The transition towards water sensitive urban design : a socio-technical analysis of Melbourne, Australia

La transition vers une gestion plus intégrée de l'eau en milieu urbain: une analyse socio-technique de Melbourne, *Australie.*

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RESUME

L'objectif de ce travail de recherche est de déterminer les qualités de transitions socio-techniques qui doivent être mises en oeuvre pour appliquer une conception urbaine prenant l'eau en compte (WSUD). Cet article donne les résultats d'une recherche sociale qualitative destinée à cartographier l'institutionnalisation de la WSUD dans la zone urbaine de Melbourne, Australie. Les résultats montrent qu'il est essentiel de promouvoir le développement d'un capital social pour la protection des voies hydrologiques et de groupes coordonnés de chefs de file locaux dans les domaines scientifiques, politiques et privés pour favoriser des « créneaux » de processus de transition. Ces « créneaux » doivent recevoir le soutien de mécanismes y compris l'établissement d'organisations passerelles, de cibles politiques scientifiquement informées, d'opportunités de financement stratégique, et la démonstration d'un cas économique pour le WSUD.

ABSTRACT

This research is focused on determining the social-technical transition qualities that need to be enabled to mainstream 'water sensitive urban design' (WSUD) across urban regions. Reported in this paper are the outcomes of qualitative social research that attempts to map the institutionalisation of WSUD, so far, across Metropolitan Melbourne, Australia. The results reveal that fostering the development of social capital for waterway protection, as well as a coordinated group of local champions across the science, policy and private domains are essential for enabling 'Niche' transition processes. The 'Niche' needs to be supported by mechanisms including the establishment of bridging organisations, scientifically informed policy targets, strategic funding opportunities, and the demonstration of a business case for WSUD.

KEYWORDS

Socio-technical institutional change, transition analysis.

1 INTRODUCTION

Worldwide, urban water managers typically face the challenges of addressing waterway health vulnerabilities, water supply limitations and providing flood protection. It is now well accepted that these issues cannot be adequately addressed by the traditional urban water development approach. In response, new thinking such as the Australian innovation of Water Sensitive Urban Design (WSUD) has become prominent across Australia, and is increasing internationally. The focus of this paper is a case-study examination of the institutionalisation of WSUD across Metropolitan Melbourne, Australia.

As set out by Wong (2006a), WSUD reflects a new paradigm in the planning and design of urban environments that is 'sensitive' to the issues of water sustainability and environmental protection. The phrase '*water sensitive'* defines new thinking around 'integrated urban water management' (IUWM). Through innovative urban design, WSUD ensures that water is given due prominence within the urban design process by 1) reintroducing the aesthetic and intrinsic values of waterways back into the urban landscape, and 2) promoting new forms of architecture within the built environment that allows for IUWM initiatives (see Wong, 2006b).

One of the most significant challenges facing urban water managers and policy makers today is the shortage of reliable knowledge and guidance on how to effectively institutionalise, and therefore mainstream, the WSUD approach (Brown et al., 2005; Saleth and Dinar, 2005). This paper attempts to contribute to this critical knowledge gap through a socio-technical analysis of the stormwater quality management dimension of WSUD across Melbourne.

Metropolitan Melbourne is located on Port Phillip Bay, and is the second largest of the Australian cities hosting a population of over 3.5 million people. Unlike many European systems, Melbourne's stormwater system is separate from the wastewater system and typically discharges stormwater to local urban waterways rather than wastewater treatment plants. Over the last 15-20 years, urban stormwater has been recognised as a significant source of pollution in Melbourne's most iconic waterways, triggering a range of responses from community groups, the media and government to achieve improved quality and protection of these waterways.

Melbourne was selected as a case study as it is often informally identified as a leading city in urban stormwater quality management. It is also relatively representative of the pressures typically faced by modern cities today, including rapid population growth; decreasing household occupancy ratios; ageing infrastructure; water supply stress; and degraded waterway health. The city stands apart from others because of its concerted attention to advancing WSUD over the last 15 years. This has resulted in the introduction of significant regulatory requirements for development practices to meet stormwater quality targets, as well as innovative market-based reforms that encourage developers and local government authorities to more efficiently participate in WSUD through an offsets scheme. These case study insights may prove useful for other cities seeking to mainstream the WSUD approach.

