Journal of Cleaner Production 113 (2016) 263–273

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Risks and tensions in water industry innovation: understanding adoption of decentralised water systems from a socio-technical transitions perspective

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ARTICLE INFO

Article history:
Received 17 October 2014
Received in revised form
7 October 2015
Accepted 10 November 2015
Available online 1 December 2015

Keywords:
Sustainable urban water management
Case study
Industry reform
Environmental policy

ABSTRACT

Globally, centralised urban water systems are under pressure to respond to environmental and economic pressures. In Australia, high infrastructure costs and variable rainfall have prompted governments, end-users and property developers to begin investing in more decentralised systems that use alternative water sources (rainwater, stormwater and wastewater). This trend is based on a fit-for-purpose principle and is part of a global shift toward sustainable urban water management. These developments suggest that Australia's urban water sector may be in the early stages of transition and represent a multi-decadal shift from centralisation of water supply and sanitation to partial decentralisation based on local conditions. Much of the scholarship on decentralised systems focuses on drivers and barriers to adoption, which implies a static and mechanistic process of change, and overlooks the complex interplay between exogenous pressures, innovation, multiple actors and industry reform. This paper addresses this gap by analysing temporal processes of Australia's urban water sector, using a regionally based case study comprising an historical review and interview study that analyses the multi-level, -decadal and -actor developments at the nexus between water service provision and property development. The analysis revealed emerging tensions between incumbent water utilities, property developers and end-users, and an inherent conflict between neo-liberal and environmental policy agendas. Such tensions and conflicts are missing from urban water policy and research discourse.

1. Introduction

Today's pervasive urban water systems are based on large-scale centralised infrastructure managed by technical organisations to efficiently supply potable water and remove and manage stormwater and wastewater, usually across vast distances (Crites and Tchobanoglous, 1998). New urban water planning and management paradigms have emerged in recent years in response to environmental and socio-economic concerns. A growing number of urban water researchers suggest that traditional urban water systems and management models are not adequate to respond to pressures posed by ageing infrastructure, urbanisation, environmental impact, climate variability and population growth (Hering et al., 2013; Mirchi et al., 2014; Sharma et al., 2010). In a developing world context, some theorists cite concerns regarding the feasibility of constructing capital intensive centralised water and sewer networks with limited funding and rapid urbanisation (Medilanski et al., 2007; Srinivasan et al., 2010).

A new paradigm has been proposed that purports to address these concerns. The paradigm has been variously referred to as 'sustainable urban water management', 'water sensitive urban design' and 'integrated urban water management'. Common among these concepts is a management logic that is flexible and inclusive of alternative water servicing options at various scales, incorporating demand management and wastewater recycling for fit-for-purpose uses (Sharma et al., 2010). Decentralised water harvesting, treatment and storage systems (referred to as decentralised systems throughout this paper) constitute one aspect of this paradigm. Decentralised systems operate at the allotment, cluster and development scales and include a broad category of water, wastewater and stormwater servicing systems, such as rainwater tanks, greywater recycling, blackwater treatment and disposal, rain gardens, and biofilters (Sharma et al., 2013).

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http://dx.doi.org/10.1016/j.jclepro.2015.11.018

Research attention has been devoted to understanding the drivers and barriers to adoption of decentralised systems within the broad sustainable urban water management (SUWM) paradigm (Brown and Farrelly, 2009; Naylor et al., 2012; Sharma et al., 2012). This research parallels studies on adoption of distributed energy options (e.g., Allen et al., 2008) and microgrids (e.g., Soshinskaya et al., 2014). In short, these energy studies highlight significant technical (e.g., integration difficulties with existing infrastructure), economic (e.g., high costs) and socio-institutional (e.g., unsupportive regulations) barriers to widespread deployment. Recent urban water research has emphasised the socio-institutional dimension. Socio-institutional barriers relate to the lack of financial incentives and accounting for externality benefits, fragmented industry structure and limited community buy-in, and the limited knowledge regarding the long-term operation and maintenance requirements of decentralised systems. In addition, there has been minimal long-term monitoring to underpin this knowledge contributing to perceived higher risks to public health and safety of such systems (Brown and Farrelly, 2009; Farrelly and Brown, 2011; Sharma et al., 2012). From an asset investment perspective, Marlow et al. (2013) also identified ‘institutional biases’, including the possible conflict of alternative water sources with utility revenues as an important socio-institutional barrier.

