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Agricultural risk management of a peri-urban water recycling scheme to meet mixed land-use needs

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ABSTRACT

The use of recycled water as a valued resource is becoming well established worldwide as a means to support agricultural irrigation. This paper describes a case study of agricultural use of recycled water and associated mixed land-use needs in a peri-urban setting of northwest Sydney. The Hawkesbury campus of Western Sydney University has an established water recycling scheme to support both agricultural productivity and landscape amenity, along with increasing linkages to infrastructure protection from bush fire risk. Risk management strategies are described for a range of land use needs across the campus, and discussed in terms of supporting local resilience, activities of the range of communities of practice involved, and ecosystem services from the local peri-urban landscape. Conclusions are drawn in terms of risk management of agricultural water recycling as an integrative process for managing associated land use needs.

1. Introduction

The United Nations has declared the lives of 3.5 billion people in 40 countries as being under threat because of increasing water scarcity, with water supply being the most critical factor in achieving world food security (United Nations, 2014). Given that agriculture uses 70% to 80% of the available water supply internationally, safe water recycling has been identified as a key strategy in meeting global irrigation demands (O'Neill and Dobrowolski, 2011; Wyman, 2013). With ground and surface water reserves already dwindling in many world regions, the need to increase the use of urban effluent as a recyclable irrigation resource has been clearly identified (Asano, 1998; Chen et al., 2013). However, as reliance on recycled water grows there is increasing pressure to use lower quality recycled supplies (Bernstein, 2011). To ensure safe and sustainable use of recycled effluent it is essential that water recycling is strategically managed and monitored, along with the need to apply vision in terms of integrated distribution for a range of peri-urban uses. In many cases this responsibility is best excercised by an informed and experienced agricultural sector, keenly aware of its role as a key extension agency (Plauborg et al., 2010). Managing the water resources and environmental assets of peri-urban landscapes is a dynamic and complex problem worldwide. International peri-urban studies reflect critical challenges associated with planning processes (Allen, 2003), implications for environmental integrity and social justice associated with peri-urban water management (eg Marshall et al., 2009), and the role of local actors in development processes associated with conserving agricultural land (eg Bryant and Chahine, 2011).

In Australia, water security in the principal food producing areas is threatened by extreme climate variability under the action of large-scale atmospheric circulations, including the El Niño Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) (Ashcroft et al., 2014). In mean precipitation terms, Australia is the driest continent after Antarctica, with one of the World's most unpredictable climates, the coefficient of variation of river flow being 0.70 compared with a World average of 0.43. Australia underwent extreme drought from 2001 to 2003, with significantly decreased rainfall from 2000 to 2010, (sometimes known as the millennium drought) impacting on all uses. This situation highlighted the imperative for research into the position of agricultural management in integrative water recycling (Department of the Environment: Australian Government, 2011; Tan and Rhodes, 2013). Australian agriculture places a very heavy demand on water supply compared to most other countries with 75% of Australia's total available water being used for agricultural irrigation (Hussy and Dovers, 2007; Risbey et al., 2009). With burgeoning competition for existing supplies such as fire control, the maintence of environmental flows, min-

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ing, and irrigation of public and recreational grounds, Australia will need to dramatically increase its use of recycled effluent from the present 9% (Kiem, 2013).

To shift political opinion, agriculture must be seen to offer a custodial role in a shift away from its image as a very thirsty and dominant primary industry in many areas (Radcliffe, 2006). In recent years there has been a marked increase in the number of small, peri-urban agricultural and horticultural operations in Australia in response to a demand for high value, labour-intensive products such as salad crops, cauliflower, broccoli, herbs and asparagus, produced close to urban points of sale (Mason and Knowd, 2010; Zasada, 2011). While such schemes are small compared to staple and export crop production schemes, they are nevertheless very important in terms of meeting fresh produce demands of urban areas in an economically sustainable way, and therefore in integrating with local urban and *peri*-urban interests (Verbyla et al., 2013).

The western edge of the Sydney Basin is an area undergoing transformation from a landscape of orchards and small farms to one of encroaching urbanisation. A regional study by Merson et al. (2010) focused on the role of urban and peri-urban agriculture as a buffer between urban expansion and the neighbouring Blue Mountain World Heritage area. Building upon a review of factors influencing the local farming communities, the study investigated the role of agri-industries in relation to resilience, communities of practice, and ecosystem services. Within this region, a peri-urban example of agricultural water recycling is the Hawkesbury Water Recycling Scheme (HWRS) on the Hawkesbury campus of Western Sydney University. This region has supplied most of Sydney with a reliable food supply for over 200 years (Booth et al., 2003). The Hawkesbury campus was initially established as the Hawkesbury Agricultural College in 1891, and in 1988 was incorporated into the University.