Therefore, a core question is – *What are the key social-technical transition qualities that have enabled the institutionalisation of WSUD across Melbourne so far?*

2 THE TRANSITION CHALLENGE

To date, numerous commentators have suggested that progress towards the widespread practice of WSUD (and IUWM) has, at best, been slow. Some of the impediments to change appear to include insufficient skills and knowledge, organisational resistance, lack of political will, limited regulatory incentives, and

unsuitable institutional arrangements (see for example; Brown, 2005; Mitchell, 2005; Saleth and Dinar, 2005; Wong, 2006b). Researchers that specialise in observing the social dimension of large technical systems typically consider that impediments such as these are to be expected when attempting to advance significant programs of change such as WSUD (see, for example, Walker 2000). This is because large technical systems, such as drainage, water supply and wastewater systems are physical representations of historical and deeply embedded administrative, political and economic values. These values, and the associated historical decisions around how they should be functionally expressed within technology and institutional frameworks, collectively reinforce the status quo as a stable pattern of practice which is very difficult to change (Moss, 2000; Walker, 2000).

In addressing these impediments, the more obvious requirement is for the development of new technologies and associated implementation processes. However, it is the proposition of this paper that there is a strong need to change the underpinning institutional values that support the day-to-day practice of urban water management if WSUD is to be mainstreamed. Perhaps at the heart of the issue is the need to substantially improve the power of the institutional value of 'environmental protection', so it is considered with equal prominence to the much-longer established institutional values of water supply security, public health protection and economic efficiency within current decision and policy-making processes.

It is now reasonably well accepted that unless new technologies are socially embedded into the institutional context, their development in isolation is insufficient to ensure their successful implementation in mainstream practice (Brown 2005; Elzen and Wieczorek, 2005). Therefore, to help address the current impediments to the WSUD transition, contemporary research must consider both the technical and social dimensions of systems, and understand that they are co-dependent elements within a 'socio-technical system' (see Geels 2004, for an in-depth explanation). Understanding socio-technical change requires an interdisciplinary and integrated perspective, which has recently emerged within a somewhat loosely coordinated scholarship focusing on sustainability and socio-technical systems (see Berkhout et al., 2004).

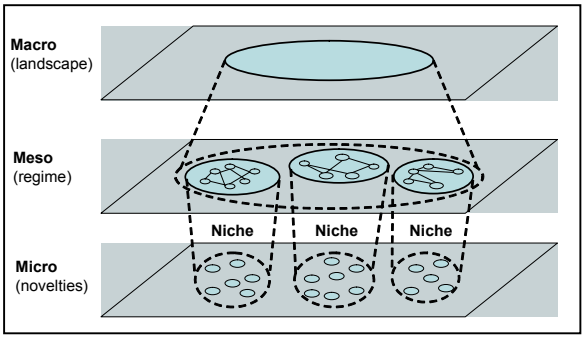

Figure 1: Multi-Level Perspective as a nested hierarchy (Adapted from Geels, 2002).

The Multi-Level Perspective (MLP) is a socio-technical research model that provides a useful framework for describing the co-relationship between technical and socio-institutional change over time (Rip and Kemp, 1998). It is increasingly being adapted as a tool to communicate the complexity of socio-technical systems and their transitions (Geels, 2002). As shown in Figure 1, the MLP represents a nested hierarchy of three levels of social structure within which change occurs, including:

- *Macro level:* this is the broader societal system in which changes in dominant cultures and ideologies (such as globalisation and environmentalism) occur, as

well as changes in the large material systems that support society (such as the infrastructural and spatial arrangement of cities, highways and water systems).

