

## **Water crisis and institutional adaptive capacity: Lessons from the Australian Experience.**

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### **ABSTRACT**

Managing large socio-technical urban water systems will be increasingly challenged under future extreme and uncertain climatic conditions. Reconfiguring these systems to meet this challenge by integrating supply sources and multiplying uses of water is well described from a technical perspective. Adjusting the institutions which frame the management of these systems, enabling adaptive governance of water resources, is not well operationalized. This study seeks to address this gap through an institutional analysis of the case of Perth, Australia, a city where extreme drought has driven the adoption of new management practices. The institutional dynamics underlying these changes were explored to gain insight into how adaptive capacity might be mobilised to implement Integrated Urban Water Management (IUWM). The study found Perth's institutional adaptive capacity, like other cities, is still largely limited. The new practices buffered water scarcity, but have not yet shifted the system toward a more adaptable configuration. The absence of certain rules within and between levels of the institutional setting which enable flexibility appear to leave conditions for ongoing adaptation unmet. This analysis suggests that to address the widely acknowledged failure of mainstream implementation of IUWM, a deeper understanding of institutional dynamics that create systemic change is needed.

### **KEYWORDS**

Institutional analysis, adaptive capacity, integrated urban water management.

### **INTRODUCTION**

Cities around the world are facing complex water management dilemmas driven by diverse, interrelated factors (Biswas and Tortajada, 2010; Brown and Farrelly, 2009). Population growth, ageing infrastructure, human and environmental health and increased frequency and severity of climatic extremes are increasing demand on urban water service performance. Such complex operating conditions have significant implications for the way water is managed, calling for greater integration of how it is supplied, sewage collected and treated and drainage infrastructure systems designed, built and operated. New management paradigms such as Integrated Urban Water Resources Management (IUWRM) seek integration of these operations and technologies through integration of knowledge, policy objectives and management practices to achieve holistic, multi-objective management outcomes (Mitchell, 2005). However these new approaches have not resolved the urban water management dilemma entirely (Biswas, 2008). Lack of successful implementation has led to a realization that incongruence between these new management paradigms and the underlying

rules, norms, beliefs and assumptions in the institutions responsible for setting the structure and directing management practice is the heart of the issue (Brown *et al*, 2009; Blomquist *et al*, 2004). '*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 functioning of the institutional setting is a key knowledge gap, and contemporary scholarship is drawing on the concept of adaptive management to explain and examine this gap (Engle, in press). It is argued that a deeper understanding of how a capacity to adapt can be instilled at the institutional level is needed in order to create the systemic change required to transition from traditional to integrated urban water management.

Institutions are socially constructed logics which provide shared meanings on which societies can make sense of their reality and act as a collective to address societal needs (Dovers, 2005). These shared meanings are manifest in values, expectations, norms and problem frames, and constitute the informal institutions that underlie the creation of formal rules, regulations and laws which serve as the formal institutions. Thus, consistent with much of the institutional theorists (see Scott, 2008), this study views the urban water institutional setting as a dynamic interplay between both formal and informal institutions, the outcome of which is the on-ground practice of managing urban water. Institutional adaptive capacity encompasses a duality of institutions acting as stabilizing structures in society, while also allowing societal needs and the practices that deliver them to be adjusted or adapted in response to change in the operating context. This emerging perspective is currently limited to discussion of institutional design principles focused on creating social learning as the primary mechanism of adaptive capacity (Gupta *et al*, 2010; Pahl-Wostl, 2009) and the call for the development of new conceptual tools to map, examine and manage processes of societal change (see Grin *et al*, 2010; Brown *et al*, 2009). It is now well recognised that the expansion of this work requires empirical studies on how institutions function to organise society with particular attention to how they adapt over time (Engle in press, Ostrom and Cox, 2010).

This study seeks to contribute insight into the functional ability of institutions in order to overcome the systemic challenges they pose. It is based on the proposition that in order to '*... peer inside the 'black box' of institutional processes and effects, to provide explanations of how institutions matter.*' (Blomquist *et al*, 2004: 927), a move beyond identification and discussion of barriers is needed. As such, by employing an adaptive capacity lens to explore and explain real world examples of institutions that are subject to pressures to adapt, a richer insight into how IUWM can be successfully implemented will result. Therefore this paper explores the institutional dynamics of the case of urban water management in Perth, Australia, that has recently been subject to extreme drought conditions, in an attempt to identify the potential conditions for enabling adaptive institutional capacity.