This paper describes the role of local agricultural risk management in providing an integrated system for meeting mixed land-use needs relating to a limited yet important supply of recycled urban wastewater. The objective is to add to the existing local and international knowledge base of the role potentially played by the agricultural sector in providing a platform for developing sustainable peri-urban water reuse.

1.1. Risk management framework for agricultural and institutional irrigation

From the establishment of Hawkesbury Agricultural College, agriculture has been an integral part of the Hawkesbury campus. The farmlands of the campus include areas initially cleared as an agricultural commons adjacent to the Macquarie townships of Richmond and Windsor in the early 1800s. The landscape includes flood prone areas of swamp soils, with adjacent areas of duplex soils and perched groundwater higher in the landscape. Recently the farm enterprise has been reinvigorated, with increasing utilisation of recycled water to increase productivity.

The Hawkesbury campus has a long standing tradition of water recycling, with risk management strategies continuing to develop in response to emerging key risks and institutional arrangements. Since the 1960's, reclaimed water from the Richmond Sewage Treatment Plant (STP) has been used to irrigate pastures of the previous University Dairy. An initial agreement for the supply of reclaimed water was initially formalised with Sydney Water Corporation in 1996, with subsequent water use agreements continuing to the present. An important regulatory change in 1997 was the establishment of the New South Wales Protection of the Environment Operations (POEO) Act, which established economic incentives to reduce wastewater discharges to the environment. In the late 1990s, infrastructure to harvest, treat and reuse stormwater on the site was developed in collaboration with Hawkesbury City Council, funded through the Federal Natural Heritage Trust and the NSW Stormwater Trust. Stormwater harvesting was designed to mimic the local hydrology of sodic swamp areas, with the capture of smaller events and environmental flows in pulses following larger rain events. These initiatives established the current structure of theScheme, with its role in transforming urban wastewater and stormwater into valued water resources for agricultural and horticultural production and landscape irrigation (e.g. Booth et al., 2003).

Environmental health perspectives provided the basis for the local assessment of microbial and chemical risks, and associated multiple barrier management strategies (Derry et al., 2003). This was complemented by a focus on risk communication with representatives of the communities of practice involved in active water use and passive use of the facilities (Attwater and Derry, 2005). Risk management of the Scheme took a further step with the establishment of an Environmental Management Plan in 2005, based upon the model of continuous improvement which underpins environmental management systems (Attwater et al., 2006). The publication of the Australian National Guidelines for Water Recycling (NRMMC, 2006)and the associated subsequent stormwater guidelines, enabled a consistent risk framework to be applied to reclaimed water and stormwater (Radcliffe, 2010). The Scheme's current Risk Management Plan reflects the framework outlined in these national guidelines, with the structure including: commitment to water quality management; assessment of sources and uses, water quality and risk assessment; preventative measures and multiple barriers based on critical control points; operational procedures and process control; verification of water quality and performance; management of incidents, awareness and training; and further validation, research and development. The continued operation of the Scheme has supported the development of applied research focusing on the advocacy for practical environmental and risk management strategies. These have included those relating to health risk management (Derry et al., 2006; Derry, 2011) and standard indicator methods (Derry and Attwater, 2014).

The Hawkesbury farm enterprise focuses on a commercial grazing enterprise, with beef cattle and sheep utilising pasture and fodder crops irrigated by recycled water. Recycled water is a critical resource for agricultural productivity, and a valuable buffer for rainfall variability. This is a key component of the case study site as a practical demonstration of risk management and urban agriculture. With the recent establishment of centre pivot irrigators for improved irrigation efficiency, this grazing system based upon water recycling is developing as a local demonstration of best practice peri-urban agriculture. The management of infrastructure and risks associated with the use of recycled water for agricultural productivity also enables broader opportunities for a range of water uses embedded within the campus, or in neighbouring areas adjacent to the campus. Organisations using recycled water resources within the campus include a demonstration area for horticulture, nursery production of native plants, and a community service provider. Along with a focus for productive use for irrigation, supplies of recycled water are provided to top up stormwater storages in the neighbouring horse racing facility, supporting safety and amenity on the site. Storages of recycled water are also important 'static water supplies' for bushfire fighting, contributing to the protection of local infrastructure assets from bushfire. Landscape amenity across the campus is supported by stormwater reuse, with constructed wetlands for stormwater treatment also providing valuable habitat for local birdlife.