilitate the formulation of new principles for water management. Resurfacing these foundational assumptions, or first principles, led to a re-evaluation of the logic behind decisions, and the creation of new logics to encompass environmental conditions and contemporary societal needs and aspirations (such as water security, amenity of public open space during drought, and waterway and coastal health). Finally, a key disruptive influence was the cognitive frame that existing institutions are open for interpretation and review. Many participants noted the flexibility current institutions afforded, but this quality seems to lie in the attitudes and interpretations of practitioners across the sector, and in those positions that provide strategic support to sanction interpretations – rather than the configuration of the formal rules themselves. While individuals following these rules can still maintain the status quo, the understanding that rules may need to be reconsidered and reinterpreted to achieve the most suitable outcomes appears to be a significant feature of normative professional practice within Adelaide's urban water sector.

This analysis suggests that disruptive activity to re-examine the foundational understandings, principles and assumptions of urban water management, in a few key domains of the institutional setting, has been a critical trigger for reconfiguration of the sector. In particular, elevation of these disruptive activities to the collective choice level for open debate has led to the sanctioning of creative work to resolve the emerging issues.

Maintaining work

Some maintaining activities seek to perpetuate existing institutions and examples identified in the research included:

- The demand for clarity around decision and approval processes, particularly in land development, emerged as a key regulatory feature
- Budget constraints for internal review, monitoring and evaluations, and reform activities
- Problems with information flow between organisations
- Lack of professional capacity to address emerging issues through policy thinking and development
- Work focused on discrediting or distrusting new approaches by reinforcing current normative associations

Conversely, cognitive work in a number of domains to legitimise and embed new routines and logics into practice are serving to begin to maintain many adjustments, and pave the way for reform of regulatory structures. This was largely dependent on the disrupting dynamics existing at the collective choice and particularly in the governance setting, strategic support and discourse domains, and the creative activities that feed information between the institutional levels. Thus, while some maintaining activities re-enforce existing institutions and tend to rely on regulative features to do this, other cognitive and normative developments from creative activities can crossover into maintenance activities. Such embedding and routinizing new problem frames, decision logics, processes and actions appear to set the grounds for more formal change in regulatory structures.

Key insights

The threat to Adelaide's water security posed by drought highlighted new value propositions for water that challenged normative assumptions underlying traditional water use and management. This situation triggered a re-evaluation of objectives for water management. The Adelaide community engaged in debate around the normative foundations of urban water management (How much water should we take from the River Murray? What is a water source? What is acceptable use of water?). Public opinions filtered through various avenues to the water industry and Government, affecting a rethink of problem frames and decision logics underlying management and governance arrangements of urban water. Such reflection, discussion and debate on current practices opened the space for alternative solutions to be developed and considered, multiple outcomes recognised and the structure and function of the sector to be reconfigured to accommodate these. While decentralised solutions appear to be becoming a mainstream component of Adelaide's urban water system, policy work to clarify a new direction for water management has many issues yet to address before a transformation of the urban water governance setting is truly achieved. However, with creative dynamics at the collective choice level, and maintaining dynamics to embed change across inter-intra organisational relations, strategic support, professional capacity and belief and cognitive frame domains, this analysis points to the sector having the capacity to reconfigure; to take on board lessons learned during the drought. This represents, not only resilience in the water management system, but reflexivity and capacities inbuilt into the institutional setting to recognise and adapt to future challenges and changes. Hence, while the results of this dynamics interplay within the institutional setting are yet to resolve whether Adelaide's urban water sector does adapt to new operating conditions, these results suggest a number of important connections in the institutional dynamics that are critical to a successful institutional reconfiguration:

- The contention between maintaining and disruptive influences
- The blurred line between maintenance activities that preserve the status quo, and those that integrate new understandings (generated from creative activities) into the formal institutional setting
- The ability of cognitive and normative work to reduce maintaining influences, through both creative and disruptive dynamics

- The importance of creative work at the operational level to inform and drive change at the collective choice level, and
- The critical role disruptive activities play in generating change by opening up the institutional setting to re-evaluation, maintaining momentum for change, and elevating developments at the operational level to the collective choice level (by translating creative activities)

6. Next steps

This report has looked exclusively at the institutional dynamics present in the Adelaide case. The analysis identifies some connections between types of dynamics and key institutional domains that were important for Adelaide to begin a process of adaptation to drought conditions. However, the results presented here are, as yet, unable to offer concrete suggestions on what the key institutional attributes and supporting dynamics are for generating adaptive capacity, and what rules-in-use might create such dynamics in the Adelaide context. This knowledge will be generated during the last phase of this research, when the comparative analysis of Perth and Adelaide will show patterns of these dynamics, what rules-in-use and contextual factors underscore them, and what overall effect these attributes have on the practice of water management.

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Government of **Western Australia**
Department of **Water**

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Appendix A: Research Design

This section presents a summary of the approach used to answer the question guiding this research: 'How can urban water governance regimes more effectively support institutional adaptive capacity to enable and expedite a shift toward sustainable urban water management?'

Overall Design

In order to explore institutional dynamics and how they might create adaptive capacity within the urban water institutional setting, an *in situ* method was essential, as the research subject (institutions) exist in day-to-day work practices and interactions of people. A multiple case design was chosen so that institutional dynamics could be explored within the context of real-world cases, and compared between cases for generalizability of the results. The urban water sectors of a number of Australian state capital cities were chosen as potential cases, as they had all been subject to significant change to their operating conditions as a result of the 'Millennium' drought. The combination of traditional and innovative solutions that were employed to cope with the reduced water availability suggested there would be significant and observable dynamics at play within the institutional setting, allowing the implementation of both traditional and alternative water management options. Contemporary centralised urban water systems are based on fundamentally different cognitive and normative associations (informal institutions) to emerging alternative solutions, such as waste and stormwater recycling, demand management, and managed aquifer recharge. Thus the implementation of these alternatives and their different institutional underpinnings sit uncomfortably against the cognitive, normative and regulative institutions of traditional urban water management. As such, these cities provided a unique opportunity to explore institutional dynamics, as their institutional settings undergo processes of questioning, challenging and possibly changing the institutional setting to accommodate these new solutions.

Case Selection

According to multiple case study research method[17, 18], cases should be selected with some differing attributes in order to provide a rich basis for comparison, and to ensure any patterns observed can be separated, to some extent, from the contextual setting and provide generalizable findings. This research sought cases undergoing potentially different forms of institutional change, by differentiating the levels of institutional activity[v] predominant in each case. These included: i.) 'Bottom-up' processes where institutional activities were predominant at the operational level of day-to-day water management decisions, and ii.) A hybrid process where a mix of top-down and bottom-up activities were equivalently influential. These forms of institutional change guided case selection and provided analytical depth to the multiple case study design.

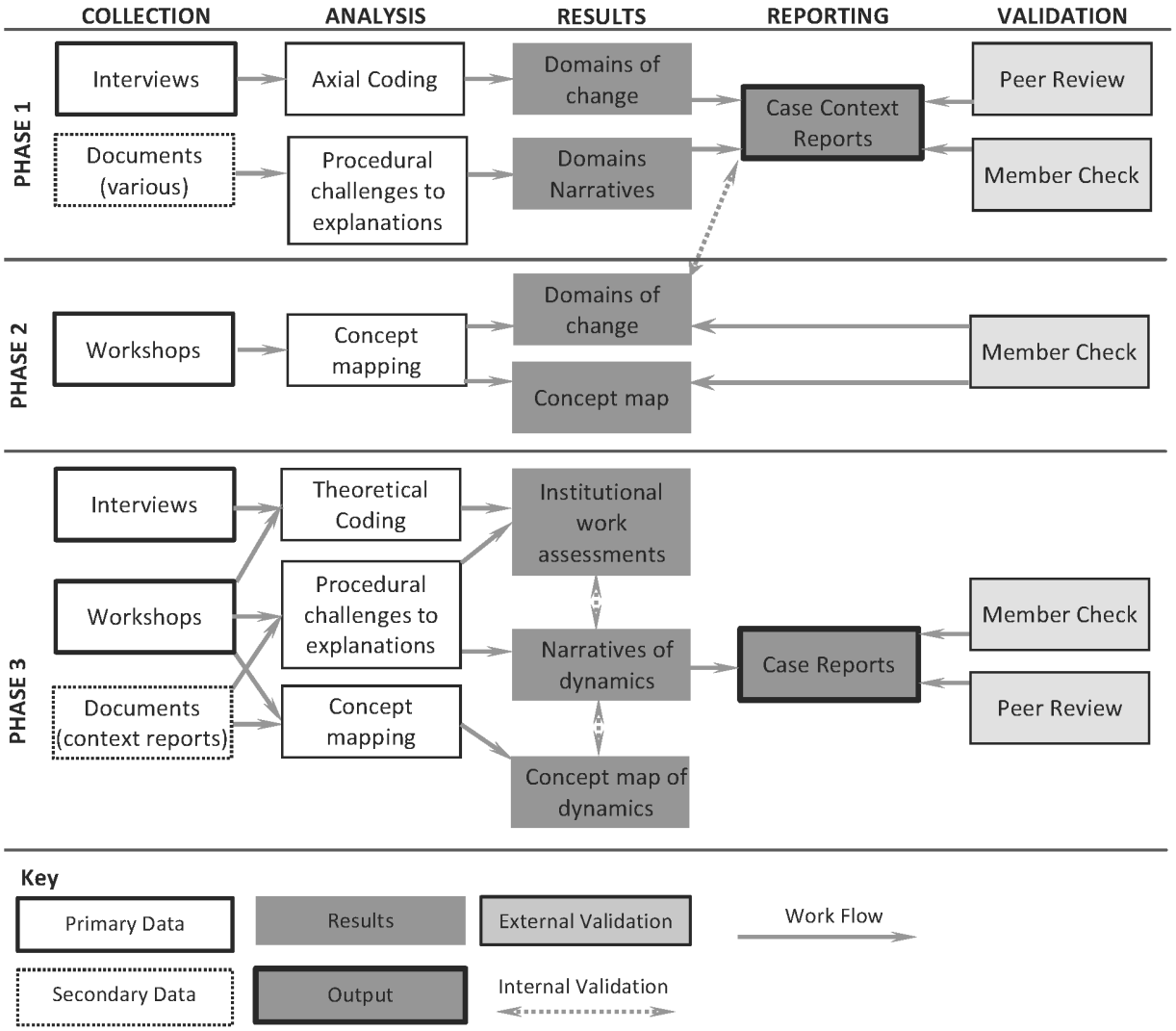
After initial scoping interviews with key practitioners in Perth, Adelaide, Brisbane, Melbourne, Sydney, and National water organisations, two cities were chosen. These cities offered the different forms of institutional change identified above, so that cross-case comparisons could reveal similarities, differences and patterns with significance. Importantly, the practitioners in the cities chosen were also engaged in the research, providing access to the source of the data; practitioner's experiential knowledge. Perth was chosen as a case of potential 'bottom-up' change, as niche activities in local governments, land developers and development authorities were cultivating alternative water management solutions in response to water scarcity. Adelaide was selected as a case of hybrid change, as new solutions had been developed and the legitimisation of these alternative practices in formal institutional reforms was underway.

Methods

[v] See 'Institutional Analysis and Development Framework on page 241 for an explanation of these levels.

Figure 10 provides a schematic of the research processes. A short description of the purpose and process for each research phase illustrated is provided in the sections that follow. Throughout the research a number of validation techniques or 'built-in reality-checks' were employed to ensure the results were credible and dependable. External validation techniques involve seeking critique and elaboration from others, while internal validation occurs when similar results are produced through the analysis of different sources of data. These are also shown in Figure 10.

Figure 10. Research Process



Phase One - Contextualising

This phase of the research sought to identify and contextualise the institutional changes occurring within each case by identifying the prominent rules-in-use guiding water management.

Information was collected through interviews with practitioners (n = 9), who had been working within Adelaide's urban water sector during the course of the drought. They were selected as being experts on water management in Adelaide, due to their long experience and/or varied roles within the sector. As a result, many interviewees were currently in management and executive roles. They included practitioners from State Government (water and planning) and local Government, SA Water, government authorities (natural resources management, environmental protection authority), research organisations, and private consultants.

Guiding questions were used in a semi-structured interview technique to identify (i) the management responses to the drying conditions, (ii) practitioner's thoughts on what some of the major changes had been, (iii) what had influenced that change and how it had come about, (iv) how the sector was

performing under water scarcity, and (v) what the future challenges to the sector might be. These interviews were transcribed *ad verbatim*, and coded using a modified version of axial coding to make thematic connections in the data. A narrative about Adelaide's water management experiences was constructed and included the presentation of contrasting or conflicting storylines. These storylines were then compared to written records, policy documents, newsletters, research reports, journal papers, and media articles to look for corroborating and conflicting accounts, which were also incorporated into the narratives. This provided contextual information on domains of the institutional setting where rules-in-use were influencing the drought response (see Table 1).

Phase Two - Characterising

Phase two of the research sought to identify and characterise the institutional dynamics underscoring water management practices. This was achieved by ascertaining the rules-in-use in the domains identified in phase one, and determining how these rules interacted to effect institutional change.

The data that informed this phase was gathered through a two-step process of workshops and interviews. Firstly, a workshop was designed to elicit the tacit knowledge of practitioners about their everyday practices, and what recurrent influences aid or hamper them. Participants (n=12) were asked, 'What influences your work?' and through self-reflection and group discussion, the rules-in-use that shape how the urban water section in Adelaide functions were identified and mapped to explore their connections and effects. These workshops were themed as 'supply and sewerage' and 'drainage and waterways' workshops, to group people working in similar areas within the sector, so participants could share and reflect on similar working conditions. Invitations were distributed broadly through a range of organisations involved in the water sector, so as to access a breadth of different experiences. Any participant who expressed an interest in sharing their experiences was able to attend. Secondly, the insights and key findings of these workshops were crosschecked in a separate round of semi-structured interviews with key informants (n = 3). These individuals were identified through the first phase of the research as having extensive knowledge of the Adelaide case, and had expressed a willingness to be further involved in the research. The purpose of these interviews was to test, expand and validate some of the initial insights into the institutional dynamics identified in the workshops, as an external validation technique (member checking). None of these interviewees had attended the focus groups, and therefore provided a fresh perspective on this data. Participants in this phase included practitioners from the SA Water, State government (water policy), the environmental protection authority, and natural resource management agency.

The rules-in-use identified in the workshops were conceptually mapped to capture prominent linkages and relationships between them. The raw data from the workshops (participant reflections on post-it notes and observations recorded by the researcher during workshops or post-workshop in response to listening to recorded discussions) and the interviews (researcher's notes and post-interview reflections) were then coded using Institutional Work Theory[vi] as a coding framework. This revealed the effect of the institutional dynamics maintaining, creating or disrupting the institutional setting, and the activities of actors that generate these dynamics. Comparing the analyses of workshop and interview data and the Context report from Phase one, which presented similar domains, provided an internal validation of the findings.

The extent of influence the identified dynamics were having on the drought response was then assessed to determine whether participants considered the influence significant, limited or insignificant (see Table 2). Using the raw data, concept maps from workshops and institutional assessments, narratives were constructed around the institutional dynamics identified in each domain (see Appendix C for these narratives). Further concept mapping was then used to link different domains through their dynamics. This painted a picture of how configurations of institutional work within and between these domains generated key change dynamics in the institutional setting (see Figure 3).

[vi] see Appendix B 'Institutional Work' on page 242 for further explanation of this theory and its relevance.

Phase Three - Comparing

The final phase of the research is yet to be conducted, but will bring the results of the case analyses of Perth and Adelaide together to compare and contrast results, looking for similarities and differences in their institutional domains and dynamics. It is anticipated that this analysis will reveal key patterns institutional dynamics that produce particular aptitudes in the institutional setting, which enable adaptation to occur.

Appendix B: Analytical Lenses

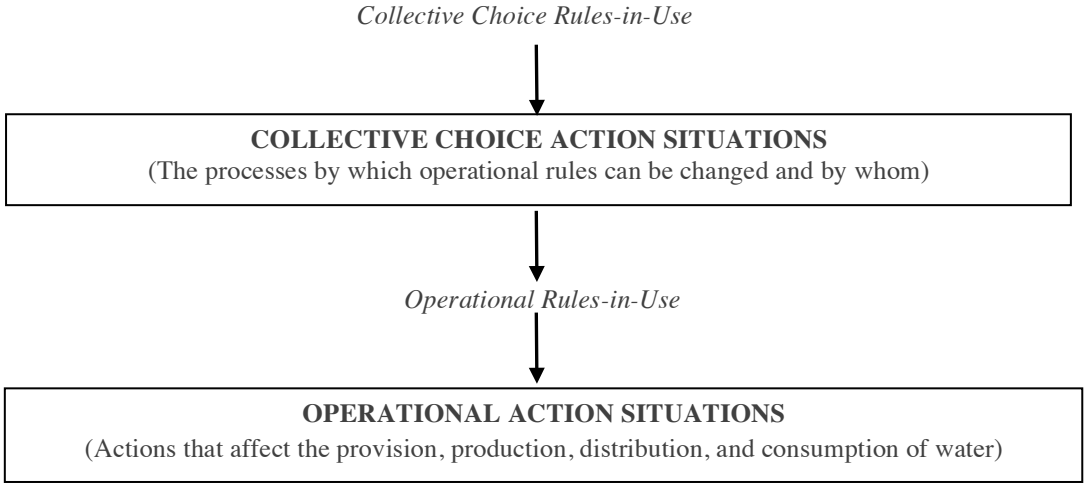
This section presents a brief summary of the theories used in the research to collect, organise and interpret the data on institutional dynamics. Some of these theoretical concepts are important for understanding the research results.