## **RESEARCH APPROACH**

This paper employs the case study approach of Yin (2009) to explore and develop insight into enabling adaptive institutional capacity in the urban water sector. The case is an institutional analysis of urban water, focused through the recent changes in management practice. The overall research project examines three Australian State capital cities (Perth, Brisbane and Adelaide) that have undergone significant practice changes in response to extended drought. Due to the scope of the paper only the Perth case is presented.

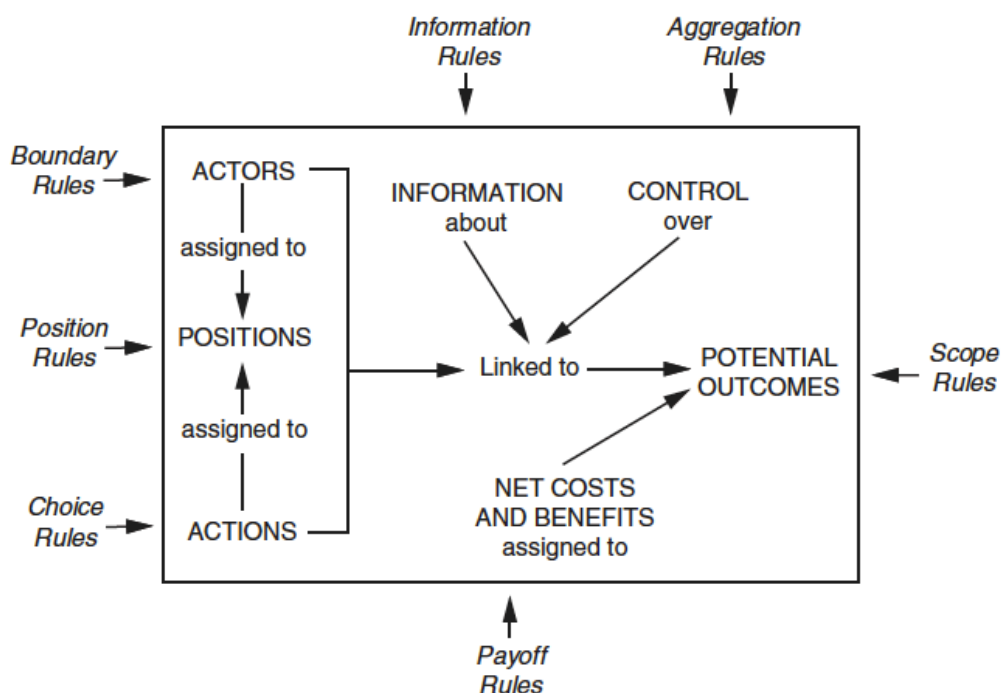
### Case Study Context

Below average rainfall since the mid 1970's, has created significant changes in operating conditions for supplying water to Perth citizens. Greater extraction from groundwater supplies, demand management, desalination, water trading, experiments with aquifer recharge schemes, and potential inter-regional transfers represent the progression of responses to secure water supplies. These practices represent significant adjustments in infrastructure and management approaches and are drawing from different philosophies for supplying water. Such different practices are unlikely to sit comfortably within current formal urban water institutions. Therefore, processes of adjustment are likely to be underway to create congruence between the new management practices, their informal institutional underpinnings and formal rules and regulations to legitimize their implementation. This case thus provides an opportune time to explore these processes of change and begin to identify the mechanisms and dynamics of institutional adaptive capacity.

### Analytical Framework

To qualitatively describe and characterize the institutional setting of Perth, the well established Institutional Analysis and Development (IAD) Framework was employed (Ostrom, 2005). It is a conceptual model of an Action Situation (Figure 1) that provides a means to describe and map the institutional setting, through which a societal problem, such as the provision urban water services, is collectively solved. The Framework identifies a series of components that interact to produce a potential outcome, or solution to the problem. These components include actors, the positions they inhabit, the actions they can chose from, inputs in the form of information and cost/benefits assessments, and the level of control actors have over the action situation, determined by the extent to which other actors have an influence over the action situation. These components are influenced by a series of working rules, which determine how the components can behave in the action situation, and are defined in Table 1.

