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Towards sustainable urban water management: A critical reassessment

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ABSTRACT

Within the literature, concerns have been raised that centralised urban water systems are maladapted to challenges associated with climate change, population growth and other socio-economic and environmental strains. This paper provides a critical assessment of the discourse that surrounds emerging approaches to urban water management and infrastructure provision. As such, '*sustainable urban water management*' (SUWM) concepts are scrutinized to highlight the limitations and strengths in the current lines of argument and point towards unaddressed complexities in the transformational agendas advocated by SUWM proponents. Taking an explicit infrastructure view, it is shown that the specific context of the urban water sector means that changes to infrastructure systems occur as an incremental hybridisation process. This process is driven by a range of factors including lock-in effects of legacy solutions, normative values and vested interests of agents, cost and performance certainty and perceptions of risk. Different views of these factors help explain why transformational agendas have not achieved the change SUWM proponents call for and point to the need for a critical reassessment of the system effects and economics of alternative service provision models.

1. Introduction

Management of water is a critical factor in urban sustainability (Schaffer and Vollmer, 2010). In most modern cities, water services are delivered via networks of buried pipes that connect customers to treatment works and, ultimately, to sources of water and sinks for wastewater. This infrastructure represents a significant capital investment and future generations will inherit the outcomes of society's ongoing investment decisions (Burn et al., 2012; Marlow et al., 2010a; Wong and Brown, 2009). The sector is facing increasing pressures associated with climate change, changes in population and demographics, a volatile global economy, increasing energy prices, heightened environmental awareness and more complex regulatory and social circumstances (Marlow et al., 2010b; Werbeloff and Brown, 2011a,b). Local pressures vary considerably, but the reality is that water service providers (WSPs) must operate within constrained budgets, while being expected to deliver quality service at a low price. In such circumstances, it is particularly important to address the growing uncertainty with respect to operational, environmental, social and economic constraints (Blackmore and Plant, 2008; Pearson et al., 2009). Moreover, there is an increasing clash between the demand for and limits to resources that result in ecological, economic and cultural '*strains*' (Vlachos and Braga, 2001). From an urban water perspective, these strains have led various authors to suggest that the current model of service provision is no longer appropriate (Pahl-Wostl, 2002; Ashley et al., 2003; Milly et al., 2008; Pearson et al., 2010; Brown et al., 2011).

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The aspiration for change has been labelled in a variety of ways, but in this article is referred to as '*sustainable urban water management*' or SUWM (Makropoulos et al., 2008; Brown and Farrelly, 2009; Novotny, 2009; Werbeloff and Brown, 2011a). SUWM concepts have been discussed and developed over a number of decades (Hengeveld and De Vocht, 1982; Button and Pearce, 1989; Choguill, 1993; Niemczynowicz, 1999; Hellström et al., 2000; Keath and Brown, 2009). However, while there has been some adoption of alternative approaches, the predominant model of service provision remains unchanged. Given the significant volume of papers advocating change, this article provides a critical review of SUWM concepts and seeks to illustrate why transformational agendas have not realised the mainstream adoption of SUWM approaches that proponents assert is needed.

As the aim of this article is to provide a critical review of the SUWM paradigm rather than the literature itself, the presentation of arguments departs somewhat from the standard model of a review paper. The concept of SUWM is first considered via a comparison to current models of service provision. The purported benefits of SUWM and the impediments that must be overcome to achieve these are then outlined. Conceptual models of investment and option selection are then used to further investigate factors that are central to the debate over SUWM.

2. Sustainable urban water management

The authors have previously delivered a body of research related to infrastructure asset management, integrated urban water management, decentralised solutions and sustainability within the urban water sector. A question that arose from this work is why SUWM concepts are so strongly supported in the academic literature, but still remain a niche innovation from the perspective of broader infrastructure provision. A critical review of the SUWM paradigm was thus undertaken. To this end, we identified relevant literature by searching academic databases using key words related to SUWM concepts. Additional literature relevant to the authors' previous experience and research was also considered.

2.1. *A brief historical perspective*

The traditional model of urban water service provision evolved through a number of phases, as explored by such authors as Tarr et al. (1984), Geels (2005), Gandy (2004, 2006) and Brown et al. (2009b). For the purposes of this paper, we have synthesised these phases in Table 1. According to the literature, the development of the associated socio-technical regime involved a co-evolution between science, technology, culture, industry structure, policy institutions and the market (Geels, 2005). SUWM concepts can be considered the next step in this co-evolution and reflect growing concerns over community wellbeing (rather than just public health), ecological health and sustainable development, all of which can be collectively labelled as '*green*' issues (Bartone et al., 1994). Green issues and related policy developments reflect a growing awareness that the natural environment is vulnerable to human activity at multiple spatial and temporal scales (Fiorino, 2001). Arguments for SUWM are essentially an articulation of this awareness, expressed in terms of the urban water cycle. In practical terms, however, the space to consider SUWM arises primarily where the urban water sector is delivering secure, reliable and safe water services. In contrast, urban centres in developing countries are still grappling with what has been dubbed the '*brown agenda*' (Allen et al., 2002), which relates to the impact of urban pollution on public health. From an urban water perspective, the immediate challenges in such countries remain the lack of access to safe water, sanitation and adequate drainage systems (Gandy, 2004).

2.2. *The meaning of 'SUWM'*

As an aspiration, SUWM reflects a generalised goal to manage the urban water cycle to produce more benefits than traditional approaches have delivered. While its meaning is not precisely definable, it is possible to characterise the concept through a comparison with a more traditional model of urban water management. The current dominant model relies on large-scale, centrally managed infrastructure systems that are designed to deliver cheap and reliable services (Brown et al.,

Table 1 – Stepwise development of urban water systems.

Existing infrastructure	Service focus	Driver for change	Solution
Unstructured system, with some storm sewers in large cities	Basic services	Population growth and associated issues, especially pollution and inadequacy of local water supply	Piped water
Water pipes	Secure supply of wholesome water	Excessive demand placed on waste disposal system, leading to contamination of urban areas with stagnant water and faecal matter. The perception of disease being related to noxious smells was also a key driver.	Sewers (combined and separate)
Water pipes and sewers (combined and separate)	Public health and drainage (in larger cities)	Contamination of surface waters with sewage and impact on health of downstream communities.	Water Treatment Works (WTWs) and protected catchments
Water pipes, sewers and WTWs	Waterway pollution	Degradation of urban water ways, nuisance issues and loss of amenity value.	Sewage Treatment Works (STWs) and separation of sewers
Water pipes, sewers and WTWs, STWs	Flood protection and drainage	Extension of paved urban areas required extensive drainage systems	Extensive storm sewers