Institutional Analysis and Development Framework

The Institutional Analysis and Development (IAD) Framework [15], draws on game theory to understand the linkages between behaviour and action. It explains the social behaviours of actors embedded in diverse and complex environmental, macro-economic and socio-political settings. The IAD Framework achieves this by identifying the institutional structures within which actors operate, how these structures interact, and how actors may reinterpret these structures. In this way, the IAD Framework provides a dynamic explanation of how an institutional setting functions. This allows the research to go beneath the formally recognised regulations, legislation, and policy mechanisms, to identify the cognitive & behavioural norms that shape how these formal institutions are interpreted, and manifest into observed practice. These characteristics or elements of the institutional setting are described by 'rules-in-use;' the formal and informal institutions that structure and/or guide the activities of actors. The interplay between these rules-in-use, and the interpretation and enacting of them by actors, goes some way to explaining the institutional origins of the practices observed in reality. It is these rules-in-use that this research sought to identify, in order to understand, beyond formal legislation, policy, regulation, business plans and work programs, how the urban water sector is functioning, and the particular dynamics behind this.

The IAD Framework offers another dimension with which to understand the dynamics of the institutional setting, by recognizing multiple levels of analysis. Sets of rules-in-use are nested within a hierarchy, where rules higher up the hierarchy determine how lower level rule sets can be changed, and who can be involved in this process (see Figure 11). These rule change processes provide the ability or capacity of the institutional setting to adapt.

Figure 11. Levels of Analysis of IAD Framework.



(Adapted from Ostrom, 2005.)

Thus, these aspects of the IAD Framework – rules-in-use and levels of analysis - provide a simple but robust way to conceptualise the institutional setting.

Institutional Work

Institutional work[16, 19] is a developing branch of institutional theory focusing on the ways actors express their 'agency,' and the affects of this activity on the way an institutional setting functions. It is based on the premise that there are three types of institutional activity or 'work' that actors conduct;

Maintaining institutional work are activities that serve to uphold current institutions. These can present barriers to changing inappropriate institutions, but they can also incorporate changes into pre-existing routines and patterns, and engage and socialise new actors into the institutional setting. Some of these types of maintenance activities include:

- Policing: ensuring compliance through enforcement, monitoring and auditing,
- Deterring: Using coercion to discourage change,
- Valourizing/Demonising: Providing positive and negative examples to exemplify the normative foundations of an institution,
- Mythologising: Preserving normative foundations by creating and sustaining traditions around an institution's history, and
- Routinizing: embedding the cognitive and normative foundations of an institution into day-to-day practice.

Creative institutional work is about establishing new rules and new rewards and sanctions to enforce these rules. While the ultimate outcome of creative work is of a regulatory nature, there are significant normative and cognitive shifts which need to occur in the lead up to the establishment of new institutions. Some types of creative institutional work include:

- Advocacy: mobilising support for new ideas and rules,
- Constructing identities: defining new relationships of actors and their operating context,
- Changing normative associations: rethinking the connections between practices and the moral and cultural foundations of those practices,
- Mimicry: associating new practices with current practices to ease adoption,
- Theorizing: naming new concepts and practices, and developing new abstractions of cause and effect to build these new ideas into the 'cognitive map' of the field,
- Educating: teaching actors the new skills and knowledge needed to support a new institution.

Disruptive institutional work involves undermining the social controls that lead members to associate and comply with institutions. It may involve directly attacking compliance mechanisms or covertly manipulating the boundaries of institutions by redefining or problematising cognitive or normative understandings of these boundaries. These activities challenge the relevance of current institutions and open them up to review and reconfiguration. Disruptive institutional activities can include:

- Disconnecting the rewards and sanctions of current practice,
- Disassociating the moral foundations of current practice, and
- Undermining core assumptions and beliefs of current practice, by reducing the perceived risk of innovations and highlighting the new assumptions and beliefs behind them.

New Institutionalism

New Institutionalism[20] recognises three forms of institutions; **Cognitive**, **Normative** and **Regulative** (see Table 1). Certain types of institutional work focus on a specific form of institution. This connection offers greater analytical depth to explore what impact institutional work is having on the institutional setting. The types of institutions creating, disrupting and maintaining activities target are described in Table 3.

Using these concepts, an understanding of the dynamic processes within the urban water institutional setting, and the institutional changes occurring as a result, can be identified and described.

Table 3: Matrix of institutional types by institutional work

	Creating	Disrupting	Maintaining
Cognitive: Thought processes, problem frames, decision logics.	*Mimicry:* Associating new practices with taken-for-granted practices in order to ease adoption. *Theorising:* Development and specification of abstract categories and chains of cause and effect. *Educating:* Teaching actors in skills and knowledge necessary to support a new institution.	*Undermining assumptions and beliefs*: Decreasing the perceived risks of innovation by undermining core assumptions and beliefs.	*Embedding and routinizing:* Actively infusing the normative foundations of an institution into day-to-day routines and practices.
Normative: Beliefs, assumptions, norms of behaviour, cultural constructs.	*Constructing identities:* defining the relationship between an actor and their operational field *Changing normative associations:* re-making the connections between practices and the moral and cultural foundations of those practices. *Constructing normative networks:* inter-organisational connections through which practices are normatively sanctioned and formation of a peer group for compliance, monitoring and evaluation.	*Disassociating moral foundations:* Disassociating the practice, rule or technology from its moral foundation.	*Valorising:* Providing positive examples that illustrate the normative foundation of an institution. *Demonising:* Providing negative examples that illustrate the normative foundation of an institution. *Mythologising:* Preserving the normative underpinnings of an institution by creating and sustaining myths regarding its history and relevance.
Regulative: Rules supported by rewards and sanctions.	*Defining:* Constructing the rule system that confers status, identity, defines boundaries or creates a hierarchy *Vesting:* Creating rule structures that confer rights *Advocacy:* Mobilising political and regulatory support	*Disconnecting sanctions and rewards:* Disconnecting rewards and sanctions from a set of practices or rules.	*Deterring:* Establishing coercive barriers to change. *Enabling:* Creation of rules that facilitate, supplement and support current institutions, such as authorisation or diverting resources. *Policing:* Ensuring compliance through auditing, monitoring and imposing sanctions for non-compliance.

(Adapted from Lawrence and Suddaby, 2006)

Appendix C: Results

This section reports the detailed results of the analysis. The institutional dynamics are described according to the different domains. Within the description for each domain, a table presents the assessment of the extent the three types of institutional dynamics are influencing the rules-in-use. These assessments differentiate the cognitive, normative and regulative institutional changes, at both the operational and collective action levels of the institutional setting. The commentary also draws connections to other domains which the dynamics may also have an influence on. Quotes from workshop and interview participants are used to illustrate the influences of the institutional dynamics described on water management practice.

Governance setting

Table 4: Governance setting institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	●	○	◐
	Normative	●	○	○
	Regulative	○	●	◐
Collective Choice	Cognitive	◐	◐	◐
	Normative	●	◐	○
	Regulative	◐	◐	●

Creative dynamics

… a broader recognition that stormwater impacts on the environment, that's there are opportunities to manage stormwater, not just as a hazard issue and flooding and use and drainage issue but also manage the water for a range of other purposes.'

'NRM boards were sort of on the fringe of state government… so, it was an interesting position to be in. It was often very rewarding in the way we could facilitate things and move things forward and then come up against some very frustrating barriers at times.'

'It [Water Resources Act 1997] recognized the need for a process of engaging the community… so it set up a process whereby Catchment Water Management Boards would be established and develop catchment plans with their communities.'

Within the creative space at the operational level, the institutional work identified is occurring within cognitive and normative spheres. Many participants noted that a normative shift had occurred with the perception of stormwater. With drainage still a important aspect of water management, and a tense issue across levels of Government, it has nevertheless shifted from being viewed as much a capture and reuse problem as a flood protection issue. A number of participants commented that rather than posing barriers, there had been enough flexibility in formal regulation and legislation to install new ideas such as WSUD and stormwater harvesting, thereby mimicking traditional practices while espousing additional benefits. These cognitive shifts in the operations of some more progressive local governments were driving the formation of new business opportunities and creating new roles as water suppliers. From a normative point of view, Natural Resource Management Boards were noted to have a useful place sitting on the periphery of Government, allowing them to take alternative positions on issues to highlight or drive action. However this could at times be a disadvantage, not being privy to the same level of support as their departmental counter-parts. Finally, some participants noted the tension arising between the normative ideal of achieving a broad range of public good outcomes through water resource management, and having a corporatised governance setting for water services. While there are provisions in place to provide funding for public good outcomes that cannot be justified under water services business models, participants highlighted that other forms of support, beyond financial, were

also needed to legitimise those actions that went beyond the provision of basic supply, sewerage and drainage services.

'…recognizing the fact that there are potentially other players in this space, particularly in councils from a stormwater harvester and capturing and re-use perspective but there are other players in a developing marketplace, providing them with equal kind of footing to compete in that.'

At a collective choice level, a normative shift occurred in the earlier years of the drought, seeing the integration of natural resources management, including water, at the regional level. However this represented a significant shift in management philosophy, not only in terms of aligning natural resource management activities, but by having a requirement to conduct regional-scale medium-term planning in consultation with communities. This opened up an avenue for facilitated public involvement in water management, and had a significant flow-on effect through a number of other institutional domains. Initially, this new requirement of the governance arrangements created a need to engage and educate the community in water management, which thereon in built water literacy and on-going engagement in water issue within the Adelaide community. Participants also noted that off the back of exploratory work to institutionalise WSUD into water and land management legislative frameworks (funded by the Federal Government), similar collective choice activity to change normative identities around stormwater occurred. The new *Water Industry Act* would be the expression of this work, changing the space for water management actors and their business operations, effectively formalising the activities that had occurred at the operational level. Prior to these normative changes reaching into regulatory change, a number of cognitive-based creative activities occurred when the crisis became evident which involved the establishment of different for a to review and deal with issues through theorising activities. One such mechanism was the establishment of the Commissioner for Water Security, with the role to develop medium-term plan of action to address the scarcity issue, by facilitating and driving cross-government collaboration. This and other collective choice forum provided arenas to theorise new cognitive frames for water management and subsequently initiate the regulatory reforms described above.

'One of the drivers was that you would have an independent commissioner on equal footing with government agency CEOs who could actually force that collaboration across government.'

Disruptive dynamics

At the operational level, there was a strong influence of regulative disruptive activity with regard to governance arrangements. This came in the form of some referral agencies collaborating to re-interpret the decision logics behind their approvals of land developments. This produced some uncertainty as to what was considered standard practice. From the opposite end of this approvals process, some participant noted the land use planning system did not necessarily provide certainty or clarity over land use development, because it could be destabilised by developers challenging decisions and lobbying for change.

'EPA are an interesting one …I see their strength increasing because they kind of teamed up with NRM and together they do a referral on a project.'

At a collective level, there was disruptive activity occurring within cognitive, normative and regulative spaces. Cognitively, government began looking internally at how water governance arrangements were organised, due to the pressure from the drought, but also driven by the controversy over the Murray-Darling basin at a national level. With Adelaide's stake in the management of water from the Basin high, the South Australian Government needed a strong position from which to argue from, and having their urban water governance arrangements in order was viewed as providing this leverage. Supporting this shift from a regulatory point of view, increasing confusion over governance of different

'It was clear that utilizing the Murray-Darling Basin as a case that there wasn't clear accountabilities or responsibilities for certain things and Cabinet were not comfortable that everything was being managed appropriately.'

aspects of water management (as these became more complex in response to drought) led to lobbying from developers for collective action to clarify these arrangements. With regard to normative arrangements for stormwater management, tensions over responsibility were testing the working relationships between State and local government.

Maintaining dynamics

I think we'll keep the WaterWise practices that people have implemented during drought, I think most of them will continue to sustain that.'

I don't want to say all developers are like this, but some, or most, like to get away with as little as possible…there are a lot of small operators out there that just want to do the bare minimum.'

Interviewees noted some cognitive 'embedding' and 'routinizing' occurring; water use practices adopted during the drought persisting, and changes to information requirements to support groundwater licensing applications becoming more routinely adhered to. However, the practice of most land developers to seek development approvals with bare minimum water sensitive features was cited as a practice, which helps to maintain the status quo. At the same time, other participants noted the star rating system was driving other land developers to include as many features as they could to get a competitive edge (this is a creative activity). So it appears there are a myriad of dynamics at the operational level in competition to either maintain current practice, or incorporate some of the practice changes driven by the drought.

'You need the formality to kick in and make sure what you've set up continues.'

'I guess the most important challenge is… working out who's going to be taking charge, running leadership, getting appropriate resources into that space and momentum can be generated, because at the moment we're at risk of losing the momentum we had.'

At the collective choice level, some cognitive influences were noted by participants, around the need to formalise other changes that are occurring. However the predominant influences were again within the regulatory space and the interplay between enabling and deterring influences. These activities seek to allow new practices to be formalised, and discourage such change to institutions respectively. Lack of clarity around governance roles and responsibilities, and lack of dedicated resources to implement reform programs (particularly those laid out in *Water for Good*) are the main influences deterring practice changes to be adopted and formalised. At the same time, the formation and work of the Department for Water was seen as a positive move towards these changes occurring.

Policy direction

Table 5: Policy direction institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	○	◐	○
	Normative	○	◐	○
	Regulative	○	○	○
Collective Choice	Cognitive	●	○	○
	Normative	●	○	○
	Regulative	●	○	●

Creative dynamics

At the collective choice level, a clear policy narrative came through the participants' accounts. Theorising stormwater harvesting had occurred as early as the 1950's through a number of research

reports. During the early 2000s a normative shift to integrate natural resources management connected urban water management to waterway and coastal health. Due to significant community engagement around catchment management, when the drought emphasised water quantity concerns the connection between water availability and ecosystem health was still recognised as an important water-related value. As such, diversification of water sources was coupled with recognition that multiple objectives (i.e. beyond supply security) could be achieved with fit-for-purpose water use. This conceptualisation of integrated water management was amplified by Federal policy developments in the Murray-Darling basin; Adelaide's main water supply was embroiled in nation-wide debates on connections between extraction and major environmental impacts. These cognitive and normative developments in thinking about water values and management informed Adelaide's urban water sectors response. The magnitude of the crisis and the prominence of the debate in media added political urgency to the issue. This in turn connected non-traditional water management actors and policy portfolios, such as land use planning, forming whole-of-government policy development to address the issues. As a result, shared direction was set down in a policy agenda, and regulative and normative activities are now serving to implement this agenda, in the form of:

'The 30-Year Plan for the Greater Adelaide was released like literally within a week or two of each other as the State Water Security Plan and they were intentionally strongly linked via guidelines and objectives.'

- Rethinking what a 'water source' might be
- Recognising that water management is a multi policy portfolio issue requiring considerable cross-collaboration
- Linking legislative reform initiatives to clarify roles (e.g. water security plan and urban planning policy) and work to establish targets (e.g. WSUD and pollution) as a mechanism to drive change.

Disrupting dynamics

Some cognitive challenges are dislocating people's framing of water management problems, making policy implementation problematic. For example, with regard to stormwater management, some participants noted that they are having some difficulty reconciling how seemingly competing management objectives – water harvesting and flood mitigation – can be realised in practice. A major normative challenge noted was finding the right 'fit' for emerging issues in terms of current programs of policy implementation, and organisational responsibility. One participant highlighted this issue with regard to trying to address the normative change in expanding groundwater management to include reuse and storage capacity objectives. Authoring a discussion paper on this issue not only highlighted the operational issues, but also the deficiencies in current governance arrangements and the lack of clear jurisdiction for existing agencies to take on the role of resolving these problems. This example illustrates the dilemma of emerging issues; they sit outside formal responsibilities and require normative change to occur at the collective choice level before they can be resolved.

'There's competing objectives of flood management and water quality because… or water recycling, because when the flood occurs you can only hold that flood in the wetlands for a certain period of time and you got to release it.'

'I had that all ready to go as a discussion paper…and there were some legal difficulties…because really as a regulator… all we can really regulate is people putting that water into the ground…I've written my code of practice from a much broader perspective, just so that you think about all the different environmental issues that are involved. So it was decided that a lot of the things I'd written couldn't really hinge off the Act.'

Maintaining dynamics

Within maintaining dynamics some influences have deterred change in the past, while recent activities have begun to embed contemporary practice changes into formal policy. For example,

We always had the Department of Water, Land and Biodiversity Conversation around this time providing advice and dealing with policy around water policy, but there probably wasn't much of a focus on urban water.

'Drought has caused a major rethink of all resources and the results of that... diversification has been now part of the whole strategy and that's why our state's gone to the four-way diversification; desalination, re-use, River Murray…and then demand management.'

a number of participants highlighted an urban water policy gap as being a past impediment to progressing a range of issues, as no agency had a role to lead policy development in this area of water management. As such, emerging issues had a disruptive influence on operational level activities. However, new thinking and practice is becoming embedded in policy and governance reform through the maintaining influence of the drought, and following the establishment of the Department for Water.

Inter and intra organisational relations

Table 6: Inter and intra organisational relations institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	○	○	◐
	Normative	●	○	○
	Regulative	◐	○	◐
Collective choice	Cognitive	◐	○	○
	Normative	●	○	○
	Regulative	●	○	◐

Creative dynamics

'Soon Local Government wanted to know what the money was going into, and these local partnerships developed.'

There were many examples of normative work going on at an operational level within and between water management organisations. For instance, new organisational identities had been negotiated between the Water Management Boards and local governments in the recent past. More recently, the remit of local governments has expanded to include water manager and supplier functions. Participants also noted the different forms of activity around connecting normative networks, such as; having 'healthy' debates on issues and organisational positions, communication to clarify agreed courses of action, and maintaining relationships across the sector through long-term colleagues and collaborators. A culture of collaboration across the sector had also enabled the leveraging of Federal Government funding to experiment with stormwater harvesting technologies.

'…it involved a lot of emails to make sure everyone was comfortable.'

'And we will have a, we will end up having a healthy debate with them about that and we will take some pain with regard to that.'

'We've been trying hard to get some quality relationships with them.'

This situation was mirrored at the collective choice level, with similar relationship building, position negotiation and debating issues occurring between organisations in a governance and policy making sense, rather than on-ground management. A number of formal working groups, coordinating committees and regular meetings of CEOs from key organisations, have also had a creative influence. While overseeing regulatory activities such as policy implementation and infrastructure development, these forums have also enabled normative changes to be recognised and addressed at the collective choice level. For example, the appointment of an independent Commissioner for Water Security with a role to conduct long-term water planning and facilitate collaboration across the sector

'… it is all the key government agencies get round the table regularly to and this is at chief executive level, to work through the implications for the government of future development.'

was an example of collective choice action to recognise and address the shift in normative understanding of water scarcity.