- *Meso level:* here, change occurs within the institutional regimes that provide structure and coordination across sectoral areas (such as water, transport and health) through formal and informal systems and rules. The organisations that collectively structure the institution of urban water management typically include water authorities, regulators, state policy makers, local government agencies, land developers, consulting organisations, academic institutions, community groups and professional bodies.
- *Micro level:* change occurs at the technical or product development level where innovations that are differentiated from the status quo are developed. Examples of these include the recent innovation of sewer mining technologies, and the innovation of stormwater gross pollutant traps in the early 1990s.

Socio-technical research is currently demonstrating the importance of 'Niche' formation and management in the process of enabling a system-wide transition across the entire MLP which would enable a new paradigm of social practice, such as WSUD. A *Niche*, as shown in Figure 1, develops when there is sufficient momentum and mutually reinforcing change within the existing *Micro* and *Meso* levels supporting alternative thinking and practice (such as wastewater recycling and reuse, or hydrogen fuel cell technology). Niches act as incubation rooms for learning by coordinating new social networks at the Meso level, and facilitating improved legitimacy for new practices through supporting technological development and refinement at the Micro level. Through providing a 'protective space' for dedicated experimentation or 'learning by doing', the Niche shields this alternative thinking and practice from the existing mainstream market forces.

A system-wide transition is thought to occur when the: 1) the values and thinking construct of the Niche are sufficiently stabilised; 2) these are then diffused across the Meso level; and 3) the three levels of social practice (i.e the Macro, Meso and Micro levels) evolve to mutually reinforce the Niche as the new mainstream practice.

3 RESEARCH APPROACH & METHODS

The research is based on the qualitative case study method (Yin, 1994), with adopting the MLP as the conceptual basis for framing the historical analysis. The research drew on multiple sources of evidence and the primary data was collected through recording oral histories from 28 expert interviewees across multiple sectors, reviewing key organisational and policy documents and facilitating a range of scientist and industry-based focus groups. This data was cross-referenced with secondary sources including associated historical policy, media, organisational and other forms of industry literature, in addition to existing scientific literature in the field.

As is typical of qualitative research approaches, the primary data synthesis technique involved actively seeking contradictory evidence from different sources to emerging hypothesis and explanations, leading to continuous reanalysis and refinement. External validity testing involved key informants across Melbourne, representing government, consultants, land developers and academia participating in: 1) a review and critique of the findings of the draft case study report, and 2) a case study validation workshop with over 40 key academic and industry experts in the field.

4 RESULTS: SOCIO-TECHNICAL TRANSITION PHASES

Four transition phases were identified as characterising the socio-technical change processes and institutionalisation of WSUD across Melbourne to date. These phases are presented in the following sub-sections (and detailed in Brown and Clarke 2007).

4.1 Macro Level Shift: 1965-1989

This phase marks a Macro-level shift within in the socio-political landscape providing for background mobilising context for the WSUD transition. Key enabling themes include: changing social capital; the emergence of environmental science programs; strategic government funding; and new waterway health policies.

During this phase, there was an important shift in local social capital towards the city's waterways, which mutually stimulated and reinforced significant media activism in relation to improving Melbourne's waterways. There were many drivers for this, including an unsuccessful proposal for a wastewater outfall to be constructed at Port Phillip Bay and high levels of concern with the degradation of urban waterways. This grass-roots activism enabled broad questioning of the validity of the traditional waterway management approach and revealed how the waterway values of passive recreation, amenity and ecological integrity were being compromised.

The formalisation of environmental scientific knowledge was also critical during this period, as evidenced by the emergence of a growing freshwater science community at the local universities focusing on waterway health and new investment in environmental studies of Port Phillip Bay. The introduction of an environmental legislative framework in 1970 created the space for subsequent waterway protection policies. Towards the end of this period, there were a number of strategic government funding opportunities which were invested in developing a bicycle and trail network around Melbourne's iconic urban waterways, which further improved social capital for protecting waterways for a range of beneficial outcomes.

It is important to note that in this phase urban stormwater runoff is still implicitly treated as environmentally benign, which is widely challenged in the next phase.