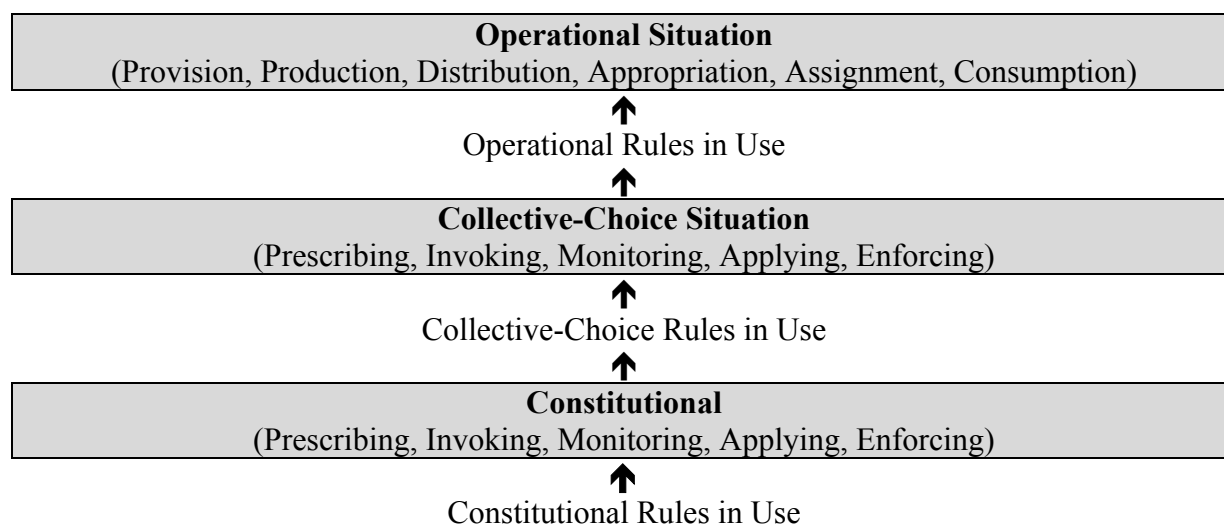
**Figure 1.** Action Situation of the Institutional Analysis and Development Framework. Reproduced from Ostrom, 2005.



**Table 1.** Working rules summarized from Ostrom, 2005.

<b>Rule</b>	<b>Influence on Action Situation Component</b>
<b>Boundary</b>	Define eligibility, selection and departure process to/from a positions
<b>Position</b>	Set the 'slots' that can be inhabited and 'hold' specific actions
<b>Choice</b>	Determine the range of actions (must, may, mustn't) and what should inform their selection.
<b>Information</b>	Set level of information available to participants
<b>Aggregation</b>	Set which positions are involved in certain actions.
<b>Scope</b>	Set the desirable, or non-desirable outcomes which can be achieved
<b>Pay-off</b>	Assign rewards and sanctions for particular actions

The IAD Framework also distinguishes between three nested levels of institutional activity. The Operational level is concerned with the day-to-day decisions that directly effect the management of water. The Collective level of analysis determines how rules governing the Operational level of activity may be changed, and by who. The Constitutional level sets up the rules which craft the activities at the Collective level and who is involved. This is illustrated in Figure 2.

**Figure 2.** Nested levels of Institutional Analysis. Adapted from Ostrom, 2005

While it is not clear in the IAD Framework exactly how these nested levels of institutional analysis and working rules fit to conceptually model the action situation, this research assumes that three action situations, their components and working rule configurations, can be used to describe the 'rules in use' between each level of institutional activity. This gives the Framework the ability to capture the ways in which the institutional setting operates in reality, which may not match with how it is deemed to operate in formal documentation. This analytical framing offers the ability to examine how the institutional setting is functioning, by describing dynamic interactions between components and between analysis levels, via the configuration and inter-linkages of working rules, thus providing the architecture to explore institutional adaptive capacity.