Disruptive dynamics

No significant disruptive activity was found in relation to inter & intra organisational relationships, at either the operational or collective choice levels.

Maintaining dynamics

A few deterring activities were noted; particularly in the use of land use planning laws to maintain current water management practices. However a significant routinizing influence was noted, in the cognitive frames between engineers and local governments. It was suggested that while engineers have a solution-orientated logic to their decision-making, local government is more focused on courses of action that produce least resistance, from Councillors, their communities, State Government department and agencies and land developers, for example. This decision logic can have a maintaining influence, as the courses of action they take tend, as a result, to be more conservative.

Often from the local government perspective it's not about problem solving, it's about …mak[ing] sure everybody's sort of happy.'

At the collective choice level, the only influence from an organisational relationship perspective that served to maintain the institutional setting was the lack of information sharing across government departments.

Strategic support

Table 7: Strategic support institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	●	◐	◐
	Normative	●	○	○
	Regulative	●	◐	●
Collective choice	Cognitive	●	◐	○
	Normative	◐	●	◐
	Regulative	●	○	●

Creative dynamics

The institutional assessment revealed that the majority of strategic support is occurring within the creative sphere of institutional work.

'[Council is] very supportive and a community which is now extremely supportive. Community and political arm ao hand-in-hand'

At the operational level, key actors are supporting many different activities to reassess and reconfigure existing institutions; sharing new information, recognising innovative water supply solutions and management approaches, and developing new models of service delivery. In particular, advocacy activities stemming from both community and political actors has legitimised and driven this creative activity. Significant financial investment from the Federal Government for on-ground experimentation and technology development has enabled this creative activity to begin to be scaled up and mainstreamed.

'Networks in Adelaide are key. The people in them have been in the business for a long time, so they know the business well, and have long held relationships with trust, and know how to work strategically together.'

At the collective choice level, the work of a network of industry champions was highlighted as a critical support force behind creative activities. While the impacts of the drought were keenly recognised at the highest levels of Government and various committees and taskforces were set up to deal with particular aspects of the crisis, these regulative based (formal) institutional structures were not the mechanism through which cognitive and normative institutional change was achieved, though they play an important role in formalising these changes in thinking into accepted practice. Dealing with the cognitive and normative challenges the drought posed the urban water sector required individuals to connect and recognised and discuss the feedback occurring to the urban water system; theorising possible scenarios and the implications for practice and the physical structure of the system. This network of champions then highlighted and promoted these emerging issues, educating other actors about them. By translating discourses and brokering feedback between the operational and collective choice levels, these individuals created new cognitive and normative understandings. By strategically using their positions and influence in concert to communicate new narratives around water management and pool and direct resources, they enabled the sector to navigate the uncertainty the drought posed.

Disruptive dynamics

At the operational level, some organisations are challenging tradition reward/sanction structures, which do not supporting new normative ideals of practice, by disregarding their underlying logics in their approvals and advice on land development applications. Some individuals were also challenging the thinking of 'late adopters' by disputing or provoking their idea of what 'best practice' water management now entails.

'…people coming through will say, "What the hell are you doing? Why aren't you doing this?" And they are already doing it, in the press '.

'A Premier once said "Rules are there to be broken, so they can be fixed"…I clearly remember him saying, "The rule book is there to work through to give you guidance, and if there's a rule to be broken, a rule to be amended, put it up for legislative review" '.

Some significant disruptive activity was detected at the collective choice level from a normative point of view. Here, an engaged and water literate community are publicly challenging the water management decisions being made. This situation highlights disconnect between the underlying moral foundations and assumptions of professional practice and societal aspirations and needs. This has key implications for keeping water issues on the political agenda. A participant also noted that a past Premier had recognised the need to sometimes question the rules, to ensure they produced appropriate outcomes. This acknowledgement that rules can be changed seems to be an important cognitive frame influencing practitioners, as many participants mentioned the need to be flexible with the way legislation and regulation are interpreted.

Maintaining dynamics

'We've had an extremely tight budget handed down by our state treasurer…and preceding that … review was done of all operations to work out where to cut most in preparation for the budget, so the chief executives knew they were going to be hard up to get anything extra, whether they liked it or not, so they were looking for ways to handball things.'

At the operational level, the main maintaining influences are attempting to embed new procedures into practice. However, lack of resourcing to embed new procedures through strategic planning, performance monitoring and review of administrative arrangements is producing a maintenance influence by enabling and strengthening existing institutions.

Likewise at the collective choice level, a tight State Government budget has constrained creative activities and the maintenance work needed to formalise their resulting institutional changes. Work to formalise the cognitive and normative changes that have occurred into practice have occurred, including the rewriting Codes of Practice, guidelines, and legislation reform to provide appropriate frameworks to

accommodate and drive policy implementation. Yet, because these activities often sit outside the boundaries or remit of departments and agencies, due to their emergent nature, in times of limited resources departments and agencies revert to core business and try to transfer responsibility for these 'non-essential' activities. In the absence of the types of maintenance work to incorporate cognitive and normative changes into the regulative sphere, traditional institutions will guide practice by default. This makes the disruptive activity of the community in challenging current decisions and the normative foundations of water management particularly critical. Having a strong influence on the political sphere, this institutional work can garner the political will needed to over-ride significant maintenance influences, like budget cycles, by legitimising the need for reform activities.

So the [political] will is there but the resources are not. They [Ministers] both know they don't have sufficient resources in their departments to do all the things they're doing at the moment as well as driving that…step change because they realise there's a period where to get the momentum happening there needs to be some resources.'

Discourse

Table 8: Discourse institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	○	○	○
	Normative	●	◐	◐
	Regulative	○	○	○
Collective choice	Cognitive	○	●	○
	Normative	◐	●	○
	Regulative	◐	○	○

Creative dynamics

At the operational level, discourse activities centred on the normative space. The need for 'healthy debate' around organisational roles and responsibilities and engaging with communities and regulators in the rethinking of water management philosophy, were cited as key creative activities.

'And we will have a, we will end up having a healthy debate with them about that…'

The institutions and people…were constantly asking these questions and some of them were in the department, some were private consultants, some were members of the community; so we effectively were closing off on all of these questions as we went.'

At the collective choice level participants noted the expansion of actors in water management had opened up educating and theorising activities, changing cognitive frames and the normative underpinnings of the sector. Examples of these topics included reconsidering the relationship between Adelaide's water supply and use and the health of the River Murray, and the management of water in the City's spatial and economic development. These cognitive and normative changes had influenced discourse in a more regulatory sphere, with both political parties standing on a platform of water reform and development of innovative alternatives at a recent State election.

Disruptive dynamics

At the operational level some disruptive discourse was noted between different water management organisations, protecting their roles and expertise in water management.

'We are in competition…so there's constantly comments made by people who are ignorant of what we do.'

Initially at the collective choice level, there was noteworthy discussion of water scarcity and water management issues in public discourse. Following a sustained

'Every time there is a lot of rain in Adelaide and people see water going down drains and down creeks and out to sea they say "Why aren't we collecting all this water?" …So there is a lot of noise made out there with those sorts of issues.'

investment in community engagement through the Water Management Boards (now Natural Resource management Boards), the Adelaide communities level water literacy was sufficient for them to question and even challenge the decisions begin made with regard to the management of urban water. The urgency of the issues in the later stages of the drought helped to prompt these public concerns, and effectively turned urban water management into a highly political issue. High profile people in the water industry engaged in public debates surrounding the different sources of alternative water and implications of their use with contradicting messages and evidence. This led to confusion and some public mistrust of the science behind water management. The lack of positive messages and misinformation in the media about water issues hampered discussions of new value propositions for water, such as the consideration of recycling for direct potable use. However, certain long held values such as waterway and coastal health and amenity of public open spaces were prominent alongside the need for water security, and the presence of these in public discourse questioned the performance of the urban water management system under the drought conditions. The presence of this disruptive dynamics opened the space for debate and consideration of new normative ideals and cognitive framing for the urban water sector.

Maintaining dynamics

'You have old school thinking still influencing the public debate.'

Participants noted that traditional normative understandings or 'old-school' thinking were still influencing public discourse on water management at the operational level. At the collective choice level no discursive influences were noted to be generating a maintenance effect.

Information

Table 9: Information institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	◐	○	◐
	Normative	●	○	○
	Regulative	●	○	○
Collective Choice	Cognitive	●	●	◐
	Normative	●	○	○
	Regulative	●	○	○

Creative dynamics

A range of cognitive, normative and regulatory creative activities involving information was identified at the operational level. Collecting longitudinal data on stormwater harvesting projects was key to educating to create change in cognitive frames. Information on water management arrangements from other states were often used to benchmark the South Australian water industry during the drought, leading to the construction of new normative ideas of professional identity in the sector. The construction of professional networks around issues was also fed by new information. These networks interpreted the information and disseminated the information and new cognitive frames around it. There was also significant creative activity in the regulatory sphere relying on new information to advocate for

'Informal networks – knowing who to talk to where about issues leads to clearer shared understanding and way forward.'

new technologies and approaches in the community, media and politically. While participants notes some reliability and interpretational problems arising from the use of information, they also recognised that the more widespread use of information on water management issues directed more financial resources into certain aspects of water management.

At the collective choice level, the majority of institutional work around information was in the creative space. Cognitive activities predominantly revolved around education, particularly informing decision-makers at the highest level of government on the water availability and what future scenarios might look like. Similarly, the stark visual conditions of the drought and widespread information on the state of the Murray-Darling system fed into reflection on the role and use of water at many levels of Adelaide's community; from the public, to government organisations and departments, through to Cabinet. From a regulatory standpoint, widespread information on drought conditions and the responses taken in other states produced an advocacy effect, driving change in governance arrangements to ensure that urban water management was afforded dedicated policy attention.

'There were some quite vocal people in the local industry and local councils who were talking up the benefits of stormwater harvesting and how you could achieve a number of objectives by doing it… they probably made it sound a bit easier than it actually was….but it was very productive in that drove some sort of better resourcing of that urban storm-water space.'

Disruptive dynamics

The only significant disruptive activity was identified at the collective choice level, where the misinterpretation of water information in media stories was seen to undermine many assumptions and beliefs about water management issues and practices. While this created confusion and misunderstanding, it also generated public dialogue on the issue (see Discourse section).

'…as soon as there's criticism of what they publish, they don't comment in opposition to the criticism and so a perception gets out there in the community that the science is not being coordinated.'

Maintaining dynamics

It was noted, at both operational and collective choice levels, that lack of data, or poor quality data, on some issues could lead to further embedding and routinizing of current practices, because alternatives did not have a strong enough business case in comparison.

'Poor data and lack of understanding within state government of what is required 'on the ground' to make things happen.'

Innovation and learning

Table 10: Innovation and learning institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	●	◐	○
	Normative	●	○	◐
	Regulative	●	○	◐
Collective choice	Cognitive	●	○	○
	Normative	○	○	○
	Regulative	○	○	○

Creative dynamics

I had an opportunity to try some WSUD projects… purely because there were environmental issues …which conventional stormwater management wouldn't have addressed

'You can have all the good policies in the world, but unless you've got some discretionary funding and effort into trialing things on the ground and bringing the community and other sectors along you're in trouble.'

'My boss understood that if we wanted to get it implemented in our region, we first needed to get Adelaide sorted so it would spread throughout the state.'

'It all sort of fell in to place in a way because they've initially built wetlands where they could, to clean up the water and then they realized that they had a water source and then they said, well, let's store the stuff and reuse it so it's all sort of flowed on from there.'

'I've currently got a couple of projects…it's an important focal part of Adelaide and the tourism and conference centre, so we're trying to see how we can manipulate some water around that.'

Creative activities dominate the innovation and learning domain. Many examples of cognitive innovation were identified, including:

- Mimicking traditional practices with new alternatives while demonstrating the achievement of additional benefits
- Demonstrating the success of alternatives approaches and highlighting systemic issues to their scaling-up, elevating the issue to the collective choice level
- Bringing regulators and scientists together on projects and including them in initial scoping work
- Recognising what the project is 'demonstrating,' thus what learnings need to be captured the and key questions that need to be answered through their success

Likewise, there were a number of new normative associations generated by innovation and learning activities. These included:

- The viewpoint of stormwater harvesting as a water supply source
- The utility value of aquifers as short and potentially long-term water storage reservoirs
- A new role for local government to become a water supplier, and
- The integration of decentralised systems into the centralised reticulated scheme.

Also central to this strong creative influence in the innovative and learning domain was the advocacy influence provided by financial resources; small amounts of discretionary funding to invest in innovative ideas in the first instance, and later substantial Federal Government investment.

At the collective choice level, the only creative activity identified was educating work – prompting the benefits of alternative designs and technologies, through industry awards, learning about the importance of influencing the design phase in the uptake of innovations, and recognising the need for greater industry capacity building mechanisms to tie the creative work together and promote it more broadly.

Disruptive dynamics

Innovative projects were noted to have some disruptive effect, in that in order to gain recognition and status, high profile projects were looking for ways to show innovation. Because of their high profile, these projects are starting to undermine assumptions and beliefs underlying traditional water management practices.

'If that Zoo project, the panda bears, wasn't environmentally sustainable someone would have asked, "Why wasn't this done using a water smart approach?" '

No disruptive activity was captured at the collective choice level.

Maintaining dynamics

A normative maintenance influence was identified in the potential to 'demonise' new projects if they failed in some way. From a regulatory standpoint, there is some policy activity to use the 'rule book' to block innovation, and a lack of data can sometimes defer the consideration of an alternative.

'A lot of these smaller systems…come to replacement time…often they'll fall over because people didn't appreciate how difficult they were or there's cheaper sources that have come off, or they're just too bloody hard to manage.'

No disruptive activities were captured at the collective level.

Professional capacity

Table 11: Professional capacity institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	●	○	◐
	Normative	◐	○	◐
	Regulative	●	○	○
Collective choice	Cognitive	●	○	○
	Normative	●	◐	○
	Regulative	○	○	●

Creative dynamics

At the operational level, there was significant creative activity in cognitive ideas and frames; thinking through various scenarios if the drought continued and drawing on professional knowledge to develop pre-emptive action plans. From an education point of view, many participants noted the expansion of disciplines in the industry had grown, many people were recognising that water management was becoming a part of their practice, and seeking professional development in these areas. An important aspect of re-skilling was noted in SA Water, where outsourcing of operational and maintenance had formed customer service and stakeholder management as key skill-sets for the organisation. A number of participants noted the capacity of teams and organisations to have passion and shared understanding and a solution-orientation, are important norms of professional practice. Some participants suggested that the small size of Adelaide's water industry, where everyone knows each other, has helped to create the professional capacity needed to cope with drought, by giving rise to a shared normative network.

'We were starting to think about well, if we got high salinity flows in the River Murray what does that mean to us?'

'Tertiary education base has been expanded, haven't been engineering focused organization.'

'The work that needs to be done understanding the issues around and looking at integration and what that actually means; and also managing the various relationships with what is a broad range of stakeholders.'

At a collective level, theorising and educating were again the predominant cognitive activities being conducted. Participants

noted that thinking through what 'integrated water management' would mean, from a governance and organisational point of view, was the first question on the mind of policy makers. Promoting this thinking at an operational level to start to educate practitioners on what the governance implications to achieving integrated urban water management might mean, was also noted as an influence on people's thinking and the normative understandings of the industry. In turn, these cognitive and normative changes are leading to networks being formed between practitioners to being to realise these changes.

Disruptive dynamics

'Greater need to harness the skills and expertise of marketing…'

No disruptive influences were identified at the operational level, while at a collective level; some participants noted the disruptive influence that marketing of water management messages could have by raising and questioning the moral foundations of water management.

Maintaining dynamics

'These funny people who are responsible for the approval process…[I'm] sick of all these rules which have been there for donkey's years.'

At the operational level, the continued routinizing of current decision-making logics through various operational processes and procedures was identified as a key maintaining influence. There was also some maintenance of normative understandings by sceptics 'demonising' new approaches to water management.

'Probably what the biggest challenge has been…the marriage of scientific expertise and policy expertise and ensuring that science supports policy development and not the other way around.'

At the collective choice level, only regulative work was noted to be a maintain influence. This was in the form of a lack of policy capacity in urban water management, making it difficult to address the challenges the drought was raising through policy development, though this was not seen to pose a problem in the long-term, with policy capacity being developed within the new State Government Department for Water.

Beliefs and cognitive frames

Table 12: Beliefs and cognitive frames institutional assessments

		Creative	Disruptive	Maintaining
Operational	Cognitive	●	○	◐
	Normative	●	○	◐
	Regulative	◐	○	○
Collective choice	Cognitive	●	◐	●
	Normative	●	○	○
	Regulative	◐	○	○

Creative dynamics

'And look, water is paramount to the growth of South Australia…'

A range of activities creating new understandings and problem frames were identified at the operational level, mostly within cognitive and normative processes. Mimicking the 'think Global, act local,' sustainability catch-cry with regard to local water extraction and use, and considering new water use behaviours and management issues were some key cognitive creative activities. There were also a number of normative developments; recognising water as an essential resource to state development, considering the change in water value propositions driven by the

'So I guess you could say that there was a greater recognition…that limited water availability has on a whole range of different things, from society to economic development to environmental amenity, and system maintenance and things like that.'

drought, and reflecting on professional practices that consider change vs. those that follow the rule book. All these examples showed normative associations between water values, uses and management practices are being reconsidered.

There were similar activities at a collective level, though from a governance perspective. For example, theorising on what impact low water availability would have on different facets of society, and what a worse case scenario for water availability would look like, were types of creative cognitive activities influencing the sector. While from a normative angle examples included understanding new public perceptions of 'good' and 'bad' water management, and the moral implications of water allocation decisions. There was also activity around drawing together professional networks around particular issues, with the purpose of conducting some advocacy work and draw on existing regulatory features to recognise and add water quality issues to a policy agenda that was becoming water quantity focused.