4.2 Micro and Meso Response: 1990-1995

This phase marks the formation of a new 'bridging organisation' (see Folke et al., 2005) within the existing Meso-level and tracks a growing number of developments in new WSUD technologies at the Micro-level, in response to the previous phase. This phase fostered the development of a new and common understanding about the urban water problem among key industry champions within the field.

The procurement of a cooperative research centre (CRC) facilitated the development of a bridging organisation, largely between local universities and Melbourne Water, the regional drainage authority. The CRC was seeded by a national priority to develop partnerships between industry and research institutions. Melbourne Water clearly identified urban water and hydrology concerns as a major knowledge gap that needed to be addressed. This bridging organisation led to the formation of new and mutually beneficial relationships (which are highly active today) between local scientists and managers, allowing for the innovative bridging of emerging scientific and policy work.

Simultaneously there were numerous examples of attempts at developing stormwater quality management technologies, such as wetlands and gross pollutant traps, within the market place. Land developers, and others, clearly identified that communities wanted aesthetically pleasing and robust waterways, which then influenced the priorities of their developments. In response, CRC scientists took on the role of investigating and developing these technologies for more reliable industry adoption.

In addition, during this period a large scientific study was commissioned by Melbourne Water to determine the health of Port Phillip Bay and inform what actions were necessary to protect it. The outcomes revealed that nutrients from stormwater runoff and wastewater plant effluent were the major threats, leading to the establishment of an important policy target of reducing the annual nitrogen inputs to the Bay from catchment sources by 500 tonnes from 1993 levels.

4.3 Niche Development: 1996-1999

This phase witnessed the formation of the WSUD Niche with the establishment of a nitrogen reduction target and expansion of the existing bridging organisation to actively include land developers, planners and local government. Perhaps the best way to characterise this period is a series of frenzied and interconnected activities being initiated, tested and implemented to advance the practice WSUD.

Local champions associated with the Niche opportunistically approached a National program for additional funding for building urban wetlands to reduce nitrogen loads entering Port Phillip Bay. This proposal was successful, with Melbourne Water being a joint funder for the construction and monitoring of 10 separate wetlands over three years, thus improving industry confidence and receptivity to WSUD initiatives.

Through the process of developing the *Best Practice Environmental Management Guidelines for Urban Stormwater* a range of practical, achievable and measurable targets to help implementers achieve the new nitrogen reduction targets were established as an industry benchmark and linked to relevant policies. This process also facilitated further consensus around the understanding of 'best practice' and the need to prioritise urban stormwater quality management.

A large-scale and scientifically rigorous demonstration of WSUD treatment train technologies (Wong, 2006b) was a clear example of the outcomes of the expanded organisational partnerships. Key actions associated with this project included the interest of a willing land developer and Melbourne Water underwriting the perceived economic risk to the local municipality if the project did not function as anticipated. In the end, the project proved scientifically, financially and aesthetically successful with benefits for all partners demonstrating the business case for WSUD. In addition to this activity, the CRC and Melbourne Water hosted a series of training workshops and seminars to educate the industry about WSUD, using the constructed wetlands and large WSUD demonstration project as case studies.

4.4 Niche Stabilisation: 2000-2006

In this phase the Niche was further strengthened by the output of a number of industry tools and programs aimed at improving the focus and skills of implementers needing to be educated in both the philosophical and technical elements of WSUD, and thus facilitating improved institutional legitimacy of WSUD.

In 2000 the first biannual National WSUD Conference was founded and hosted in Melbourne through as an initiative of key Niche champions. A competitive State Government funding scheme was established for local government agencies, to implement local stormwater quality management practices, in recognition of their limited capacity for WSUD. A new and dedicated industry capacity-building program focused on the education and training of stormwater professionals for WSUD was also established under the auspices of this fund.

