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Stormwater reuse, a viable option: Fact or fiction?

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ABSTRACT

The increasing spread of urbanisation is a common phenomenon witnessed in most parts of the world due to the perceived benefits of urban living. A compounding issue is the growing shortage of safe and reliable water sources. Perennial water shortages are becoming a common feature in many parts of the world. It is important to recognise stormwater reuse as a key resource for securing adequate future water supplies based on the concept of 'water fit for purpose'. These require careful prioritisation of vulnerabilities, identification of the areas requiring adaptation and provide certainty of outcomes. Given the increasing inevitability of climate change it should be viewed as an opportunity to take advantage of new opportunities which stormwater reuse presents. This study identified key barriers to stormwater reuse and the difficulties in removing them.

1. Introduction

The increasing spread of urbanisation is a common phenomenon witnessed in most parts of the world due to the perceived benefits of urban living. This results in irrevocable changes to the landscape and creates economic, social and environmental impacts on a region. Currently about 53% (3.8 billion) of the estimated world population of 7.2 billion are living in urban areas (PRB, 2014) and this is projected to increase to 66% by 2050 (UN, 2014a, b). A compounding issue in relation to the increasing urban and rural populations is the growing shortage of safe and reliable water sources (for example, see Mahanta et al., 2016). Seasonal and sometimes perennial water shortages are becoming a common feature in many parts of the world. On one hand, there is the escalating demand for residential, commercial and industrial uses (Hadadin et al., 2010; Wu and Tan, 2012).

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On the other hand, increasing living standards are also exerting pressure on water demand. This has led to unsustainable extraction of surface and groundwater resources and declining water quality in urban areas. The rate of depletion is further compounded by changes to rainfall patterns and increasing unreliability of the rainfall seasons (Bandara' and Cai, 2014; Rosell, 2011; Strauch et al., 2015; Yaduvanshi and Ranade, 2015). A further undesirable consequence of urbanisation is the pollution of surface and groundwater resources from generation and discharge of a range of pollutants from anthropogenic activities. This limits the availability of safe water resources where treatment is economically feasible.

Under these circumstances, options such as desalination and inter-basin water transfers may appear attractive. However, these options can be cost prohibitive and may not be within the economic means of less affluent countries. One of the most common solutions to water shortages is restricting usage. This in turn impacts on human well-being and stifles economic growth. Unfortunately, the increase in demand and greater variability in weather patterns from climate change only serves to exacerbate the related issues of inability to meet water demand and declining quality, leading to water stress. In such a situation, stormwater presents a highly under-utilised resource (Managi et al., 2016). Depending on the level of rainfall in a particular region, stormwater can be either be the primary or the supplementary supply source.

2. Challenges to reuse of stormwater

Globally, stormwater reuse though popular (happening on a small-scale, barring Singapore) in some regions, is not widespread. This is primarily because stormwater reuse presents a number of distinct challenges. As rainfall is seasonal, it creates a level of unreliability. Appropriate storage capacity is a key requirement to ensure water availability during low or non-rainfall periods. Where subsurface characteristics are favourable, managed aquifer recharge is a viable option for storing stormwater underground. However, if geological conditions are unfavourable, costly storage reservoirs are needed. This uncertainty also needs to be considered in planning and designing stormwater storages. Furthermore, depending on its origin, stormwater can be highly polluted—in some cases more so than secondary treated sewage. Therefore, formulation of appropriate treatment strategies based on intended use is essential. These issues when considered together, give rise to the key challenge of ensuring reliability of supply at an economical cost, compared to other water supply options.

Stormwater reuse should be based on the concept of 'water fit for purpose'. This entails use of water of different quality based on intended use. This allows use of water of varying quality and reduction in water treatment costs with the highest quality water used solely for direct consumption. These approaches need to be embedded into urban planning strategies. It also requires the adoption of a range of appropriate technologies which are already available. It does not require the development of new technologies, but rather the tailoring of existing technologies and application strategies to suit given situations.

There is universal consensus regarding the importance of water for enhancing human well-being. Access to safe water was a key focus of the Millennium Development Goals (MDGs) and has be re-inscribed into the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015 (UN, 2014c).

It is also acknowledged that stormwater reuse helps reduce adverse impacts of urban stormwater runoff on the environment. Urbanisation results in quantitative and qualitative impacts. Quantitative impacts include increased runoff and higher peak flows, thereby increasing flood vulnerability. Qualitative impacts include transportation of physical, chemical and biological pollutants generated by natural and anthropogenic processes. Given stormwater reuse entails the storage of urban stormwater flows, its reuse will contribute to strengthening flood resilience and reducing pollutant loads to surface water bodies. Therefore, stormwater reuse will also contribute to improving urban water ecosystems.

Furthermore, urban water environments are important community assets. As urban population densities increase, water environments will play a more significant role as aesthetic and recreational resources (Asakawa et al., 2004). The need for 'islands of tranquillity' in congested built environments has been identified in the literature (Gobster and Westphal, 2004). In addition, degradation of urban water environments creates conditions for breeding disease vectors and vermin. There is confirmation of this occurrence in Brazil and some other countries in South America where there has been a rapidly escalating outbreak of the Zika virus.

A key reason for the current limited reuse of urban stormwater is because the true cost and benefits have proven to be difficult to assess. The application of quantitative economic tools alone is inadequate to take into consideration the qualitative benefits discussed above. Non-market valuation techniques are needed to evaluate community and environmental benefits and of stormwater reuse. In this case a holistic Multi Criteria Decision Making (MCDM) analysis employing market and non-market values is warranted.

However, decision makers need to consider barriers to adopting stormwater reuse. Although its use has been proven to work in a number of water stressed localities, it cannot be assumed that all cities and regions will adopt stormwater reuse. We, therefore, examine some barriers to stormwater reuse and how they vary between cities and regions.

Some foremost barriers relate to severity level of water stress, its duration, and costs associated with increasing the supply of water. If the costs of alternative technology (e.g., desalination) are less, then the use of stormwater reuse technology is less likely. Given desalination involves removal of salts and minerals, the resulting by-product is highly concentrated salt solution. If not disposed of appropriately, the salt residue results in environmental damage. Desalination is also energy intensive and non-renewable energy produces GHG emissions. Hence, non-marketed costs need to be taken into account if an unbiased assessment of benefits and costs between various water supply technologies is to be made. Furthermore, flexibility of existing systems and technology to process stormwater is a factor which could favour its use. Equally, method of water storage is an important consideration in justifying stormwater use.