'But also a lot of this is also around the changing of the values, and that does have an impact on a lot of discussions and how you interpret those values and how you deliver them and at what cost and that sort of thing.'

'But we work hard to ensure that [water quality on the policy agenda is] maintained…it's often the informal networks that you drive that through.'

Disruptive dynamics

No disruptive activity was identified at the operational level, while at the collective choice level, it was recognised, as water became a critical issue, the number of actors and their interests grew. With large numbers of stakeholders, claims in water expertise grew, and knowledge that was promoted began to undermine many assumptions and beliefs about water, with no scientific basis.

'…this enthusiasm is expanding the actors who are involved and problems are arising as "everyone is an expert".'

Maintaining dynamics

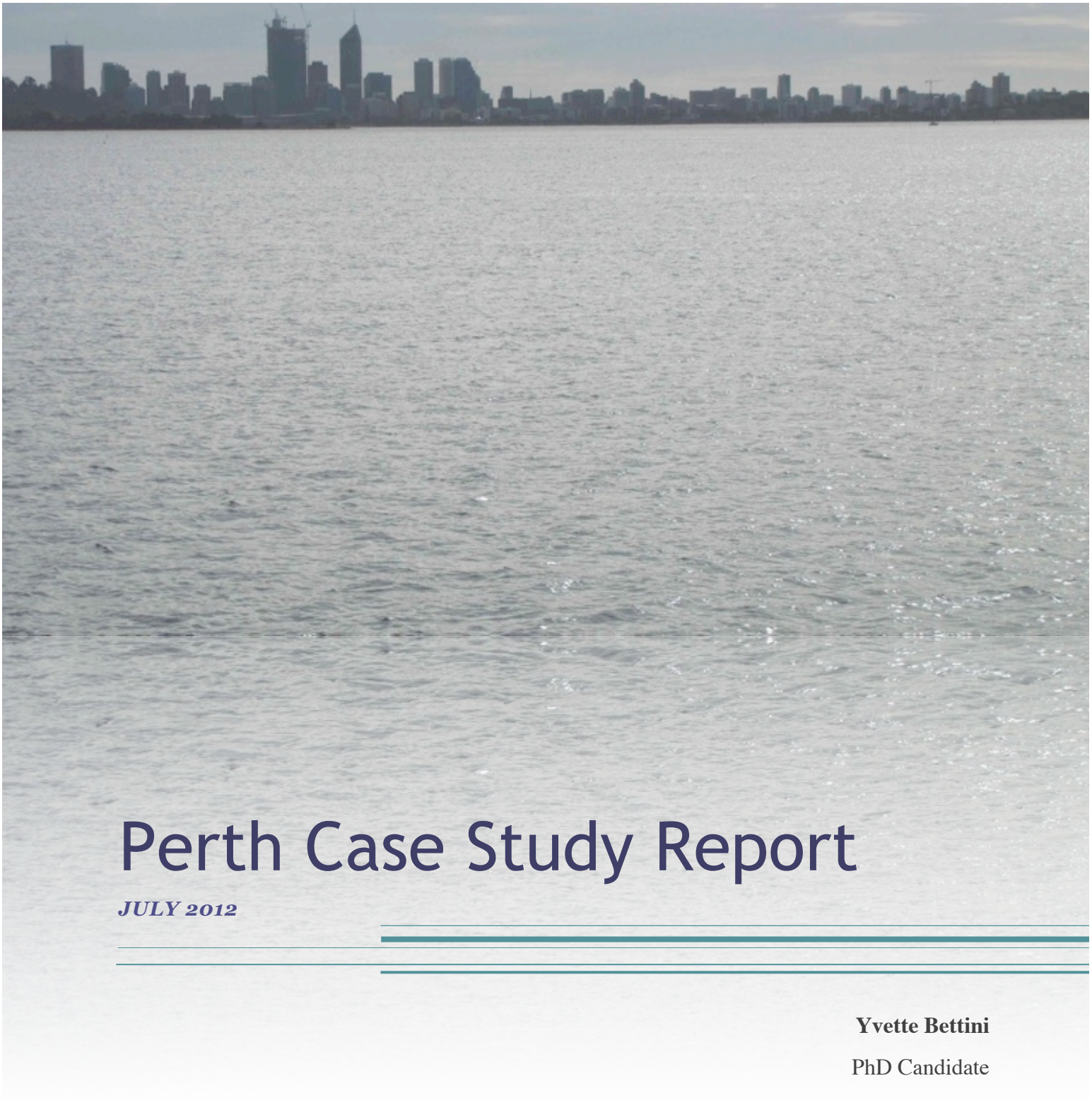
Similar to creative activities, maintaining activities were predominantly found in the cognitive and normative spaces of institutional work. Two significant influences were the need from land developers to routinize approval processes so they were efficient and expedient, and the demonising of recycled water for direct potable use.

At the collective level, there was a significant influence in cognitive embedding and routinising; asking pertinent questions around the implications of changing practice and why it was necessary, the prediction that complacency in government and communities would set in with the breaking of the drought, and it would take another crisis to get change moving again.

So developers expect consistency across development sites and the same sort and some sort of treatment generally speaking.

'I don't think people in Adelaide are ready to accept stormwater as drinking water; there is that mindset thing.'

'I think grappling with it from a basic policy perspective of 'why would you do it in the first place', really. There are competing views across government…'



Perth Case Study Report

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water for liveability | MONASH University

Executive Summary

Background

This report forms part of a PhD research project on 'Processes and Pathways to Water Sensitive Cities.' The research asks, 'How can urban water governance regimes support institutional adaptive capacity to enable and expedite a shift toward sustainable urban water management?' By identifying the interplay between informal institutions (shared meanings and understandings, norms, conventions and interactions) and formal institutions (documented rules and regulations), the research provides an understanding of the socio-political dynamics underlying urban water management practice. Describing these dynamics reveals how institutions change overtime, and how this capacity to adapt can be utilised.

This report presents the case study of the Perth urban water sector[1], focusing on the years 2009-2012. It provides an institutional analysis of how the sector responded to drought, focusing on a more socio-political perspective. In providing this analysis of the management assumptions, beliefs, cross-sectoral relationships and other informal institutional attributes that underpin the professional practices that deliver urban water services, this research provides insight into the 'institutional black box' of urban water management. The analysis identifies institutional attributes and dynamics that explain perceived 'institutional barriers' to change in the Perth context. However, the analysis also reveals opportunities within these attributes and dynamics to facilitate collective action toward common goals. These present prospects for building capacity within the institutional setting to adapt to changing future conditions. This report presents recommendations on where these opportunities lie for the urban water sector in Perth.

Results

This research has shown that while Perth responded successfully to three decades of drying climatic conditions by maintaining water supplies, attributes of its institutional setting are now creating a lock-in dynamic to maintain current practices. This compromises the sector's ability to take a long-term, integrated perspective of water resources management, and to act collectively and strategically to manage the resource for changing needs and circumstances into the future. These 'maintaining' attributes are summarised in Table A, along with some of the costs implications this situation is generating for the sector as a whole.

[1] The management of water to supply a city's metropolitan area loosely defines the boundary of the case study. The urban water sector encompasses the actors (individuals, groups or organisations) with a formally recognised role in collecting, distributing, using, valuing, treating and disposing of water. Other actors may also have an influence over the management of water (e.g. the community, other departments), and this research is designed to capture these influences without the direct participation of these diverse and sometimes indefinable actors.

Table A: 'Maintaining' institutional attributes and associated costs identified in Perth.

#	Institutional attributes	Associated cost(s)
1	Disparate beliefs, values and problem frames of urban water practitioners, Politician's and the public.	Provision of water is not recognized as a key foundation of economic development, and as such water management poses a significant barrier to the State's future prosperity.
2	Disconnected identity and mission of urban water management organisations.	Opportunity costs for public good outcomes as each organization works toward their own contribution to public good without integration or coordination.
3	Silos within organisations and across the urban water sector.	Significant transaction costs and lost opportunities for efficient investment through collaboration.
4	Prescriptive governance setting relying on regulation.	High compliance costs.

A more detailed analysis of these and other attributes, and descriptions of the dynamics they create, can be found in Section 3 'Perth's Institutional Dynamics' on page 261.

As the first three institutional attributes identified in Table A are key areas for the creating social learning needed for adaptation.[1, 2], the impact of these maintaining dynamics in Perth is to disable learning and adaption in water management practice. The institutional analysis revealed that greater 'creative' and 'disruptive' dynamics need to be created in Perth's institutional setting to balance these maintaining dynamics. Therefore, reconfiguring the attributes in Table A into those listed in Table B will provide the leverage points to generate institutional dynamics that support innovation, learning and adoption, due to their inter-linkages. Strategies to initiate these reconfigurations are briefly described in Table B.

In addition, the information and learnings generated from strategies to reconfigure attributes 1 – 3 can be utilised to address issues in the formal governance setting (attribute 4, Table A), by providing the information and feedback mechanisms needed to inform adaptive water governance (attribute 4, Table B). Further detail on these opportunities and strategies can be found in found in Section 4 'Discussion' on page 275.

Table B: Institutional attributes and strategies to support an adaptive urban water sector.

#	Institutional attributes	Strategies to generate creative and disruptive dynamics
1	Shared understandings, values and problem frames.	***Learn how to learn together.*** Encourage professional discourse to generate shared understandings and narratives. Provide capacity building in stakeholder engagement skills to mobilise networks and collaborative projects.
3	Collaborative cross inter and intra-organisational relationships.	
2	Integrated visions and organisations missions, with new professional identities that support these.	***Foster collective action*** Provide leadership through clear, shared forward-looking vision and agenda to provide direction and support to for change experiments. Identify and remove the perceived risks and sanctions of 'doing things differently,' and provide incentives to encourage champions. Identify projects where collaboration can be built, capturing the learnings and governance implications of these initiatives.
3	Collaborative cross inter and intra-organisational relationships.	
4	Performance based governance encouraging continual improvement.	***Create system feedbacks*** Improve information collection and dissemination. Particularly, investigate true costs of current approaches, efficiencies in multiple benefit solutions, and risk management practices and risk tolerances embedded in current governance arrangements. Instigate monitoring and reporting aimed at demonstrating the efficient, effective performance of the overall water sector (not just for water supply provision). Work towards better transparency and accountability throughout the sector.

Detail of these strategies and the inter-linkages between them can be found in Section 6 'Discussion' on page 275.

Recommendations

The strategies provided in Table B represent management principles that could be implemented in a number of different ways. During a validation workshop on the research results, participating urban water practioners from Perth brainstormed some potential opportunities currently existing in Perth's urban water sector to instigate these strategies. These are included below to provide more tangible illustrations of how the results of this research could be implemented.

Learn how to learn together

The industry capacity building program, New WAterways is a well-recognised and trusted feature of Perth's urban water sector. Providing more stable funding and targeting the program at more specific capacity building needs such as those identified in this research could support better learning outcomes and collaborations across the sector, Some suggestions for more strategic, targeted initiatives the program could adopt include:

- More active participatory initiatives, beyond traditional seminars and training sessions, e.g. topical discussion forums, identifying consultative networks of expertise, developing communities of practice.

- A knowledge broker role between industry and research activities, i.e. not just disseminate information but provide avenues for involvement and input into research.
- A broader target audience to build water management skills and knowledge in 'non-traditional' professions and organisations that have a stake in water management (and to also gain broader funding support).
- Initially bringing the program into the Department of Water to provide a more stable funding base, with a longer-term plan to adopt a more self-supporting program model e.g. Water by Design (SE QLD).

Foster collective action

Many opportunities for collaboration on demonstration projects were identified in discussions at the validation workshop. Other strategies to ensure the learnings and 'demonstrations' of these projects filter through to the broader water sector, to lead to their adoption into mainstream practice include:

- Using shared, consistent messages to influence decision-makers through many avenues, by engaging with other organisations and networks, e.g. AWA, UDIA, land developers and Redevelopment Authorities, Committee for Perth.
- Providing leadership training through New WAterways.
- Broadening the target audience of New WAterways to engage with other organisations/professions e.g. consultants, architects, Departments of Health and Planning.
- Building on the collaborative relationships with Dep. Planning generated through the development and implementation of Better Urban Water Management policy.
- Finding ways to piggyback water management outcomes on other policy hooks (e.g. planning, energy and economic development) through consistent messaging and robust evidence.

Create system feedbacks

In the medium to long-term, developing the capacity to learn and act collectively to respond to system feedbacks will provide the urban water sector with the with the capacity to adapt over time. An important component of this capacity is adequate feedback mechanisms. These must provide information on not only how the urban water systems AND sector are performing to meet current water services, but evaluating whether these services meet societal needs, aspirations and values for water. Some considerations for such feedback mechanisms include:

- Designing monitoring, evaluation and performance reporting to collect information and learnings beyond the technical performance of new infrastructure, e.g. benefits of collaborations, and multiple outcome solutions, investigate full life-cycle costs, implications for current governance arrangements etc.
- Working closer with developers will providing significant opportunities to get things in ground to explore new possibilities.
- Building capacity to engage with communities to a.) identify water values, aspirations and negotiate the water services needed to address these, and b.) manage community expectations of government performance, thereby mediating the political risks of water policy implementation.

Next Steps

This report identifies some institutional attributes underlying Perth's 'locked-in' institutional setting. It provides strategies to reconfigure these institutional domains, based on the assessment of institutional dynamics and socio-political context of the urban water sector in Perth. A comparative analysis of Perth, Adelaide and Brisbane is yet to be conducted as part of this PhD research project. It is expected this further research will provide greater insight into the capacities needed within the institutional setting, in order to create the dynamics that enable them to adapt more responsively over time.

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1. Introduction

Contemporary urban water systems have been centralised to deliver optimised water supply, sewerage and drainage services, based on historic water availability. These optimised systems are becoming 'locked-in' to current service delivery objectives (supply, sewerage and drainage), and cannot easily accommodate a growing diversity of water sources (e.g. recycled water), water services (e.g. recreation, waterway health) and variable operational conditions (e.g. droughts and floods, population growth). These complex socio-technical systems call for the integrated management of water, so as to maximise resource efficiency by matching water sources to fit-for-purpose uses, which considering and minimising adverse, distributed impacts. Separated infrastructure and governance arrangements of water services cannot adjust to this level of integration. As such, scholars, practitioners and governments across the globe are recognising the need for fundamental change to water resources management in a number of domains. From the technology, system design, operational practices, and governance arrangements, to the underlying assumptions, beliefs and attitudes that determine how water is valued and utilised in society. To ensure water management is adaptable and meeting societal needs in the face of uncertain future conditions, all these dimensions of urban water management will need to be regularly reconsidered, operating parameters adjusted, and underlying assumptions and objectives reviewed. Understanding the institutions that underpin physical water systems, professional practice and governance arrangements is key to enabling such adaptive change processes.

Institutions are often defined as formally documented rules and regulations. However, the way actors[ii] interpret, act on and implement these guiding structures is as much responsible for what is observed in practices as what is written on paper. Thus, it is the socially constructed understandings, norms, and cognitive frames that shape interactions in society, allowing individuals, groups and organisations to act cooperatively, and therefore determine the management paradigms and professional practices of water management. In exploring how these social structures facilitate collective action, this PhD research aims to identify the institutional dynamics that generate 'adaptive capacity,' within the urban water context. Understanding how underlying institutions allow the urban water sector to function, to respond to feedback from the operating environment and adjust needs/objectives and the actions to achieve them, represents an explicit capacity to adapt. Such ability will ensure urban water systems can be reconfigured to meet future water management challenges, anticipating and accommodating changes in social, environmental and economic conditions in a more proactive manner.

This PhD research uses the urban water sectors of Perth, Adelaide and Brisbane as multiple cases to explore institutional adjustments and the dynamics behind them. Each city has been subject to prolonged drought, and the study period (2009-2012) offered the opportunity to examine the institutional dynamics that underpinned and/or enabled the significant adjustments to water management practices that were required under the extreme conditions. This report presents the analysis for the Perth case study. It reports the contemporary 'state of play' of Perth's urban water institutional setting, highlighting some of the issues these conditions present as the city responds to significant changes to its operating environment. The report also proposes opportunities within Perth's institutional attributes that could be addressed or utilised to build better capacity to adapt governance arrangements and management practices to suit the new conditions, now and in the future.

[ii] In this study, the term actor describes any individual, group, or organisation whose activities directly or indirectly influence water management.

2. Research Foundations

This section provides a quick guide on the theoretical grounds of the research approach, to help the reader interpret the research results presented. Further information on the research design, methods, and the analysis framework used to interpret the data can be found in Appendix A and B respectively.

Research Design Overview

This research identified the institutional dynamics underpinning Perth's urban water sector, by drawing on people's experiences of working within the sector. The tacit knowledge practitioners develop through experiences and interactions underlie how they interpret and navigate the formal institutions that articulate water management aims and legitimise actions toward them. This knowledge includes the informal institutions that guide and shape the way the urban water sector operates.

Focus groups provided a way to access and understand this experiential knowledge; by providing practitioners with the time and space to reflect on their tacit understandings, identify the more tacit rules-in-use they operate under, and discuss the influence of these on their decisions and actions. This revealed the informal institutions guiding their professional practices, and the interplay between these and the formal rules and regulations.

Analytical Framework: Key Concepts

To make sense of this data, two scholarships based on institutional theories were drawn together as an analysis framework; The Institutional Analysis and Development Framework[3], and Institutional Work Theory[4]. The key concepts behind these scholarships are defined below to aid the reader in understanding the results presented herein.

'Rules-in-use' are both the rules and regulations, and the social conventions that shape the way people interact, and the actions they decide to take. These formal and information institutions constitute the institutional setting of the urban water sector.

'Institutional work' is a type of activity an actor carries out which can influence on the 'rules-in-use'. There are three types of activities; **'Maintaining'** activities enforce or conform to current rules-in-use, **'Creating'** activities generate new rules-in-use, by questioning the assumptions and conventions behind current rules-in-use, and **'Disrupting'** activities explicitly challenge current rules-in-use or undermine their legitimacy. If significant institutional work is being carried out, i.e. if these types of activities are aggregated and connected across the sector, it generates dynamics within the institutional setting that maintain, create and/or disrupt the rules-in-use.