Barriers and drivers of decentralised systems have also been examined in the context of urban land development. For instance, Sharma et al. (2010) observed that cost to allotment holders increased with greater implementation of more decentralised systems. They found that no acceptable economic framework exists for sharing costs and benefits of alternative approaches. In terms of drivers for the adoption of decentralised systems, Sharma et al. (2013) recently reviewed 30 property developments across Australia, and found that such systems were being deployed to overcome lack of available services, defer upgrades to existing infrastructure, protect sensitive waterways, showcase sustainable development, promote water conservation, improve landscape amenity (e.g., greening) and demonstrate innovation.

While the adoption approach is a useful framing of the opportunities and challenges to innovation, it is derived from an ecological modernisation policy logic, which tends to be technology centric and assume a mechanistic view of uptake, and overlooks complex socio-technical system dynamics (Geels et al., 2008). Adoption research falls within an approach to causation referred to as variance theory, which assumes simple cause–effect relationships (Poole et al., 2000). By contrast, process theory is concerned with tracing events and actor interactions through time to understand underlying dynamics of change (Langley, 1999; Poole et al., 2000). A feature of this approach is the focus on temporal order and patterns of change to institutions as revealed by historical narratives and process analysis (Van de Ven and Poole, 2005).

Following the process theory approach, the socio-technical transitions literature has made important contributions to understanding historic socio-technical shifts in a variety of domains (Brugge and Rotmans, 2007; Smith et al., 2010). The notion of transitions aligns with the process theory approach to causation because human agency, social systems and technological development are seen as co-evolving through interactions between actors and events over time. It has become clear from this literature that systemic change is complex and often characterised by power struggles between actors, and unintended consequences arising from the complex interplay of actors and exogenous factors (Brown et al., 2000; Quezada et al., 2014; Smith et al., 2005). For example, Quezada et al. (2014) recently demonstrated tension between end-users and supply chain actors in Australia's electricity regime, emerging from the interplay of climate change, societal attitudes toward environmental issues, technological innovation, neo-liberal economic reform and clean energy policies (and politics). They identified evidence for transition in electricity supply from centralisation in a growing market context to partial decentralisation in a declining market, with significant risks of stranded assets for utilities and social inequity among end-users.

In the instance of Australia's urban water sector, there is significant pressure for change emerging from climate change and variability, societal concerns over water quality, rising infrastructure costs and policy responses related to these issues. For example, severe and widespread drought at the turn of this century (so called millennium drought) raised the profile of decentralised systems, with most state and territory governments mandating and incentivising rainwater tanks in new urban developments. Furthermore, developers of large master-planned communities have become more interested in new infrastructure models due to rising costs for traditional approaches and increasing environmental standards for inflows (Sharma et al., 2010). These changes suggest that Australia's urban water sector may be in the early stages of socio-technical transition (Geels, 2002) – a slow multi-decadal shift from centralised control of large infrastructure to partial decentralisation, with multiple water sources and treatment systems operating at centralised and decentralised scales. The long-life of water assets and piecemeal nature of replacing ageing assets will make adoption of decentralised systems difficult, slow, and subject to gradual urban development/renewal, a process Marlow et al. (2013) refer to as ‘incremental hybridization’.

If the urban water sector is beginning to shift to new infrastructure and management models under the SUWM paradigm, what are the dynamics of this change and what are the risks? Surprisingly, little research has explored risks of transitioning old consolidated industries, and the authors are not aware of any urban water research that has examined the complex temporal processes of change involving decentralised systems or SUWM more broadly.

The present paper sought to address this research gap by analysing the temporal dynamics of change in Australia's urban water sector, with particular focus on urban development in the South East Queensland (SEQ) region. The paper presents a case study consisting of a detailed analysis of the interplay of exogenous pressures and urban water and property sector actors through historical review and interviews. The historical review positioned the adoption of decentralised systems as a transition process, while interviews with key professionals in SEQ were used to anchor the inquiry to actor motivations and experiences with specific greenfield land development projects. The study focused on the SEQ region due to the notable exogenous pressures from high population growth and recent climate extremes of severe drought and flood events. In addition, the region has several satellite cities (greenfields) under development, which are out-of-sequence with existing water infrastructure. The interface between urban water and property industry actors in new urban development offers an ideal setting to examine innovation in water servicing. Greenfield urban developments, or the development of un-serviced (rural) land for urban uses, are spaces where questions regarding water servicing options, including alternatives to traditional infrastructures, are explored and contested. Therefore, SEQ offers fertile ground with which to analyse the dynamics of innovation in the urban water sector.

2. Analytical framework and methods

This study sought to understand the innovation and institutional dynamics at the interface between land development and water industries. To understand pressures impacting on innovation in SEQ's water sector, and the behaviour of actors as they