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Editorial

In an increasingly globalized world, societies have become less resilient in regard to their natural environment. Long-term changes such as economic development, population growth and urbanization, as well as the impending threat of climate change, have increasingly resulted in global impacts on natural resources. Water resources, in particular, have become more polluted, mismanaged, misgoverned and poorly allocated.

As water demand has increased for numerous uses and users, and resources have become more limited because of physical scarcity, over-exploitation and pollution, it is therefore necessary to develop more options for water supplies. These options include the production at large scale of so-called non-conventional sources of water, such as recycled water from municipal sources, and desalination of seawater and brackish groundwater.

Appropriate planning and management consideration and improved treatment technologies can result in the production of high-quality water with no negative health or environmental impacts. Their economic, social and environmental benefits are many, as they address water supply scarcity, efficient resource use and environmental and public health considerations. Overall, they are used for potable and non-potable purposes, either directly or indirectly. Their usages include agriculture, landscape, stream and groundwater augmentation and managed aquifer recharge, cooling water for power plants and oil refineries, processing water for mills, toilet flushing, dust control, construction activities, concrete mixing and artificial lakes (United States Environmental Protection Agency [USEPA], National Risk Management Research Laboratory & U.S. Agency for International Development, 2012).

According to the US Environment Protection Agency, direct potable reuse is

> the introduction of reclaimed water (with or without retention in an engineered storage buffer) directly into a drinking water treatment plant, either collocated or remote from the advanced wastewater treatment system. Indirect potable reuse (IPR) is the augmentation of a drinking water source (surface or groundwater) with reclaimed water followed by an environmental buffer that precedes drinking water treatment. (USEPA, National Risk Management Research Laboratory & U.S. Agency for International Development, 2012, pp. 1–2)

However, terminology can be different in other countries. The terms 'reused', 'recycled' and 'reclaimed' water are also not always used interchangeably. For example, in the United States, reused water is known in different states as 'recycled' or 'reclaimed' water (Miller, 2006); in Singapore, it is known as NEWater (Lee & Tan, 2016).

Interest in the potential of reused water has increased globally, with studies focusing on policy, management, technology and public acceptance. With the best of the knowledge and experience available, governments, water utilities, academic institutions, non-governmental organizations and members of society are trying to develop or contribute towards development of guidelines and risks analyses; better understanding of economic aspects; safety, health and water quality considerations; social perceptions; environmental impacts and benefits; and more advanced and cost-effective technologies (e.g. ATSE, 2013; Eslamian, 2016; National Research Council, 2012). The analyses concur on the enormous potential of reused wastewater as a reliable source of clean water that also enhances urban resilience.

Rather than technological aspects, the main constraints on implementation of water reuse projects in different parts of the world seem to have been lack of full public support due to perceived health hazards and environmental impacts. A main handicap has been that governments and water utilities are usually slow to understand public concerns and perceptions. After backlashes

in several places, public information, communication and awareness campaigns, broader participation and educational programmes have become integral parts of development policy and decision-making frameworks.

With the objective of better understanding water reuse, the Institute of Water Policy of the Lee Kuan Yew School of Public Policy, National University of Singapore, the National University of Singapore Environmental Research Institute and PUB, the Singapore national water agency, organized a workshop on water reuse policies for direct and indirect potable use, their associated global trends, health and environmental considerations and social perceptions and acceptance. The workshop was held at WaterHub, Singapore, on 15 and 16 June 2015.

Forty national and international experts participated in the workshop. Contributions were presented on how the water portfolios of different cities and countries have been diversified with high-quality reused water. These included Australia, China in general and Beijing in particular, Saudi Arabia, Singapore, the European Union, the United States and Windhoek in Southern Africa. Topics discussed included policies, legal and regulatory frameworks, guidelines, standards, water pricing, business models, participation of the private sector, health considerations, technological development and public perceptions, participation and acceptance. Also elaborated at the workshop were the potential of production failure and reliability and how to address them; how to communicate to the public; whether the global trends are expected to change over the short, medium, or long term due to scientific and technological developments; evolving global attitudes and social perceptions; and increasing water scarcity.

Robust papers based on the presentations and discussions during the workshop are published in this special issue on Water Reuse Policies for Potable Use.

The history of potable water reuse and frameworks for decision making, policy development and implementation, and the reasons for their success or failure, are topics argued at length. Ong (2015) discusses safety, health issues, water quality considerations, concerns of potential presence of pathogens and inorganic and organic constituents in the reused water and their health implications, and the need for specific or international guidelines or standards for treatment or monitoring when municipal wastewater is used for potable purposes.

Two most relevant examples are presented: Windhoek (van Rensburg, 2016) and Singapore (Lee & Tan, 2016). Windhoek started producing high-quality effluents and distributing them for direct potable use 48 years ago, in 1968. Specific breakthroughs in wastewater technology (mainly membrane technology) have allowed reclamation of water for reuse. In addition, support at the political level, technical design of the treatment plants, maintenance programmes and the appropriate skill level of operating personnel, together with public acceptance, were noted to play important roles in supply of potable water to the population during the last almost five decades.

In the case of Singapore, water reclamation was introduced in 2003. It has been planned as a key element of the nation's water sustainability and self-sufficiency strategies. Notable in the case of the city-state has been its large-scale implementation and wide public acceptance. NEWater (as it is known locally) is part of an overall approach that has the objective to change the mindset of the population to consider reused water a long-term renewable source to significantly increase the available water resources.

Cases were cited where projects have failed not because of lack of appropriate know-how or technological development but because of lack of governmental support, fear of public perceptions, and lack of public support, e.g. in Queensland, Australia.

Horne (2015) summarizes important lessons learnt that can apply to every other case discussed. These include the need for approaches to urban water security that are forward-looking and risk-based; health and safety guidelines that are stricter, to ensure very high-quality effluents; and public information and management of community perceptions as integral parts of policy and decision-making frameworks to ensure long-term acceptance and viability.

With rapid changes in the human and natural environments, including scarce natural resources that have the potential to impose limits on socio-economic growth and affect livelihoods, non-conventional sources of water will have a more important role to play in the future. For this to be achieved, decision making, planning and implementation should not focus so much on urban resilience or water resilience, as that would limit water reuse. It is social resilience that should be at the centre of the development discourse. Only then will unceasing progress be achieved.

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