There are two levels of the institutional setting that these dynamics can take affect on. The **'Operational level'** is focused on the day-to-day delivery of water services, so the institutional dynamics at this level are effecting rules and regulations governing water management, and practitioners interpretations of these. Water service providers and resource managers predominantly conducted institutional work at this level. The **'Collective Choice level'** is a level of the institutional setting where the day-to-day rules are monitored, evaluated and changed. This process must me conducted jointly by stakeholders, as the new rules-in-use must be understood and shared collectively in order for them to become legitimised. In the urban water context, activity at this level of the institutional setting would be carried out by executive management within organisations, policy makers, regulators and other broader stakeholders.

The research approach was to identify the rules-in-use, determine the types of dynamics these rules were creating, and at what level of the institutional setting these dynamics were influencing.

3. Perth's Institutional Dynamics

This section presents the results of the research, identifying and describing the institutional dynamics underlying the way the Perth water sector functions.

Making sense of the data

The rules-in-use identified in the research were conceptually mapped to capture the prominent linkages and relationships[iii] between them, thus revealing the institutional dynamics affecting the way in which Perth's urban water sector is operating. This analysis revealed a number of domains in the institutional setting where activities are generating institutional dynamics, or not (see Table 2). These domains therefore represent key attributes of Perth's institutional setting.

Table 1: Domains of institutional activity identified in Perth

Domain	Description
Governance setting	Regulation, legislation, levies, policies and other formalised incentives and disincentives that shape the industries operational environment.
Policy Direction	The purpose water management fills in society, articulated and communicated in a policy agenda subscribed to across Government.
Inter & intra organisational relations	The relationships and working culture of organisations across the urban water sector.
Strategic support	Managerial support for reinterpretation of roles and responsibilities, and networks of frontrunners to disseminate and champion innovations.
Discourse	Public debates and public perceptions of water management, as understood by practitioners. Professional discussions on the beliefs, cognitive frames, professional identities and other assumptions underlying the current water management paradigm.
Information and feedbacks	Information on system performance, opportunities, emerging issues and pressures from the broader contextual environment the urban water industry is situated in.
Space for innovation and learning:	The culture of learning and experimentation across the sector, and the supporting structures provided by organisations and individuals for such activities.
Professional Capacity	Skills, capabilities and technical knowledge resources for performing water management, and for deriving innovative approaches to this task.

[iii] For more information on this mapping technique, refer to Appendix A 'Phase Two: Characterising' (page 290) and Appendix B 'Action Situation' (page 291).

The institutional dynamics were then classified as having a maintaining, creative or disruptive influence. The extent of this influence was assessed, with each type of institutional dynamic (maintaining, creative and disruptive), within each domain, classified as generating either a significant (●), limited (◐) or insignificant (○), influence. This assessment is presented in Table 2. A limited influence indicates that there is some institutional work of this type, but it is not producing dynamics that are having a substantial effect on the rules-in-use. An insignificant rating suggests that while this type of institutional work may exist, it is currently generating dynamics with a negligible effect on the institutional setting. The institutional dynamics at different levels of the institutional setting (operational or collective action) are aggregated in this summary table.

Table 2: Summary of institutional dynamics within institutional domains

Institutional domains	Maintaining dynamics	Creative dynamics	Disruptive dynamics
Governance Setting	●	○	◐
Policy Direction	●	◐	○
Inter & Intra-organisational relations	●	◐	○
Strategic Support	●	◐	○
Discourse	●	○	○
Information and feedbacks	●	○	○
Space for innovation and learning	◐	○	○
Professional Capacity	●	○	○

The institutional dynamics within these domains are described in detail in the sections that follow. Within the description for each domain, a table presents the assessment of the extent the three types of institutional dynamics are influencing the rules-in-use, at both the operational and collective action levels of the institutional setting. The commentary also draws connections to other domains which the dynamics may also have an influence on. Quotes from workshop and interview participants are used to illustrate the influences of the institutional dynamics described on water management practice.

Governance setting

	Maintaining	Creative	Disruptive
Collective Action	●	○	◐
Operational	●	○	◐

Table 3: Governance setting institutional assessment

Maintaining dynamics

Collective action level: The roles of water resources management, services delivery and regulation are separated in Perth's urban water governance arrangements. The responsibilities and powers vested in these roles are very clearly defined. There is little over-lap in the formal remits of departments and agencies, and also in the informal organisational and operational cultures of these actors (see the discussion on Inter & intra-organisational relations, page 266). This corporatised governance setting is geared toward optimisation and efficiency, by prescribing service delivery goals in operating licences and regulating actions to achieve them. This maintains discrete delivery of water supply, sewerage and drainage services by penalising deviations from this operational framework (see the discussion on Space for innovation and learning, page 272). Thus the historic assumptions and values for water embedded in legislation are enforced. Given the Metropolitan Water Supply, Sewerage and Drainage Act, 1909 is the current legislation setting core principles for urban water management, these assumptions and vales are likely to be unsuited to contemporary society.

'The Public Works here in Western Australia was eliminated because they felt it was not competitive… and the reason why you have these three bodies here now, the Economic Regulator, Department of Water and the Water Corp, is to get more competition… but in actual fact if you look at it it's probably less efficient than it's ever been.'

'Working with outdated legislation – MWSS&D Act = 1909.'

Operational level: With a single service provider for Perth, there is a large amount of vested interest for this actor to maintain these arrangements. They are empowered to conduct institutional maintenance activities through their operational actions, including through the allocation/control of resources and assets, ensuring compliance through monitoring and enforcement, deterring or deferring the need for change, and embedding formal institutions and their normative underpinnings in operational procedures, professional identify and practices.

'Water Corp does have such a strong, clear mandate, and that's what they want to stick to, so it's really difficult to get them to shift beyond that.'

Creative dynamics

Collective action level: The predominant cognitive frame of the water management problem as a water supply problem has generated a focus on finding new water sources and managing demand. This framing of the water scarcity problem has not prompted a reassessment of the value of water, the services it delivers, and how it can be managed to achieve these services, in light of the changing operating context. This type of reflexive activity prompts the creative institutional work to develop new rules-in-use to account for these changes within the institutional setting (see discussion on Discourse, page 269). Creative institutional work that change regulative institutions by

'I think there's a general recognition in the community, and I'm talking the political community as well, that there are water supply and water use issues in Perth and that they need to be addressed.'

[Researcher's emphasis]

'The Department of Water is still an embryonic organisation, they're still building capacity.'

establishing new formal rules and rewards and sanction to enforce them, can only be

achieved by certain actors with politically and/or economically strong positions. The Department of Water has the legislative power to determine water resources management objectives and develop legislative frameworks and regulations to deliver these. However, as a relatively new Department, it has not established political support for these creative activities in a political climate highly sensitive to water issues.

Operational level: New water management solutions and approaches are measured compared with traditional methods on their ability to optimise the delivery of clearly defined and separated water services. With this limited view of efficiency, the additional benefits offered by multi-functional solutions are generally not taken into account in cost-benefit analyses. Service delivery also separated within the Water Corporation, adding transaction costs to exploring and developing new practices or technologies to meet multiple objectives, and making it difficult to justify these activities within divisional budgets. There is therefore a significant disincentive to step beyond the bounds of current practice and explore new management approaches, and in the process, create new operational rules-in-use.

'We don't have any government position in relation…alternative water supplies; it's got to compete with our current one.'

'Difficult to build a case for alternative decentralized solutions for a monopoly.'

Disruptive dynamics

Collective action level: A cognitive shift has begun to prompt the recognition of new values and uses for water across the urban water sector. A consortium of actors from the local government level are highlighting the value of water quality as a goal of drainage management, and challenging the governance arrangements for this aspect of water management. This draws the service delivery assumptions embedded in current water management legislation into question.

'Paradigm shift in acceptance of alternative water/wastewater management practices.'

Operational level: Some demonstration projects in Perth are decreasing the perceived risks of new practices and beginning to highlight that new values and benefits of water management are not addressed in current practices. However, unless the implications of these projects on current governance arrangements are explicitly considered, captured and promoted, these projects do not generate a disruptive dynamic beyond the project. Thus in Perth, demonstration projects are showing the successful application of new technology but have not generated a sector-wide dialogue on the deficiencies of current legislation, regulations and organisational arrangements to facilitate the uptakes of these innovations.

'There have been some great projects… but how do we make it mainstream?'

'No one asking questions about the governance behind them [demonstration projects]. Liabilities just being created and shifted. Demo projects not thought of in terms of what should be 'demo'd.'

Policy Direction	Maintaining	Creative	Disruptive
Collective Action	●	◐	○
Operational	●	◐	○

Table 4: Policy direction institutional assessment

Maintaining dynamics

Collective action: There is no clearly articulated vision for Perth's water resources management aspirations. While there is clear planning and direction provided for water supply needs, the contemporary value of water to the Perth community, and the multiple outcomes its management should therefore aim to achieve, are not communicated. Without a clear vision, the urban water sector is left with little guidance on what overarching goals their management objectives should contribute to, and how their activities should align with those of other actors. In the absence of a vision and such strategic direction, legislation is being interpreted narrowly to meet disparate aims and objectives of individual organisations, and there is no driver for actors to collectively consider issues and challenges outside these current boundaries.

'Department's focus is on what they have to deliver, as there will be repercussions if they don't deliver that. So they are focusing on the legislative/regulative side of things, not on the whole road map. No overall vision.'

'…until you change the policy, change the guidelines, change the standard... then the implementers will continue to implement.'

Operational level: Without a clear vision for water management and strategies/guidance on how this may be achieved, competing agendas arise and activities of actors are becoming misaligned toward different outcomes. The default strategy for practitioners working at the operational level is to fall back on traditional processes and practices as a way to try and safely navigate this confusion.

Creative dynamics

Collective action level: The problem frame, normative understandings and over-arching objectives for water management are not shared and integrated across the sector. It is difficult to develop a forward-looking policy agenda when these foundational assumptions and understandings may be in conflict between actors. This also creates confusion and is contributing to the politicisation of water. However, some common ground has been found in the shared problem of finding water sources to support new land development. This has prompted a policy focus on integrating land-use and water planning and management, and resulted in some clear guiding policy. The implementation of this policy is subject to the land-use planning system, which has delivery problems of its own. Nevertheless, it represents the development of new operational rules-in-use by collective action level actors, albeit focused only consumptive supply needs.

'[There's] lots of networking to figure out the agenda.'

'…the integration of land and water planning…that's again something that's happened really over the last couple of years, and I think that's been a positive step…'

Operational level: With policy changes in the land-use planning legislative framework, new normative and cognitive understandings about the connections between water management and land planning and development have been created. While this creative institutional work focuses on the consumptive needs and run-off treatment requirements for water, it has the potential to prompt a broader consideration of the role of water in contemporary Perth society.

Inter & Intra-organisational relations	Maintaining	Creative	Disruptive
Collective Action	●	○	◐
Operational	●	◐	○

Table 5: Inter & Intra-organisational relations institutional assessment

Maintaining dynamics

'Bureaucracy – process, systems, compliance, "risk" avoidance…'

Collective action level: With segregation of water management responsibilities embedded in legislation, and working cultures of key organisations internally focused, there is limited intersection of responsibilities and collaborative activities. Interactions between actors occur only where formally required, and there are historic tensions that also prevent more proactive collaboration. As a result, the overall management system is not systemically considering issues that emerge beyond assigned roles and responsibilities, and there is no informal mechanism to deal with these issues collectively.

'… people 'pushing back' and only doing what's strictly in their job description…'

Operational level: Without clear strategic guidance across the sector and strained inter-organisational relationships, operational actors rely on current rules, roles and procedures to provide them with certainty to conduct their work, and to avoid exposing themselves to risk. This need for certainty serves to maintain current institutions.

'…both of them would point the finger at the other one and say 'Oh they won't let that happen'. And yet he'd get them in the room and they'd both say well you know, 'Isn't this you that's stopping this?' And then they'd say 'No, not us, isn't it you?'

Creative dynamics

Collective action level: Creative activities are suffering from historic inter and intra-organisational relationships; when there is a lack of trust between organisations or internal divisions, it is difficult to admit uncertainty and collaborate. In addition, with roles formally separated, it is difficult to find areas where collaboration would result in mutually beneficial outcomes to motivate actors to conduct such work.

'Informal 'coffee chats' to discuss issues, ideas, ways forward collaboratively...'

'Ignoring the politics …and getting on with doing my job that I believe will have a real impact – i.e. flying under the radar to get some positive action happening.'

Operational level: Operational actors are connecting and collaborating informally through networks of like-minded individuals or over shared problems. This activity is on a case-by-case basis and has created trust and collaborative 'rules-in-use' between these individuals. However, such activities are not always supported by the broader organisation's formal operating procedures and cultures. These activities need to be recognised and supported, so the rules-in-use are legitimised more broadly, and used as a basis of better inter-organisational relations, which will facilitate creative institutional dynamics.

Now they've formed the so-called C21….support by the WA Local Government Association,…they're the ones that are driving the broader questions, things like urban water drainage, and water quality.

Disruptive dynamics

Collective action level: There has been some formative disruptive activity occurring at the collective action level. While assumptions behind drainage management roles and responsibilities have been questioned in a number of review in the past, these activities did not prompt reform. A recent review driven by the Western Australian Local Government Association has the

potential to generate momentum for reforms in this aspect of urban water management, because of the broad-based support from its members – (i.e. an actor network built for mutual benefits and based on support and trust),

Operational level: Practitioners are experiencing a growing dissonance between legitimate practices endorsed in regulations and operational procedures, and the practices their expertise and experience suggest will produce the best outcomes. The change in operating conditions is challenging their individual moral foundations, beliefs and assumptions, which underpin the current institutional setting. Actors are reinterpreting these rules as individuals, and reforming assumptions, but this disruptive activity has not developed into a broader debate across the sector, and so have not generated disruptive institutional dynamics on roles and responsibilities in the urban water sector.

'Stated goals that say one thing, while in reality you're not trying to achieve that.

'People within other organisations being prepared to think outside the box and look at the greater outcome rather than getting stuck on a set point.'

Strategic Support		Maintaining	Creative	Disruptive
	Collective Action	●	◐	○
	Operational	●	◐	○

Table 6: Strategic support institutional assessment

Maintaining dynamics

Collective action level: Water has become a highly political topic in Western Australia, due to the drought and it's coverage in media, but also as water management was used as a platform in a failed election campaign. Past Corruption and Crime Commission cases involving senior bureaucrats have also left residual fears in senior decision-makers of pushing the boundaries of their positions. Water is therefore not viewed as a politically safe topic to be questioned or challenged, as maintaining good public and political support is the priority. As the legitimacy of current institutions provides certainty and safety for decision-makers, they are enforced and generally not questioned or their boundaries stretched by these decision-makers.

'The higher levels are scared of getting sacked.'

'People not willing to make decisions – fear of recriminations of making decisions.'

'Political will – lack of political will to make tough decisions.'

Operational level: The lack of visible leadership for water issues is sending a message to the operational level that current practices are considered adequate. It is therefore difficult for managers and staff to justify exploration of new ideas and approaches. It may also be discouraging actors from raising questions about the suitability of current rules-in-use, prompted by their practical experiences.

'You get some people who are passionate about changing it and doing things differently. And yet there's this strong middle layer management that just want to keep doing it the same old way.'

Creative dynamics

Collective action level: Strategic support has enabled the creation of new policy to link water management and land-use planning and development. However there seems to be a lack of strategic support for fundamental review and adjustment of the

'The previous Government were very active about trying to get in the water reform…and when the new Government came in, they've just sat on it, and nothing's progressed.'

water management institutional framework. A process of legislative reform has been underway for a number of years, but at time of writing is yet to be passed by Parliament.

'Being supported by my manager to try a new approach, to allow for innovation.'

'Staff resourcing/priorities can make it difficult to undertake new project initiatives when previous work balance still required day-to-day.'

Operational level: Some managers are supportive of explorations of new ideas and practices. Others are not willing to risk investment in such learning and experimentation at the cost of the delivery of 'core business.' Some practitioners are also pursuing creative activities without endorsement, personally taking on the risk of challenging managerial authority and normative ideas and values for water management. However, without strategic support for these activities from higher decision-making levels in organisations and across the water sector, the potential creative dynamics of these activities will not be captured, connected, and momentum built for the new rules-in-use they create to be legitimised.

Disruptive dynamics

'Unstable directional statements – inconsistencies/change in direction/stance. Difficulty in maintaining consistency.'

'Instability in Ministerial Portfolio creates a lot of problems… creates reactivity.'

Collective action level: Current economic, environmental and social conditions are challenging Perth's water values and management paradigms. Leadership is needed to recognise, consider and make sense of this feedback through reflexive processes. However political and bureaucratic instability is forming a leadership void and leaves the sector to deal with these disruptions uncohesively. This erodes the institutional setting of the sector, as new ideas, assumptions and thinking are not developed and shared collectively. As such, disruptive dynamics are not utilised as opportunities to produce more appropriate rules-in-use, and instead are decreasing the cohesiveness of the sector overall.

'Need for strategic planning. Without a clear direction set by senior management, it can be difficult to make change or progress issues internally & externally.'

'Lobbying up the line creates instability in teams and lack of certainty in going forward.'

Operational level: In the absence of leadership and direction, the implications of system feedbacks are not being considered through collective learning processes. As such, the sector is becoming destabilised, as old rules and norms on how to operate are increasingly irrelevant, but no guidance is provided on what new operational practices are appropriate. It also opens opportunities for actors to conduct disruptive activities to further individual agendas.

Discourse		Maintaining	Creative	Disruptive
	Collective Action	●	○	○
	Operational	●	◐	◐

Table 7: Discourse institutional assessment

Maintaining dynamics

Collective action level: Public dialogue about the implication of the drying climate have been predominantly around the need to change consumptive water use behaviours, and the appropriate mix of new water sources. This discourse has not progressed to a deeper debate about the full range of services water needs to provide, given its increased scarcity, how the resource should be valued and allocated to meet these societal needs, and therefore whether current governance arrangements are best placed to deliver these management objectives. At the political level, water management issues are framed as a potential perceived failure of government. As such, public discussions about the impacts of the drought have been discouraged, to maintain the perception that successful water management has been achieved. Without public acknowledgement of the challenges, the performance criteria, or societal expectations (hydro-social contract) for water management have not been renegotiated in light of the changes to the operating context. Therefore, the general public are still judging government's performance on criteria that may not be realistic in the new circumstances, or represent performance goals that match community needs and expectations. As such, the traditional understandings and expectations remain and enforce the institutional structures that deliver them.