## Methods and Data Analysis

The study began with conducting and transcribing ten semi-structured interviews with professionals with five or more years experience in a range of roles in Perth's urban water sector. Interviews sought narratives of change, from which the elements for the IAD Framework could be drawn. Working rules and levels of analysis were identified and coded, so that the configuration of the action situation at each level of the institutional setting could be ascertained from the practitioner's reflections. A construction of the institutional setting at the three analysis levels, and its functional configuration in the working rules could then be derived from the data. This interpretation of the institutional setting was then peer reviewed in an iterative process through three focus groups with urban water professionals from local and state government (water, environment, planning and health areas), the water utility, statutory authorities, land developers, private consultants and peak industry bodies, and nine further semi-structured interviews with professional working at a more strategic/political level.

## RESULTS AND DISCUSSION

The configuration of working rules and how they interact to determine the functioning of the operational setting are summarized in Table 2.

**Table 2.** Operational Analysis Level Results

<b>Rule Type</b>	<b>Summary</b>	<b>Example Quotes</b>
<b>BOUNDARY</b>	Absent as Positions are clearly assigned to specific Actors. Process and sanctions for leaving a Position are largely undefined	<i>'has such a stronghold on the wastewater source and supply and systems'</i>
<b>POSITION</b>	Clearly assigned to specific Actors and closely tied to achieving specific Outcomes.	<i>'You've got one big agency here which is controlling the way water is supplied'</i>
<b>CHOICE</b>	Determine what Actors in Positions 'must' or 'mustn't' do. Rules to guide what should be considered are limited.	<i>'that serves the purpose for which it was built, and that's what we're paid to maintain and that's what we'll do.'</i>
<b>INFORMATION</b>	Lack of rules to provide some Positions with the information to make well informed decisions.	<i>'still hold all the information that will help people actually really work out what the cost-benefit is of these alternative sources of water.'</i>
<b>AGGREGATION</b>	Not always clearly defined. Some have been set around routine processes, little recognition of crosscutting roles and responsibilities.	<i>'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?'</i>
<b>PAY-OFF</b>	Rules identify sanctions for taking 'mustn't' Actions. Sanctions for failing to take a 'must' Action, or for Actors choosing to withdraw from a Position are absent, as are rules that assign rewards.	<i>'Where's the benefit of the developer actually recharging this water and then being able to use it? There's no incentive that allows that at the moment.'</i>
<b>SCOPE</b>	Prescribe Outcomes to Positions focused on service delivery functions.	<i>'We do the drains...the pipes... the treatment...it mainly deals with licensing ...planning ...water management.'</i>

This description of the operational level of the institutional setting begins to offer insights into how Perth's urban water management practices are positioned to adapt in the face of changing climate. With explicit roles and responsibilities, evident in clear scope, position and choice rules, an outcome of secure supply has been very successfully achieved. This is evidenced by the progressive diversification of water sources, from a greater reliance on groundwater to desalination, water trading, piloting of sewer recycling to recharge aquifers, and the consideration of inter-regional transfers. Also, while demand management has been producing water saving as a new 'source' to supplement supply, water restrictions have not been utilized to the same extent as other Australian cities. This is suggestive of resilience to scarcity, where the institutional setting has produced management responses to buffer the experience of shortages, but has not changed the management practices and societal expectations to match operating conditions more appropriately. The analysis of operational rule configurations reveals that there is little activity at this level to produce innovative responses due to:

- Narrow scope rules defining potential outcomes,
- Outcomes linked to single positions to deliver, and
- Imbalance of pay-off rules towards sanctioning undesirable outcomes.

For example, many interviewees acknowledged third pipe systems as potentially viable options, but indicated that without greater certainty around risk management and cost of these systems instilled at higher institutional levels, such alternatives would not be considered viable. Despite this, a number of private land developers are installing these systems, as the pay-off rules of doing so provide a competitive angle to differentiate themselves in a new market niche. This innovative practice change in the private sector is not influencing broader uptake, because boundary and aggregation rules functioning at the operational level of institutions prevent these actors from gaining a position or influencing the control component in the action situation.