Simultaneously the CRC innovated an industry-wide WSUD tool, which is a modelling tool for conceptually designing WSUD interventions (see Wong 2006b). The tool was also developed to be used by regulators for assessing proposed WSUD initiatives in terms of meeting water quality objectives and thus addressing a key issue of providing industry consistency and transparency in the process. The achievement was essential to enabling the more rapid adoption of WSUD measures.

These capacity building tools and programs provided the necessary stimulus for the recent introduction of significant regulatory requirements for development practices to meet stormwater quality targets, as well as innovative market-based reforms that encourage developers and local government authorities to more efficiently participate in WSUD through an offsets scheme.

5 KEY SOCIO-TECHNICAL TRANSITION REFLECTIONS

This case study essentially reveals a process of how a new value set – environmental waterway protection – has been institutionalised and enabled the emergence and subsequent stabilisation of the WSUD niche across Metropolitan Melbourne. The application of the MLP framework and transition thinking assisted in the identification of four interdependent transition phases involving socio-technical change and interaction between each of the three levels of social structure.

The early Macro-level shift was critical for the destabilisation of the tradition waterway management approach through the rapidly growing social activism in relation to protecting and rehabilitating waterways and their passive recreation opportunities. This shift is also reflective of the broader social movement of 'global environmentalism' experienced across first world countries at this time. The development of a new sub-institutional regime, or bridging organisation, at the Meso-level allowed for both providing policy incentives, and the coordination and advancement of local science at the Micro-level for innovating urban stormwater quality management technologies. However, the detailed outcomes of the socio-technical analysis strongly suggests that the effective progress with advancing WSUD was highly dependent on the development and nurturing of the WSUD Niche.

While the WSUD transition is still not complete, this case analysis provides an example of an ongoing and effective WSUD reform agenda that is 'currently in practice' and has so far achieved the institutionalisation of a new value set (ie the environmental protection of waterways), and acceptance of a new urban development philosophy by a traditionally conservative arena that is used to privileging conventional flood protection, economic efficiency and maintaining the status quo. Overall, from an institutional perspective, the progress of this WSUD transition has, so far, essentially occurred over a relatively short period of time given what is already understood about transitioning periods (see Geels, 2002 and 2004). The next level of analysis (as outlined in Brown and Clarke, 2006) revealed that it was the interplay between adaptive governance and technological development that underpins this relatively rapid transitioning.

From the adaptive governance perspective (Folke et. al. 2005), capacity development for the WSUD niche was driven by: 1) an important bridging organisation that facilitated collaboration across industry sectors; 2) a key organisational champion that promoted knowledge-brokering, secured funding contributions and established strategic programs for WSUD; and 3) the efforts of a group of key industry champions to promote change. It is important to highlight that the key champions identified through this research were found to be an associated group of change agents across multiple sectors including state and local government, industry and science that worked together to advance change. However, the key champions within Melbourne Water were instrumental to strategically supporting and influencing the efforts of change agents across the city. Overall, this innovative group of change agents significantly bolstered the Niche through their commitment to building industry capacity, expanding policy networks and promoting initiatives that were amenable to a 'best practice' ideology.

The technological developments within the case study have been significant, with a succession of stormwater quality treatment technologies evolved from constructed wetlands, gross pollutant traps and bio-retention systems through the innovative modelling tools that assist both designers and regulators in assessing compliance for improved stormwater quality outcomes. This work has been enabled through systematically reconsidering the urban design footprint and taking advantage iconic retrofitting opportunities within the existing urban landscape.

6 CONCLUSION

This case study has revealed an experiential process of how a new value of environmental waterway protection has been institutionalised across Metropolitan Melbourne, and how this fundamentally underpins the WSUD reform. Four interdependent transition phases where identified involving change and interaction at each level of social structure, as well as the concerted formation of a WSUD Niche as a critical reform mechanism. High levels of social capital for waterway health and the existence of coordinated local champions represented across the science, policy and private domains were essential for fostering Niche development. In addition, the establishment of bridging organisations, scientifically informed policy targets, strategic funding opportunities, and the demonstration of a business case for urban stormwater quality management were essential variables to the WSUD transitioning process.

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