'There's no doubt that the water scarcity in Perth and the potential scarcity is accelerating people's interest in trying to save water.'

[Researcher's emphasis]

'You've had total sprinkler bans in the East; we've never got near that and our government's reluctant to go near that.'

Operational level: Discourse at a professional level is recognising some of the implications drought has had for water management institutions. However, due to the dynamics discussed under Governance setting and Inter & Intra-organisational relations, there are few institutional mechanisms to facilitate broader dialogue and collective action to address these emerging issues. Also because this challenges the institutional setting and the norms embedded in political and public discourse, these concerns are not voiced publically, and the current institutions persist.

Creative dynamics

Collective action level: With limited discourse to look reflexively at traditional management objectives and approaches and how they match with current societal needs and expectations, the cognitive and normative understandings and assumptions underlying the institutions that deliver current practice have not been questioned. As such, there is no driver to create new understandings of the value of water, the roles it fills in the urban environment, and how best to manage it and the subsequent governance arrangements need to achieve these outcomes.

'Paradigm shift in the acceptance of alternative water/wastewater management practices.'

'And people don't quite know how to challenge it and work their way through with you know, new sort of opportunities.'

Operational level: Professional discussions are helping to change normative associations and define possible new solutions and approaches. There are the beginnings of institutional building activities. Recognising the connections between land-use planning and water management and subsequent development policy guidelines were the most significant example of this. This initiative was driven by

the State Government's focus on the economic development of Western Australia, which provided legitimacy for pursuing this policy innovation. However in general, the discussions and debates about the appropriateness of current practices and institutional arrangements are largely informal between individuals. Thus they are not captured and taken to a broader audience to inform wider debate and develop new institutions.

'People can look out our river from the city and then can see the dolphins jumping and you can catch a 40-pound Mulloway right at the city door, then they go "What's the problem?" '

Disruptive dynamics

Collective action level: With a lack of public debate on appropriate water services and management objective under water scarcity, and the inability for internal actors to question current expectations (due to dynamics described under Governance setting, Information and Strategic support), there is little support or drivers to disrupt the certainty provided by existing institutions.

'Hopefully it is changing the mindset within some of the staff.'

'All it takes is a few networked champions operating in different areas selling the same message in the right ways to get things moving.'

Operational level: There is some discourse surrounding the moral foundations, suitability of sanctions and assumptions and beliefs on which water management is based between practitioners. However without broader recognition of the dissonance between these current institutional underpinnings and the new operating conditions, the personal costs (reputational, job security) of challenging these foundations remain too high for individuals to promote these types of fundamental debates.

Information

	Maintaining	Creative	Disruptive
Collective Action	●	○	○
Operational	●	○	○

Table 8: Information institutional assessment

Maintaining dynamics

'We've gone from an expert system, a system run by experts to a system run purely for political expediency.'

'Politicisation of water is a big issue, and relate to the lack of expertise being used to make decisions. Need to be able to engage with Minister's advisors better and understanding what they base decisions on.'

Collective action level: The access to, interpretation of, and use of information were highlighted as significant issues. This was particularly in terms of the reliability and relevance of the data available, qualities that are essential to give decision-makers the confidence to make, justify and defend their choices. In addition to problems with the information itself, it was highlighted that the advice provided to decision-makers is regularly contradictory between departments and agencies, and even from within organisations. Without confidence in the information or consistency in the interpretations forming the advice they receive, decision-makers are drawing on sources of information outside water management expertise and utilising traditional logics for decision-making in order to make defensible decisions.

'Good industry connections which help obtain hard to get information.'

Operational level: Many participants noted that access to relevant information is predominantly gained through membership in informal networks. Issues with availability of relevant information were also highlighted as a concern. Information flow is therefore an issue, as it provides an important feedback

mechanism for the water management system. With gaps in information relevancy and accessibility, the urban water sector in Perth is unable to assess the overall performance of the system within the changed operating context. In this way, there is limited feedback to drive adjustment or change, and current practices continue to be viewed as optimal or appropriate.

'It would help to have greater access to research and information on WA circumstances. Much of the research that is easy to locate is international or interstate. '

Creative dynamics

Collective action level: It was noted that there is a lack of reporting and communication mechanisms across governance. This has implications not only for the flow and sharing of information, but also the joint consideration or processing of this information, and thereby the generation of shared interpretations of this feedback. Such a process feeds the initiation of creative activities, by recognising gaps and discrepancies in implementation vs. performance, and changes to operating conditions. Thus, without these feedback mechanisms across the sector, there is no strong driver for collaboratively examining the appropriateness of management outcomes and the institutional frameworks that deliver them.

'...perhaps we're relying too much on science, that whole precautionary principle…is probably almost acting the other way around now, in preventing action.'

'Current Minister is stepping outside the box on water recycling. However, getting conflicting advice…, so is asking questions as to what is going on.'

Operational level: Relevant and reliable information is needed to inform the design of new technologies and practices. With these gaps in information in Perth, it is difficult to compile the business case needed to justify experimentation and to develop innovations into mainstream practice.

'Poor database organising creates difficulties in finding 'free' information.'

'Science is lacking, cut backs in monitoring, too much reliance on models.'

In terms of the generation of new information and knowledge to fill these gaps, some participants suggested that a greater reliance on modelling without explicit recognition or considerations of the limitations of modelled data is affecting the perceived quality of information. There are also disagreements between organisation on appropriate assumptions and limitations to these models. The perception of the relevance of information was also seen as a limiting factor, as information is often dismissed if it has been generated in different contexts/conditions, rather than this knowledge being applied or adapted where applicable and appropriate.

'You have to be able to show exactly where the conditions are the same… [otherwise] they say "Oh no, we're different." '

Disruptive dynamics

Collective action level: Similar to the discussion of creative institutional activity, with information flows impacting on system feedback mechanisms, there are limited prompts for disruptive activities. These activities use feedback to challenge the assumptions underlying institutional structures, so without adequate information to provide this feedback, it is difficult to recognise where these foundations might be inappropriate, and mount a case to review them.

Operational level: Information deficiencies also hamper the ability to demonstrate the added benefits or efficiencies of new approaches, as opposed to traditional practices, for which information on performance is well known and trusted. While some decision-making tools and new technology trials are being developed, comprehensive information on the added benefits needed to 'disrupt' the cognitive and normative

'It's such a big concern when Water Corporation still hold all the information that will help people actually really work out what the cost-benefit is of these alternative sources of water.'

understandings of what is the 'best practice' is not yet available. Without such reliable information, activities that question or challenge current institutions are unsubstantiated.

Space for innovation and learning		Maintaining	Creative	Disruptive
	Collective Action	◐	○	○
	Operational	◐	◐	○

Table 9: Space for innovation and learning institutional assessment

Maintaining dynamics

There is innovation and learning occurring at both collective action and operational levels that maintains current practices. This activity is in the form of finding new, more efficient ways to deliver the same services/objectives/outcomes, so these innovative practices only have a low significance when it comes to this maintaining influence.

Creative dynamics

Collective action level: Conditions created by the institutional dynamics described under the Governance setting, Policy direction and Strategic support themes have created significant costs for perceived 'failure.' These include professional reputation and job security as well as financial costs. Experimentation, which can manage risks in order to develop improved practices, is more likely to be viewed as an unnecessary risk, because the deficiencies in old practices have not been considered or acknowledged, and/or the additional or different benefits provided by innovations are not valued. Thus the dynamic created by a number of the institutional rules-in-use generates a working culture unsupportive of experimentation and learning.

'No-one will make the first step…no-one's going to go over the trench because they're going to, the machine guns are going to mow you down.'

'Not willing to investigate or innovate as this is a liability.'

'So I mean there are people who are actually finding some of these solutions, but they're doing it out of necessity... And that seems to be what's driving most of our innovation.'

'Not having a safe place to trial new technologies and water management concepts.'

'…they do some really good stuff and yet unless it's business as usual, you don't really hear about it.'

Operational level: The scarcity of water has helped to drive innovation out of necessity. However this innovation tends to be conducted 'under the radar,' and on a case-by-case basis. There are limited rules-in-use that encourage learning and experience to be shared to improve current accepted practice, or to be developed further and scaled up into mainstream approaches. Thus while the industry capacity building program, New Water Ways, has provided a mechanism to share and discuss alternatives and build skills and knowledge to implement them through workshops, speaker series, and a web porthole for information, this relies on practitioners having the time and support to conduct these learning activities. As described in a number of other themes, actors are not always enabled or supported in these types of creative activities.

In addition, the rapid population growth experienced in WA due to the mining boom has added significant time pressures to the provision of services. This leaves little opportunity to consider trial and develop new practices. Instead, innovative activities focus on making practices more efficient.

Professional capacity	Maintaining	Creative	Disruptive
Collective Action	●	○	○
Operational	●	○	○

Table 10: Professional capacity institutional assessment

Maintaining dynamics

Collective action level: The ability to navigate the political realm is a specialist skill, and difficult to achieve when it is a highly contested topic. It relies on access to networks and intimate knowledge of the industry, which can only be built up over time. Instability at the higher levels of bureaucracy is impacting on the ability of actors to build these connections and expertise. Also, the large salaries offered in the mining industry are attracting people with these skills and experience.

'CEO's stay for shorter-terms. Really need more time to build their reputation and credibility. Makes it harder to find Champions for causes.'

'[There is] a skills shortage in Western Australia with the mining industry sucking up a lot of the people, you know often being twice the salary as what you'd get for doing a similar job in Perth.'

Operational level: Similarly to the collective action level, participants noted a loss of expertise to the mining industry and through retirement. This leaves the workforce with less experience to draw from, and coupled with the lack of strategic support, policy direction and space for learning and innovation, disempowers actors to try different approaches. Instead they rely on traditional, accepted methods.

'Everyone knows what their comfort zone is, what they know and love and have been doing for the last 30 or 40 years.'

Creative dynamics

Collective action level: The turn-over of key decision-makers and their support staff, and the inter and intra-organisational issues that are creating an uncohesive water sector, have reduced the understanding of water issues, monitoring of emergent issues and any policy/governance gaps that need to be addressed. Increased effort and capacity from within the water sector is required to engage with key-decision makers to highlight these issues and solutions in ways that are relevant to them.

'Public servants should be apolitical, and able to provide frank and fearless advice. Does take some work to build a relationship with a new Minister in order to do this.'

Operational level: The capacity to question current operational boundaries relies on reflexivity, creativity, knowledge and experience. Actors also need to be willing and empowered to collaborate through these processes of exploration in order to validate and support new ideas and develop strategies to promote them. Because institutional rules-in-use (including those discussed under the Space for learning and innovation, Strategic support and Inter & Intra-organisational relations themes) are not supportive of these activities (as they assign costs them), these skills and capabilities are not valued, actors are discouraged from using them, and the building of this capability in the workforce is limited.

'People are less willing to take risks, because if they make a mistake, they aren't supported by the political sphere.'

Disruptive dynamics

Collective action level: There is a lack of willingness to upset the status quo by challenging the norms embedded in current legislative frameworks. The need to conduct and guide disruptive activities in order to improve the outcomes being achieved is therefore not a recognised role for leaders and

'Some Director Generals also … micro-manage…instead of seeing their role to look more strategically across their portfolio and provide the vision and direction departments need to do good work.'

'All about getting runs on the board…make the Minister look good in the eyes of colleagues and the community. Then you have their trust, and can start to push other issues with them.'

'Engaging where Minister gets his information so he hears the same message coming through.'

decision-makers. Some imbalance in the cost/benefits associated with these positions as described in Governance setting and Strategic support is devaluing this aspect of leadership.

Operational level: Due to the lack of rules-in-use that connect actors and structure interaction and collaboration (see discussion in Information and Inter & Intra-organisation relations themes), the operational actors are struggling to find ways of working together to highlight the dissonance between accepted practices, management objectives and changed operating conditions, to elevate it to a collective action level and resolve the dissonance by disconnecting the assumptions and sanctions which encourage current practice from the legislative frameworks which legitimise them.

4. Discussion

The following section discusses some of the practical implications of the institutional dynamics found in the results, in relation to their effect on the way the urban water sector operates. Some preliminary suggestions are provided on how to address or utilise these institutional dynamics to tackle these implications.

Perth's urban water institutional setting is characterised by a predominance of 'maintaining' dynamics, as illustrated in Table 11. This table presents an aggregated over-view of the institutional dynamics found in Perth, at the two different levels of the institutional setting.

Table 11: Matrix of Perth's Institutional Dynamics

	Maintaining	Creative	Disruptive
Collective Action	●	◐	○
Operational	●	○	○

The dominance of maintenance dynamics is not only because of the significant presence of these types of activities at both the operational and collective-action levels, but also because of deficiencies in creating and disrupting dynamics. This has resulted in a resilience to buffer the city against persistent dry conditions. However, creative and disruptive dynamics are needed to prompt and drive change initiatives, and balance maintaining dynamics. Without these influences, Perth's institutional setting does not generate a capacity to initiate change processes, if broader environmental or operating context conditions change, making the city's urban water system vulnerable.

The availability of new water sources, their cost implications, population growth, and subsequent land development needs are some of the external pressures highlighting some of the key assumptions underlying the urban water institutional setting in Perth. The issues and questions raised can be outwardly evident, but can also take the form of dissonance between current accepted practice, professional opinions, and beliefs of what 'best' practice is. This dissonance was apparent when participants expressed their confusion over the way they interpreted their professional roles, as opposed to management expectations or what their role had traditionally been. Many expressed disagreement with the outcomes their efforts were contributing to, versus what they believed were better outcomes for 'public good'. Thus, the maintaining dynamics of Perth's institutional setting do not appear to be conducive to the shift in practice needed to adjust to these external pressures and reconcile this professional dissonance. This is described further in the commentary of each institutional work type below.

Maintaining dynamics

This predominance of maintaining institutional dynamics is primarily a result of problems with feedback to the system. Many participants mentioned the lack of reliable, relevant information. As a result, feedback loops, which inform the water system on how it is performing with regard to its operating context and the suitability of its ultimate objectives, have been inadvertently suppressed.

Maintenance tendencies also stem more from lack of direction and leadership than from the belief that current governance arrangements for water management are appropriate. There is acknowledgement within the sector that current arrangements are not responsive to the new environmental conditions and that the practices entrenched in these governance arrangements are increasingly inappropriate. However because of the political sensitivities around water, it has been difficult to acknowledge these deficiencies, challenge their inappropriateness, and build the support and momentum for reform. Without the cohesion provided by a shared vision and leadership support, the sector suffers from confusion over the appropriateness of practices, and from competing agendas that emerge in the absence of a shared

direction. The coping strategy is to fall back on formal organisational positions, rules and processes, as, being embedded in current formal rules, these practices are not subject to any penalties or risks.

Another significant form of feedback in Perth's urban water sector is the public perception of water management. The community's tacit expectations for water management, or the hydro-social contract, set the criteria by which Government's water management performance is judged. The social norms, beliefs and understandings that underlie community expectations for water management may no longer be realistic under current operating conditions. However, as water management issues are framed as potential 'failures of government', water managers strive to meet these expectations against their professional judgement. This sets water managers, and by-proxy Governments, up for failure, as the community's increasingly unrealistic expectations are not renegotiated in light of feedback from the operating conditions, delaying potential impacts and implications to future generations. When prompted, participants could not identify the role or avenue for community to provide input into water management. This suggests a need for greater community engagement, to clarify or develop new community expectations and renegotiate the hydro-social contract, and to provide greater public acceptance of water management policy and practices.

Creating dynamics

The hierarchical, centralised, corporatised arrangements for water management have produced little space for the creative institutional activities needed to continuously improve water management techniques, technologies and outcomes. Water management has been separated functionally and philosophically into distinct services, to be delivered in optimised and highly efficient ways. This prescriptive structure makes it very difficult to alter if these 'services' are no longer appropriate, as organisations delivering services are bound by penalties for operating outside the prescriptions of their licences. Thus they have little room to be creative in the way services are delivered, or to question the suitability of these services. This situation can only be adjusted through lengthy processes of legislative and regulative review, and while the Department of Water has been created to take overall responsibility for water resources management, they have not developed the public, professional and political kudos to allow them to enact their powers for fundamental reforms.

Alternatively, creative activities can focus on changing the normative and cognitive assumptions behind current legislation and regulation, as a starting point for reform. In Perth, due to the long history of the water management profession's role in the State's development, there is a very strong sense of professional identity and pride connected to current management philosophies. Therefore, maintaining these connections by enforcing current institutions validates an individual's sense of professional identity. To question or challenge the assumptions underlying their work threatens this sense of professionalism. Some actors therefore use formal powers to generate maintaining institutional dynamics and undermine or discredit creative and disruptive work, to protect their professional identity.

Disrupting dynamics

Questioning and challenging current practice is limited, due to the lack of public acknowledgement that the drought is pressurising current water use practices, and the political and professional sensitivities around water management. This creates powerful disincentives to disruptive institutional activity. While some practitioners acknowledged that they sometimes operate against managers or organisational directions, because they believe it is the more appropriate course of action, they are exposing themselves to personal risk in doing so. As such, the results of this activity, which challenge the suitability of current practice, are not highlighted. So while there are localised practice innovations, they are implemented ad hoc and are not connected enough to align and reinforce messages about the unsuitability of current practice. Without connecting disruptive work to develop consistent messages about the dissonance between formally and informally accepted practices, and raise these cognitive and normative challenges to a collective-action level, broader support and momentum for institutional change is not being built. This type of disruptive activity requires the strategic manoeuvring of leaders

or champions, but as has been discussed, in Perth water is too politically sensitive to be seen to be championing these kinds of activities.