Narrow scope rules, paucity of choice and pay-off rules to compel actors to move beyond their designated positions and choices to act more collaboratively and achieve joint, integrated outcomes, is also leading to a lack of uptake of alternatives. Such institutional conditions stifle innovation and silo water management practices, leading to duplication of effort and loss of efficiency. It is also leading to a lack of action to address emergent cross-cutting issues. Management of water quality in the delivery of drainage services is the prime example in this case. In terms of the working rule configuration:

- Boundary rules leave the position of drainage manager open to many actors,
- Lack of sanctioning pay-off rules leave drainage the responsibility of no one,
- Choice rules in terms of who has the ability to act through access to the infrastructure are split between actors,
- Disparities between actors positions in drainage management, their assigned choices, and their ability to influence the choices of others through aggregation rules, and
- No recognition in scope rules to converge the efforts at play within the action situation into a common outcome to address drainage management and water quality together.

Through this rule configuration, a potentially significant alternative water source in stormwater is left largely uninvestigated, and the operational institutional level largely unable to consider this opportunity.

Overall, the functioning of the operational institutional level has resulted in a level of resilience to buffer Perth against its persistent dry conditions. However, limits in terms of availability of new sources and their cost implications are beginning to exert pressure for new

strategies for water management and reassessment of the preferred outcomes. The functioning of some rule configurations described above does not appear conducive to an innovative shift in practices at the operational level. However, given the role of the collective-choice level is to monitor and amend operational rules, it seems more likely that a capacity to adjust the operational performance to produce more appropriate outcomes should rest at this level of the analysis. The implications of gaps in Perth's operational institutional setting, and the opportunities for achieving adaptive capacity through the collective-choice and constitutional levels will now be discussed. Due to the need for brevity, the results of the analysis designating the full rule configurations for these levels cannot be presented here.

The lack of rules at the operational level to prompt shifts in traditional practices may be remedied if activities at the collective level of the institution are set up to drive and structure actions to assess, evaluate and where necessary alter operational rules. The analysis at the operational level suggests that scope rules setting a holistic vision for water management outcomes, to focus the actions of actors when working beyond their operational level outcomes, would be a key requirement. A number of key rule configurations would also be needed to legitimise and structure the activities at the collective level:

- Formally recognized actions assigned to positions to designate responsibility and authority to alter the operational rules would clearly be necessary.
- Similarly, aggregation rules would need to be clearly articulated to ensure collective actions are not circumnavigated or co-opted by other actors.
- Appropriate pay-off rules may also be needed to encourage appropriate actors to act at this level of the institutional setting.

At the constitutional level, scope rules would also be critical in articulating broader objectives of urban water management to promulgate cross-overs with other sectors, such as energy. As actors are largely crafted into existence at this level (statutory authorities, departments, government owned corporations) careful consideration as to the positions and choices set up at this level and how they flow through to influence rules at the lower levels would be critical. Particularly in terms of aggregation rules, which would appear to carry this influence between levels to a large extent, but also pay-off rules which may exist latently at the collective level but come into operation at the lower levels of the institutional setting. This suggests that conducive rule configurations, which operate across institutional levels to provide feedback and facilitate smooth transitions by aligning the efforts and activities, will also be an important dynamic of institutional adaptive capacity.

## **CONCLUSION**

Initial application of the IAD Framework to this case has revealed a number of preliminary insights into institutional adaptive capacity. Thus far Perth's institution setting, with its strength in clearly defined operational level rules has served well to manage a secure supply through drought. However, some rule configurations suggest gaps in the capacity to adapt which will need to be addressed at higher levels of the institutional setting to enable a shift toward IUWM, in order to cope with the expected future dry conditions. More work is yet to be done to broaden and deepen these initial results through cross-case comparisons. However, the identification of these gaps in rule configurations, and the need for configurations that span across the institutional levels, offers an explanation as to why efforts to reform urban water management through 'integrated' approaches have only been partially successful. By only seeking to influence scope rules, these new management paradigms have not been wholly successful at creating fundamental change in the institutional setting and it's

functioning. The results from the case of Perth strongly suggest that more attention paid to the working rule configurations, and particularly the interplay between those which cut across institutional levels, will be crucial for the creation of institutional settings with the capacity to integrate and adapt the management of urban water resources.

## ACKNOWLEDGEMENTS

Thanks go to the Western Australian Department of Water for their funding and support for this research, and the participants of the study.

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