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Framing water sensitive urban design as part of the urban form: A critical review of tools for best planning practice

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ABSTRACT

Spatial planning for green stormwater treatment technologies, known as Water Sensitive Urban Design (WSUD), is a 'wicked' problem which can greatly benefit from the application of Planning Support Systems (PSS). Our review of currently existing WSUD-PSS shows that WSUD is approached from three perspectives: hydrological, urban planning and water governance. As a form of best (urban) planning practice, WSUD requires PSS that regard these technologies as an integral part of the urban form. We argue that suitability of location for WSUD has two sides: 'WSUD needs a place' and 'a place needs WSUD'. No framework or PSS exists that frames WSUD from both sides of suitability. We propose such a suitability framework, building on evidence from literature. Our review found no comprehensive tool or strategy incorporating all relevant factors for suitability analysis. Our proposed framework addresses this gap, and serves as the basis for rigorous WSUD-PSS.

Contents

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1. Introduction

Integrated Urban Water Management (IUWM) and Sustainable Urban Water Management (SUWM) principles have emerged in the past decades (Larsen and Gujer, 1997; Mitchell, 2006; Pahl-Wostl et al., 2008; Vlachos and Braga, 2001). Focusing on the urban drainage aspect, numerous similar urban planning and design approaches for distributed, 'green systems' have emerged around the world (Fletcher et al., 2014). These include: Sustainable Urban Drainage Systems (SUDS) (Woods-Ballard et al., 2007), Low Impact Development (LID) (US EPA, 2000), Green Infrastructure (GI) (Benedict and McMahon, 2006), and Best Management Practice (BMP) (US EPA, 2011), Water Sensitive Urban Design (WSUD) (Wong and Ashley, 2006) and Sponge City (MUHORD, 2014). Although there are differences in scope and context between these concepts, their main philosophy is the same: instead of ignoring the natural hydrological cycle, they rely on the "activation of natural processes" (Fryd et al., 2012). Judging from the exponential growth of academic as well as grey literature on this topic, IUWM and SUWM paradigms are gaining momentum, both in academia and practice (Fletcher et al., 2014). This can be explained on two levels: firstly the persistent pressures that continuing urbanisation and climate change exert on our urban systems; secondly - and on a lower level - demonstration of best practice, policy compliance, environmental protection and, to a lesser extent, service constraints of existing infrastructure (Sharma et al., 2012). The latter drives local governments to adopt SUWM practices, as prominently evident in the Singapore example (Tortajada et al., 2013).

WSUD, as an example of a SUWM strategy, is described by Lloyd et al. (2002b) as an approach to urban planning and design that integrates the urban water cycle with the aim to minimise hydrological impact of urban development on its surrounding environment. It is practiced through both structural (green infrastructure systems e.g. raingardens, wetlands) and non-structural measures (i.e. policies aimed at improving efficiency of water use) (Beecham, 2003; Butler and Memon, 2006; Taylor and Wong, 2002). WSUD is associated with the integration of multiple objectives that have traditionally been addressed separately: water security, public health, flood protection, waterway health, amenity, economic vitality, equity and long-term sustainability (Ashley et al., 2004; Fryd et al., 2012; Martin et al., 2007; Wong et al., 2013; Wong and Brown, 2009; Woods-Ballard et al., 2007). Lloyd et al. (2002a, b) outline two fundamental aspects to WSUD: *best management practice* and *best planning practice*. While the former refers to these structural and non-structural measures, the latter refers to urban planning aspects of the implementation of green, distributed systems.

Best planning practice for SUWM as a multi-objective, interdisciplinary and multi-stakeholder problem requires integrative, inclusive and interactive practices in urban planning (Brown et al., 2015; Coutts et al., 2013; Malmquist, 2006; Pahl-Wostl et al., 2008; Van der Brugge et al., 2005). As such, the quality of planning processes ultimately determines the success of distributed systems. This highlights the need to approach WSUD as an urban planning challenge. However, the majority of research focuses on best management practice, such as refining WSUD philosophy, simulating and analysing the performance and potential of green systems and optimising technology engineering (e.g. Beck et al., 2011; Hijosa-Valsero et al., 2010; Payne et al., 2014; Zinger et al., 2013). As a result, we may be confronted with technologically optimised systems that fail to deliver to their potential in practice due to ad-hoc planning and implementation.

This raises the question why the "planning side" of urban water management remains underexposed? The answer may be found in the fact that we are faced with a highly complex planning problem that is beyond conventional infrastructure engineering (Ashley et al., 2004; Cross, 1989; Jin et al., 2006; Makropoulos et al., 2008; Rahman et al., 2012; Rijke et al., 2008; Sakellari et al., 2005). Such problems, characterised by a lack of understanding and lack of agreement both in terms of their causes and solutions, have been called "wicked" problems (Cross, 1989; Klosterman, 1997; Rittel and Webber, 1973).

If we are serious about employing best planning practice for the implementation of green systems, we need frameworks and tools that: (i) consider both primary function and additional benefits of green systems, (ii) conceptualise green systems in terms of their relevant planning aspects, (iii) explicitly link these benefits and planning aspects to a complete set of measurable indicators and (iv) allow for spatially explicit analysis on variable scales. Essentially, there is a need to consider WSUD planning as a *location choice*.

This review aims to improve understanding and promote *best planning practice* for WSUD through the development of a comprehensive planning framework, targeted towards advancements in WSUD planning support (in this paper, WSUD is narrowed to implementation of green stormwater treatment technologies within the urban form). The key objectives of the review are to:

- Organise the diversity approaches to WSUD planning in a typology of tools and models;
- Assess the extent to which WSUD planning is currently approached as a *location choice*;
- Review the use of GIS and MCDA techniques in urban water management, an emerging sub-class of tools designed to support planning processes;
- Rigorously define the 'location suitability' for the implementation of WSUD assets through the development of a suitability framework.