Implications and Opportunities

As has been identified in the analysis presented, the institutional dynamics in the Perth urban water sector are combining to encourage maintaining institutional work, and in some areas inhibit creating and disruptive institutional work. This setting is therefore functioning to obstruct the production of alternative options,[iv] and is consequently on a locked-in pathway of system development. The most significant institutional dynamics generating this lock-in are:

- Information flows that do not produce adequate feedback to the system to prompt and justify creative and disruptive activities.
- Disincentives in governance setting for leadership, learning and experimentation.
- Disconnection of actors across the sector, in inter & intra-organisational relations, and between operational and collective-action level actors
- A lack of shared cognitive and normative understanding of water management problems, objectives and solutions, which is then communicated in future visions, policy directions and management objectives.

If Perth is to break free from this locked-in pathway, to adapt to changing operating conditions over time, it will need to loosen the influence of maintaining dynamics and enhance creative and disruptive activities. This analysis has revealed that there are a number of domains where there are opportunities to develop and strengthen existing activities to generate these dynamics within the sector. These are discussed below.

Potential Capacities for creative and disruptive dynamics

Governance experimentation

Existing demonstration/innovative projects offer a way to examine not only new technologies, but also the new management practices and governance arrangements needed to support their implementation. Asking questions about the implications of these latter aspects at the outset of the project, and preferably building them in to the monitoring and evaluation of a project, will ensure these learning's are captured. Disseminating these findings generate creative and disruptive institutional dynamics, as they will provide the information needed to justifiably question and challenge current practice.

Also, demonstration projects outside of the Perth metropolitan area, and hence with different inter-organisational relations between stakeholders, may also provide more neutral territory to explore these questions, and a safer space for experimentation.

Developing Policy Direction

A clear water policy agenda needs to be developed, shared and supported across the sector and the Perth community. This would provide clear outcomes and targets for water management, and certainty to water managers. The successful adoption of Better Urban Water Management and the significant engagement and capacity building supporting its implementation, offer a successful model for development of clearer water policy. A review of the process of developing the planning policy could offer good procedures and principles for future policy development processes.

Also, finding crossovers with other policy portfolios such as infrastructure development, energy, and natural resource management (e.g. drainage and river health) offer areas where collaborative policy work could help to highlight water issues and policy needs, outside the politicised water portfolio.

Building Inter and Intra-organisational relations

[iv] These options are not only new technologies, but also new concepts, management strategies, values, assumptions, understandings e.tc.

The previous two activities should also be used to foster better inter & intra-organisational working relationships across the sector, and between the operational and collective-action levels. Innovative problem solving between individuals at the operational level should be recognised and supported. These collaborative relationships, which also build professional trust, need to be elevated to organisational and sector-wide scales, so that current and future water management issues can be addressed at a collective action level. Recognising the innovative work of individuals and networks, and building on the goodwill and trust of past collaborative initiatives (such as the work done around water and planning policy) through follow-on projects, would help to highlight the benefits of these collaborations, and remove some of the disincentives for innovating and championing new ideas.

Generating Strategic Support

There is a need to build strategic support at a line management and key decision-maker level across the sector for new and innovative initiatives. Showcasing successes and highlighting the learnings gained from supposed 'failures' in past work will help to sell the benefits of the different ways of working that are described in the previous sections up the chains of command. Also, recognising these benefits and achievements will also encourage innovators and frontrunners within the sector to highlight issues and new solutions.

Facilitating Discourse

The connections between planning, and more recently, drainage governance issues are vocalising the dissonance between traditional and current informal practices, and starting conversations around the need for more integrated water management approaches. These discussions need to be given a forum to develop a more formal debate around water management issues, future directions and subsequent management objectives, to feed into a more integrated and shared water policy agenda. Such a process should also aim to eventually open these discussions to public participation, to address the issues raised around the hydro-social contract.

Creating Space for innovation and learning

The resource scarcity of water is driving innovation in Perth. Similar to the discussion on governance experimentation, these activities need to be collected and the right questions asked to feed new information and learnings into both professional practice and the collective action level to change formal institutions.

Through this analysis and the opportunities described above, there are indications that Perth is in a learning phase of its development, as it comes to terms with a new operating context of drying climate. Therefore strategies and initiatives should be underscored by participatory principles including engendering mutual respect and knowledge exchange, clear boundaries and ground rules for participation, and clear expectations of outcomes. This will help to ensure that the professional and social learning needed for Perth to understand and accommodate its new operational environment can be created.

Missing Capacities in Perth's institutional dynamics

System Feedback Mechanisms.

Establishing formal monitoring and reporting obligations would be an important step to support inter & intra-organisational relations, transparently circulating information and generating new knowledge. These feedback mechanisms would need to measure progress and performance indicators, not simply focus on water services delivery compliance. The monitoring and reporting would also need to be transparently and sensitively conducted. Informal mechanisms should also be encouraged to boost sharing and professional discussion of information across the sector, so common interpretations and understandings of feedback produce new cognitive and normative informal institutions. These activities would create a capacity for the sector to respond to feedback in a more timely, coordinated and effective way.

Appropriate incentives and disincentives for actors

Understanding what motivates actors and why certain courses of action are routinely chosen will reveal some of the perverse incentives that are resulting in the maintaining dynamics observed in this research. This could help identify where incentives for leadership and innovative practice can be created to encourage actors to be creative and disruptive, and create a culture of continuous improvement across the sector.

Inter-organisational connections at different levels.

Lack of inter-organisational relations slows the building of adaptive capacity, as trust and collaborative relationships are needed to cope with and accommodate uncertainty and change. Investing in better information management and access, stakeholder engagement skills training, and smaller-scale demonstration projects with governance experimentation, offer opportunities to build such relationships in small but systemic ways.

It is also important to foster connections between operational and collective-action levels of institutional activity. Creating forums for two-way information exchange between actors operating at these levels will build professional knowledge, skills and capacity, and generate greater strategic support. It will also build confidence in information and expertise between different types of knowledge holders (technical, strategic, scientific, decision-making) and generate better consensus on what best practice water management and governance should be for Perth. This will help to generate creative/disruptive dynamics at the collective action level.

Professional discourse to develop shared cognitive and normative understandings

Shared beliefs and aspirations construct identities, normative associations, and cooperative networks among diverse actors. These understandings and collaborative relationships provide the basis for creating and legitimising new institutions. Facilitated opportunities to reflect on professional practice and personal beliefs, moral associations and aspirations, are needed to generate these deeper learning processes, agree on objectives and targets, and align the sector toward common goals. Eventually, such a dialogue should be expanded to a more public discourse on a vision for Perth in the future. In this way, the hydro-social contract can be renegotiated and create more realistic performance criteria for Government to be judged by. However, basic shared understandings and framings of current urban water challenges need to be developed within the sector, to create a clear, consolidated and robust message behind this kind of public engagement process.

5. Next steps

This report has looked exclusively at the institutional dynamics present in the Perth case. It has highlighted the types of dynamics that were uncovered in significant domains of the institutional setting, and their effect on how the urban water sector is operating. The analysis identifies some opportunities where existing institutional attributes can be developed and strengthened to balance the effect of Perth's predominant maintaining institutional dynamics. However, the results presented here are, as yet, unable to offer concrete suggestions on what the key institutional attributes and supporting dynamics are for generating adaptive capacity, and what rules-in-use might create such dynamics in the Perth context. This knowledge will be generated during the last phase of this research, when the comparative analysis of all three cases (Perth, Adelaide and Brisbane) will show patterns of these dynamics, what rules-in-use and contextual factors underscore them, and what overall effect these attributes have on the practice of water management.

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Department of **Water**

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Appendix A: Research Design

This section presents a summary of the approach used to answer the question guiding this research: 'How can urban water governance regimes more effectively support institutional adaptive capacity to enable and expedite a shift toward sustainable urban water management?'

Overall Design

In order to explore institutional dynamics and how they might create adaptive capacity, an *in situ* method was essential, as the research subject (institutions) exist in day-to-day work practices and interactions of people. A multiple case design was chosen so that institutional dynamics could be explored within the context of real-world cases, and compared between cases for generalisability of the results. The urban water sectors of a number of Australian state capital cities were chosen as potential cases, as they had all been subject to significant change to their operating conditions as a result of the 'Millennium' drought[v]. The combination of traditional and innovative solutions that were employed to cope with the reduced water availability suggested there would be significant and observable dynamics at play within the institutional setting, allowing the implementation of both accepted and alternative options. Current centralised urban water systems are based on fundamentally different cognitive and normative associations (informal institutions) to alternative solutions, such as waste and stormwater recycling, demand management, and managed aquifer recharge. Thus the implementation of these alternatives and their different institutional underpinnings sit uncomfortably against the cognitive, normative and regulative institutions of traditional urban water management. As such, these cities provided a unique opportunity to explore institutional dynamics, as their institutional settings undergo processes of questioning, challenge and change to accommodate these new solutions.

Case Selection

According to multiple case study research method[5, 6], cases should be selected with some differing attributes in order to provide a rich basis for comparison, and to ensure any patterns observed can be separated, to some extent, from the contextual setting and provide generalisable findings. This research sought cases undergoing potentially different forms of institutional change, by differentiating the levels of institutional activity[vi] predominant in each case and included: 1.) 'Bottom-up' processes where institutional activities were predominant at the operational level of day-to-day water management decisions, 2.) 'Top-down' processes where institutional activities revolved around more formally imposed 'constitutional' reforms, and 3.) A hybrid process where a mix of both top-down and bottom-up activities were equivalently influential. These forms of institutional change guided case selection and provided analytical depth to the multiple case study design.

After initial scoping interviews with key practitioners in Perth, Adelaide, Brisbane, Melbourne, Sydney, and National water organisations, three cities were chosen. These cities offered the different forms of institutional change identified above, so that cross-case comparisons could reveal similarities, differences and patterns with significance. Importantly, the practitioners in the cities chosen were also engaged in the research, providing access to the source of the data; practitioner's experiential knowledge. Perth was chosen as a case of potential 'bottom-up' change, as niche activities in local governments, land developers and development authorities were cultivating alternative water management solutions in response to water scarcity. Adelaide was selected as a case of hybrid change, as new solutions had been

[v] The Millennium drought, as it has popularly come to be known, was a period of below average rainfall which began in mid 1970 in the west of the continent, and the late 1990's in the east. The eastern states experienced a return to 'average' conditions in 2009/2010, but the west has remained dry.

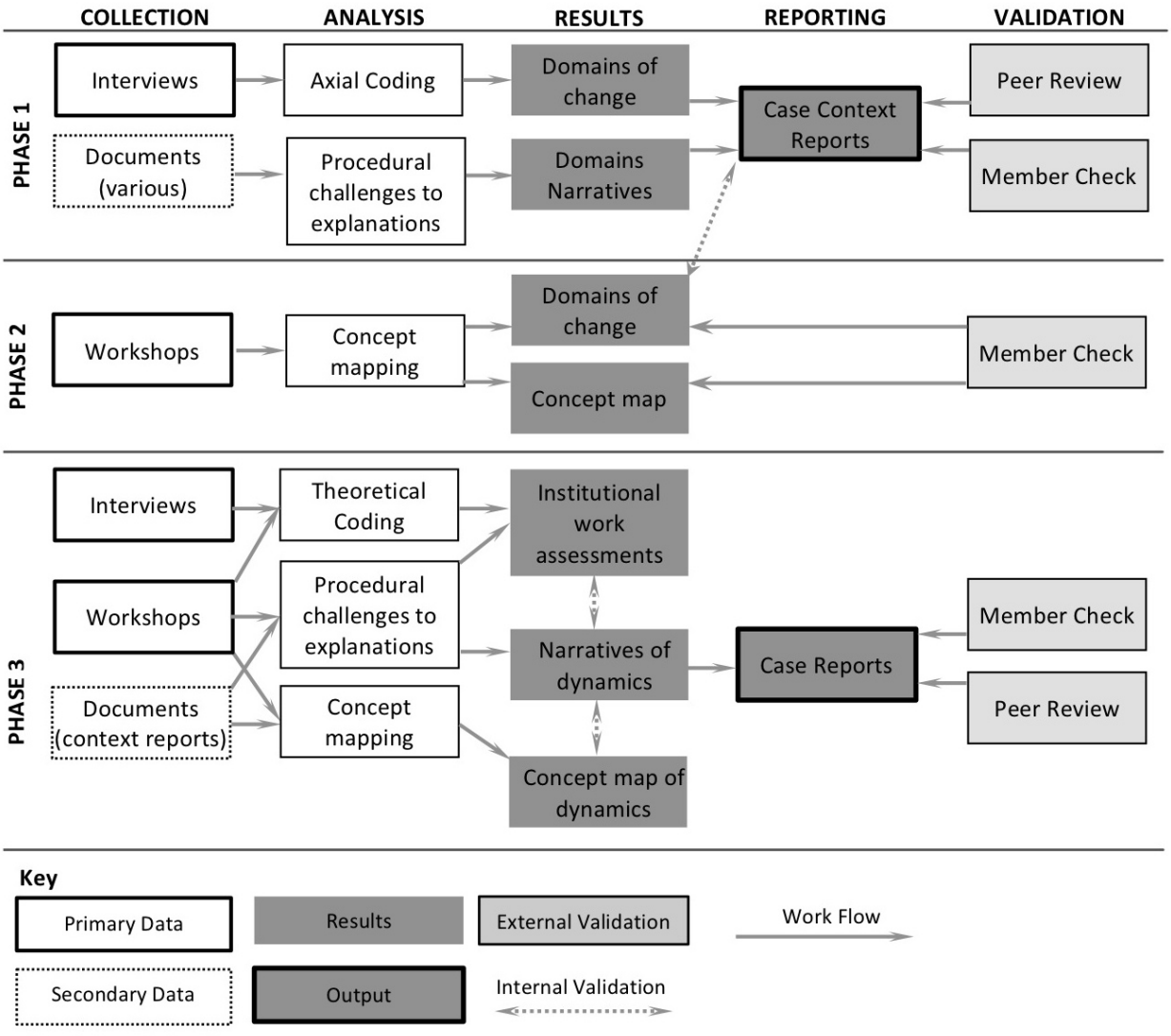
[vi] See 'Institutional Analysis and Development Framework on page 291 for an explanation of these levels.

developed and the legitimisation of these alternative practices in formal institutional reforms was underway. Brisbane was selected as a case to explore 'top-down' change, as formal institutional reforms had recently significantly restructured the urban water sector, and presented the opportunity to explore how these new formal arrangements were being translated into practice.

Methods

Figure 1 provides a schematic of the research processes. A short description of the purpose and process for each research phase illustrated is provided in the sections that follow. Throughout the research a number of validation techniques or 'built-in reality-checks' were employed to ensure the results are credible and dependable. External validation techniques involve seeking critique and elaboration from others, while internal validation occurs when similar results are produced through the analysis of different sets or sources of data. These are also shown in Figure 1.

Figure 1. Research Process



Phase One - Contextualising

This phase of the research sought to identify and contextualise the institutional changes occurring within each case. The question guiding this first phase was, 'What has been the management response to the drought, what other drivers are influencing urban water management practices, and what are the future challenges?

Information was collected through interviews with practitioners (n = 10), who had been working within Perth's urban water sector during the course of the drought. They were selected as being experts on water management in Perth, due to their long experience and/or varied roles within the sector. As a result, many interviewees were currently in management and executive roles. They included practitioners from State Government (water and public health) and local Government (water and planning), the Water Corporation, government authorities (natural resources management), research organisations, private consultants, developers and peak industry bodies.

Guiding questions were used in a semi-structured interview technique to identify (i) the management responses to the drying conditions, (ii) practitioner's thoughts on what some of the major changes had been, (iii) what had influenced that change and how it had come about, (iv) how the sector was performing under water scarcity, and (v) what the future challenges to the sector might be. These interviews were transcribed *ad verbatim*, and coded using a modified version of axial coding to make thematic connections in the data. A narrative about Perth's water management experiences was constructed and included the presentation of contrasting or conflicting storylines. These storylines were then compared to written records, policy documents, newsletters, research reports, journal papers, and media articles to look for corroborating and conflicting accounts, which were incorporated into the narratives. These narratives were written up into a case context report[vii], which was sent to key informants in Perth (n = 6, identified through the interview process) to provide external validation of the information.

Phase Two - Characterising

Phase two of the research sought to identify and characterise the institutional dynamics underscoring water management practices. This was achieved by ascertaining the 'rules-in-use'[viii] that describe the institutions structuring the urban water sector, and determining how these rules interacted to effect institutional change.

The data that informed this phase was gathered through a two-step process of workshops and interviews. Firstly, a workshop was designed to elicit the tacit knowledge of practitioners about their everyday practices, and what recurrent influences aid or hamper them. Participants (n=22) were asked, 'What influences your work?' and through self-reflection and group discussion, the rules-in-use that shape how the urban water section in Perth functions were identified and mapped to explore their connections and effects. These workshops were themed as 'supply and sewerage' and 'drainage and waterways' workshops, to group people working in similar areas within the sector, so participants could share and reflect on similar working conditions. Invitations were distributed broadly through a range of organisations involved in the water sector, so as to access a breadth of different experiences. Any participant who expressed an interest in sharing their experiences was able to attend. Secondly, the insights and key findings of these workshops were crosschecked in a separate round of semi-structured interviews with key informants (n = 9). These individuals were identified through the first phase of the research as having extensive knowledge of the Perth case, and had expressed a willingness to be further involved in the research. The purpose of these interviews was to test, expand and validate some of the initial insights into the institutional dynamics identified in the workshops, as an external validation technique (member checking). None of these interviewees had attended the focus groups, and therefore provided a fresh perspective on this data. Participants in this phase included practitioners from the Water Corporation, State government (water, public health and land use planning), the environmental protection authority, natural resource management agency, local government, private land developer, water technology company, consultants and local researchers.

[vii] A summary of the Perth Case Context Report is provided in Appendix C on page 294.

[viii] See 'Institutional Analysis and Development Framework' section on page 291 for a further explanation of these rules.

The rules-in-use identified in the workshops were combined using a conceptual mapping technique and a generic model of collective action[ix] to organise the data into a generalised map of the institutional dynamics influencing urban water management practice in Perth. The raw data from the workshops (participant reflections on post-it notes and observations recorded by the researcher during workshops or post-workshop in response to listening to recorded discussions) and the interviews (researcher's notes and post-interview reflections) were then coded using Institutional Work Theory[x] as a coding framework. This revealed the effect of the institutional dynamics in terms of whether they maintained, created or disrupted the current institutional setting. The results of this analysis revealed a number of domains within the institutional setting as having significant institutional dynamics (see Table 1 and 2 on pages 261 and 262). Comparing the analyses of workshop and interview data, which presented similar domains, provided an internal validation of the findings. Some of these domains also matched some of the contextual drivers identified through phase one of the research, signifying further internal validation of the results.

Phase Three - Comparing

The final phase of the research is yet to be conducted, but will bring the results of the case analyses of Perth, Brisbane and Adelaide together to compare and contrast results, looking for similarities and differences in their rules-in-use and institutional dynamics. It is anticipated that this analysis will reveal patterns of rules-in-use and institutional dynamics that produce particular aptitudes or attributes in the institutional setting, which suggest a capacity to adapt.

[ix] Refer to the 'Action Situation' section of Appendix B (page 291) for more information on this model.

[x] see Appendix B 'Institutional Work' on page 292 for further explanation of this theory and its relevance.

Appendix B: Analytical Lenses

This section presents a brief summary of the theories used in the research to collect, organise and interpret the data on institutional dynamics. Some of these theoretical concepts are important for understanding the research results.

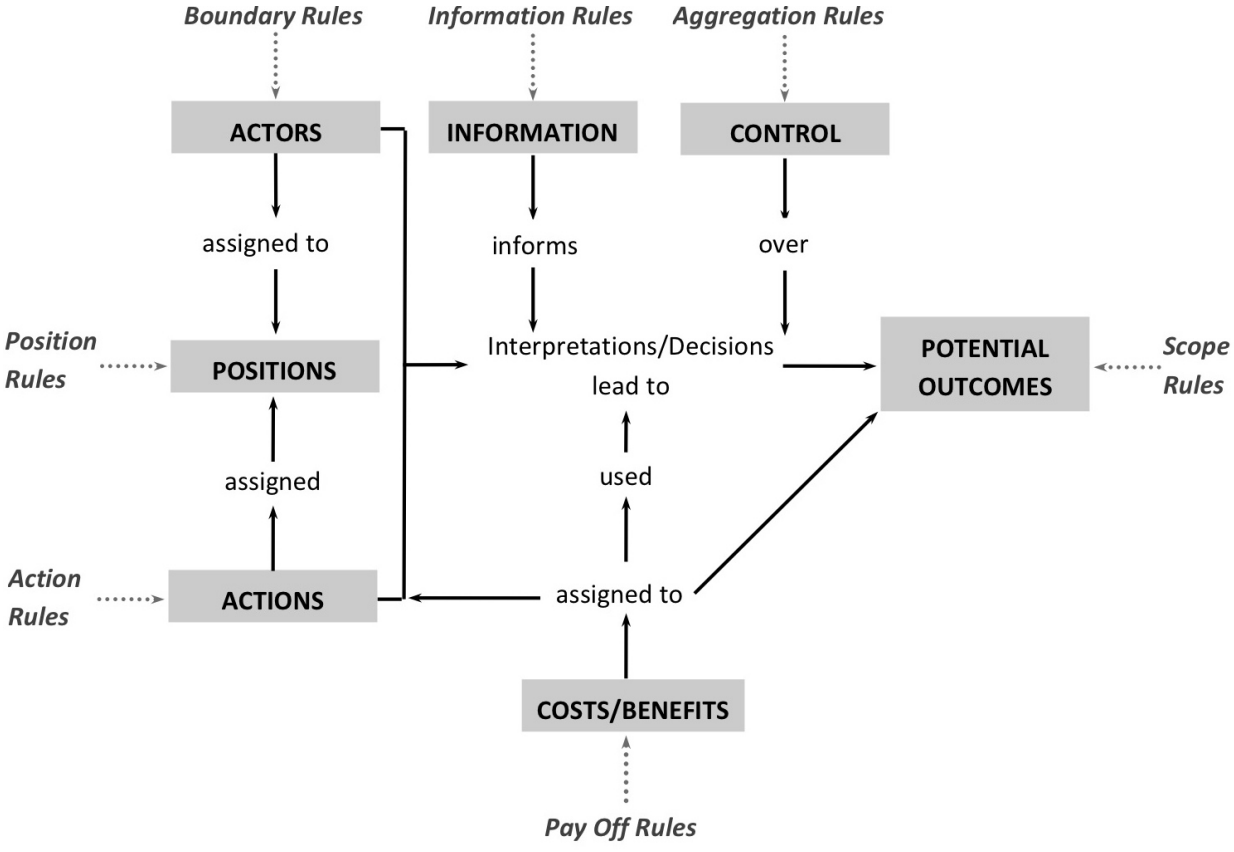
Institutional Analysis and Development Framework

The Institutional Analysis and Development (IAD) Framework [3], draws on game theory to understand the linkages between behaviour and action. It explains the social behaviours of actors embedded in diverse and complex environmental, macro-economic and socio-political settings. The IAD Framework achieves this by identifying the institutional structures within which actors operate, how these structures interact, and how actors may reinterpret these structures. In this way, the IAD Framework provides a dynamic explanation of how an institutional setting functions. This allows the research to go beneath the formally recognised regulations, legislation, and policy mechanisms, to identify the cognitive & behavioural norms that shape how these formal institutions are interpreted, and manifest into observed practice. Thus, for this research, the IAD Framework provides a dynamic way of conceptualising the urban water institutional setting. It provides a structure to organise data collection, to analyse the institutional rules identified, and to understand how they interact to produce fundamental change.

Action Situation

The IAD Framework's conceptual model of an 'action situation' depicts the setting where collective action takes place to solve a shared problem or achieve a common objective. In this research it describes the institutional setting of the urban water sector, the backdrop for the management of water in the urban landscape. By defining the components of this setting and the relationships between them, this conceptual model explains, in generic terms, the dynamics that are occurring to produce observed or potential outcomes (see Figure 2).

Figure 2. Action Situation of the IAD Framework. Adapted from Ostrom, 2005.

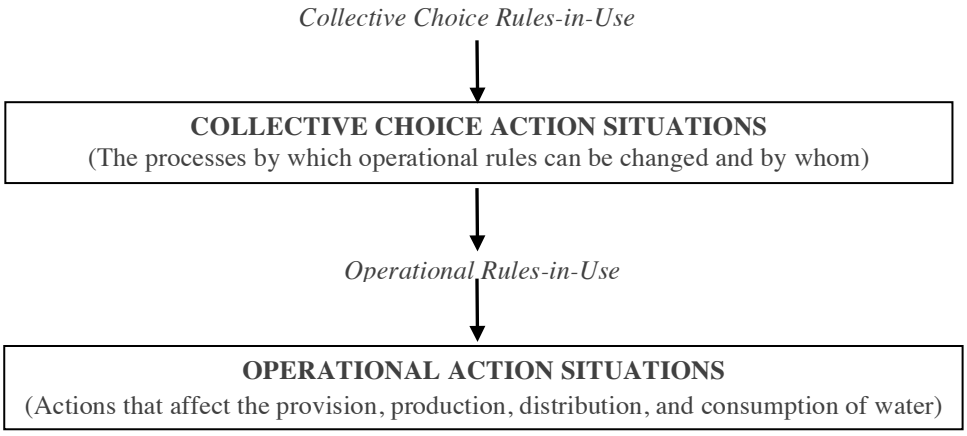


This model is dynamic because, it describes not only the process by which outcomes are produced, but also the characteristics, influences and interactions that can effect this process. These characteristics and relationships are described by 'rules-in-use;' the formal and informal institutions that structure the action situation. The interplay between these rules-in-use, and the interpretation and enacting of them by actors, determines how the action situation functions, going some way to explaining the institutional origins of the practices observed in reality. It is these rules-in-use that this research sought to identify, in order to understand, beyond formal legislation, policy, regulation, business plans and work programs, how the urban water sector is functioning, and the particular dynamics behind this.

Levels of Institutional Analysis

The IAD Framework offers another dimension with which to understand the dynamics of the institutional setting, by recognizing multiple levels of analysis. Sets of rules-in-use are nested within a hierarchy, where rules higher up the hierarchy determine how lower level rule sets can be changed, and who can be involved in this process (see Figure 3). These rule change processes provide the ability or capacity of the institutional setting to adapt.

Figure 3. Levels of Analysis of IAD Framework. Adapted from Ostrom, 2005.



Thus the IAD Framework provides a simple but robust way to describe the urban water institutional settings through the conceptual model, and the analytical power in the rules-in-use and their nested hierarchy, to describe the functional dynamics that lead to institutional change.

Institutional Work

Institutional work[4,7] is a developing branch of institutional theory focusing on the ways actors express their 'agency,' and the affects of this activity on the way an institutional setting functions. It is based on the premise that there are three types of institutional activity or 'work' that actors conduct; activities that serve to *maintain* current institutions, activities that *disrupt* the rules and order, and those activities that *create* new rules and structures.

Maintaining institutional work has received little study, as most institutional research has tended to focus on mechanisms to change institutions. However, activities that maintain institutions are critically important to the process of change, not only because they present barriers to changing inappropriate institutions, but because they can also incorporate changes into pre-existing routines and patterns, and engage and socialise new actors into the institutional setting. Some of these types of maintenance activities include:

- Policing: ensuring compliance through enforcement, monitoring and auditing,
- Deterring: Using coercion to discourage change,
- Valourising/Demonising: Providing positive and negative examples to exemplify the normative foundations of an institution,

- Mythologising: Preserving normative foundations by creating and sustaining traditions around an institution's history, and
- Routinising: embedding the cognitive and normative foundations of an institution into day-to-day practice.

Creative institutional work is about establishing new rules and new rewards and sanctions to enforce these rules. While the ultimate outcome of creative work is of a regulatory nature, there are significant normative and cognitive shifts which need to occur in the lead up to the establishment of new institutions. These activities generally develop in small, peripheral groups (networks), as they depend on cooperation to associate new practices with existing institutions. Some types of creative institutional work include:

- Advocacy: mobilising support for new ideas and rules,
- Constructing identities: defining new relationships of actors and their operating context,
- Changing normative associations: rethinking the connections between practices and the moral and cultural foundations of those practices,
- Mimicry: associating new practices with current practices to ease adoption,
- Theorizing: naming new concepts and practices, and developing new abstractions of cause and effect to build these new ideas into the 'cognitive map' of the field,
- Educating: teaching actors the new skills and knowledge needed to support a new institution.

Further empirical testing and development of institutional work theory is needed to build more comprehensive understanding of the activities within these different types of institutional work, and the combinations of activities that can create change (or inertia) in institutional settings. However, in this research, institutional work theory offers a way to characterise institutional dynamics and understand their effect on the overall functioning of the institutional setting.

Disruptive institutional work involves undermining the social controls that lead members to associate and comply with institutions. It may involve directly attacking compliance mechanisms of the institutional setting, or it may involve manipulating the boundaries of institutions by redefining, re-categorising, reconfiguring, abstracting and problematizing the cognitive or normative understandings of these boundaries. This work can be purposive, carried out by disenfranchised actors whose interests are not served by existing rules, but it can also be unintentional. Such processes of 'deinstitutionalisation' are not well understood, but are important for institutional change, because, in disrupting current institutions, these types of activities challenge their relevance, and open them up to review and reconfiguration. Disruptive institutional activities can include:

- Disconnecting the rewards and sanctions of current practice,
- Disassociating the moral foundations of current practice, and
- Undermining core assumptions and beliefs of current practice, by reducing the perceived risk of innovations and highlighting the new assumptions and beliefs behind them.

Appendix C: Case Context

This section presents the contemporary context of water management in Perth, compiled during an earlier phase of the research. This information provided a contextual understanding of the case in order to explain the results presented in this report. While there is no reliable overall account of Perth's water management experience over the last three decades of drying conditions, this section presents what was revealed in the narratives of interviewees. More detail on this contextual information is compiled in a separate document, the Perth Case Context Report, available from the author on request.

The results of a contextual analysis of Perth are summarised below in three sections; (1) the formal institutional arrangements for water management in Perth, (2) the management practices employed in response to the extended drought conditions, and (3) landscape factors or other broad drivers and influences which participants identified as having an effect on the urban water sector and/or water management practices.

Formal Institutional Arrangements

Like most Australian cities, Perth's urban water governance arrangements can be characterised as hierarchical and corporatized. The key actors in urban water management and their roles and responsibilities are described briefly below:

- **The Premier, Water and Planning Minister, Local Councillors**, have certain powers of delegation and approval/decision, to manage water or other activities relating to its management, on behalf of the people of Western Australia. Most of the Departments and Agencies listed below are answerable to the Ministers for Water, Environment and/or Planning. As final decision-makers influenced by their constituents, they have significant power and influence in water management activities, both directly and indirectly.
- **The Water Corporation**, a government owned corporation, responsible for supply, sewerage and some drainage services across most of the state.
- **Economic Regulation Authority**, licences and monitors compliance of the Water Corporation, and may conduct inquiries referred to it by the State Government.
- **The Department of Water**, created in 2006, is responsible for the overall management of water resources in the state, and its key responsibilities include water monitoring, allocation and licensing, policy for regulation and future planning, identification and assessment of new sources, and providing information and assistance to water users and government.
- **The Environmental Protection Authority** also plays a role in water regulation through its State Protection Policies, and responsibility to conduct Environmental Impact Assessments on major new source developments. It also has a role to provide strategic advice to Government.
- **Local Governments** are responsible for local drainage provision (in conjunction with Water Corporation, who manage the city's main drains) through local drainage infrastructure, and land use planning, approvals and management.
- **The Department of Planning** sets the land use planning policy framework through which this aspect of urban water management is governed, and most of the Departments and Agencies mentioned above have a referral role in the assessment and approval of new developments.
- **Land developers**, both private and government owned, have an integral role in designing and implementing water management infrastructure often in close collaboration with the Water Corporation, Local Government and Department of Water.
- **The Swan River Trust** is a government agency and caretaker of the Swan-Canning River system and foreshore (known as the Riverpark). It has a policy role in developing a river protection strategy and associated management plan, a facilitation role to work closely with local governments and other relevant agencies to coordinate activities under these, and a role as a statutory referral agency for development applications.

Management Practices

While successfully surviving three decades of significant water scarcity, Perth's response to secure water supplies has been largely focused on source development. Increased extraction of groundwater

and 'climate independent' desalination have provided new sources of water, while demand management and large-scale water recycling projects have also increased available supplies. While the rhetoric of Integrated Urban Water Management (IUWM) is used in Perth, implementation of this management paradigm has gone so far as integrating supply sources into the 'Integrated Water Supply Scheme,' and beginning to integrate water management planning into land development. Integration of water services to achieve economic, environmental and social outcomes, distributing fit-for-purpose water at multiple scales to meet these needs, and other dimensions of IUWM are not enabled by Perth's centralised urban water system. For example, while small-scale approaches have been developed to provide alternative water sources and/or means of supplementing central supply through on-site harvesting, treatment and recycling, these novel approaches are not mainstream water management approaches.

Landscape Factors

A variety of other broad scale contextual factors were identified by interview participants as having an influence on water management and the urban water sector in Perth, and these are identified summarised below.

Environment: the geomorphologic features of its environment, its soils and groundwater systems, largely define the management of Perth's water supply. However the changing climate is beginning to have a profound impact on Perth's urban water management practices and leading to significant shifts in approach.

Environmental Connection: There were mixed views on the extent of the Perth community's connection and engagement with water management issues. While engagement in water saving behaviours to secure human supplies was evident, there was a strong view that without recognition of a crisis it was difficult to get the community engaged in more complex issues. For example while research has shown that the Perth community assign intrinsic values to the Swan River[8], the understanding of the connection between river health and water supplies/availability may not be enough to generate sufficient socio-political drive for more sustainable water management approaches.

Realisation of Resource Scarcity: The Perth community's acknowledgement and acceptance of their water supply situation appears to have been delayed by protective strategies of government, and a lack of information on the issue in public discourse. An expectation that high quality water is readily available at low cost for universal use exists.

Hydro-Social Contract: This term encompasses the expectations of citizens surrounding the provision and use of water (as touched on above). Practitioners feel constrained by the performance criteria they are judged by under this 'contract,' which are based on social norms and community expectations that may no longer be realistic given the changed environmental conditions water managers are operating under. However, rather than working toward shifting these expectations, water managers employ strategies to try and meet these demands and avoid controversy. This sets water managers, and by-proxy governments, up for future failure, as the community's unrealistic criteria for judging performance remain unchanged.

Economic Development: Development pressures resulting from Western Australia's favourable economic climate, and the resulting development focus of Government priorities, are significant underlying influences on current water management practices. Participants talked of the prevalence of economic concerns in their day-to-day work, and suggested that this was leading to solutions that were potentially locking-in future users to inappropriate infrastructure, due to their current lower financial costs.

Water Policy Development: While there is Government policy around some aspects of water management, there is no umbrella policy agenda to provide the guidance and direction needed to streamline water management activities toward the achievement of clear overarching objectives. Without common strategic objectives and frameworks, water managers are unable to manage the

resource in conjunction with other managers. Without this alignment of activities inefficiencies are occurring, and the ability to plan strategically to look beyond current needs and address future challenges is also compromised.

Leadership: A lack of leadership is widely recognised in Perth, not only a result of difficulties in garnering political support for water issues, but also due to an absence in external championing of these issues, and a disconnection of efforts to strategically lever windows of opportunity when they arise.

Professional Capacity: Changing workforce demographics, professional 'cognitive-lock in,' distrust in new technologies and the science and information behind their development, and organisational cultures were some critical factors influencing the urban water workforce.

Niche Activities: Development of niches are known in the literature as one of the main pathways by which practice changes are fostered and eventually taken up as mainstream practice, altering formal institutions in the process. There are some niche activities in Perth, and some innovative projects outside the Perth metropolitan area, but they are disconnected and not yet forming the 'critical mass' needed to not only demonstrate but also promote more suitable water management practices.