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Integrated urban water management applied to adaptation to climate change

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ABSTRACT

Integrated Urban Water Management (IUWM) is the holistic management of urban water supply, sanitation, stormwater, and wastewater to achieve sustainable economic, social and environmental objectives. All parts of the urban water cycle are managed together instead of separately. IUWM can be part of the solution for cities facing singular or multiple water management stresses under present and future climates. It has particular advantages for adaptation because it can be implemented over time and space as climate and others conditions change with options preserved for future actions, it contains no-regrets and co-benefits actions, and integrates local stakeholders into the planning process. Research was conducted to qualitatively examine how IUWM can be used to manage multiple urban water stresses under present and future climates and land use conditions upon the built, natural, and social systems of Exeter, New Hampshire, a small town located in a semi-rural area of the northeastern United States. With its emphasis on holistic solutions and systems thinking, it is shown that by looking at Exeter's suite of challenges through the lens of IUWM there are opportunities for integrated strategies that may lower overall adaptation costs and also provide wide-scale multi-criteria benefits.

1. Introduction

A major theme is emerging in urban water management – that of Integrated Urban Water Management (IUWM). As defined by Bahri (2012), IUWM is the holistic management of urban water supply, sanitation, stormwater, and wastewater to achieve sustainable economic, social and environmental objectives. In its fullest applications, it closes the loop between water supply and wastewater disposal. IUWM is also referred to as “One Water” or the Whole Water approach or Water Sensitive Urban Design (Mukheibir and Currie, 2016). Daigger (no date) and others refer to the concept as part of “Cities of the Future.” All parts of the urban water cycle are managed together instead of separately (Diaz et al., 2016; Rietveld et al., 2016).

Whitler and Warner (2014) state that IUWM considers:

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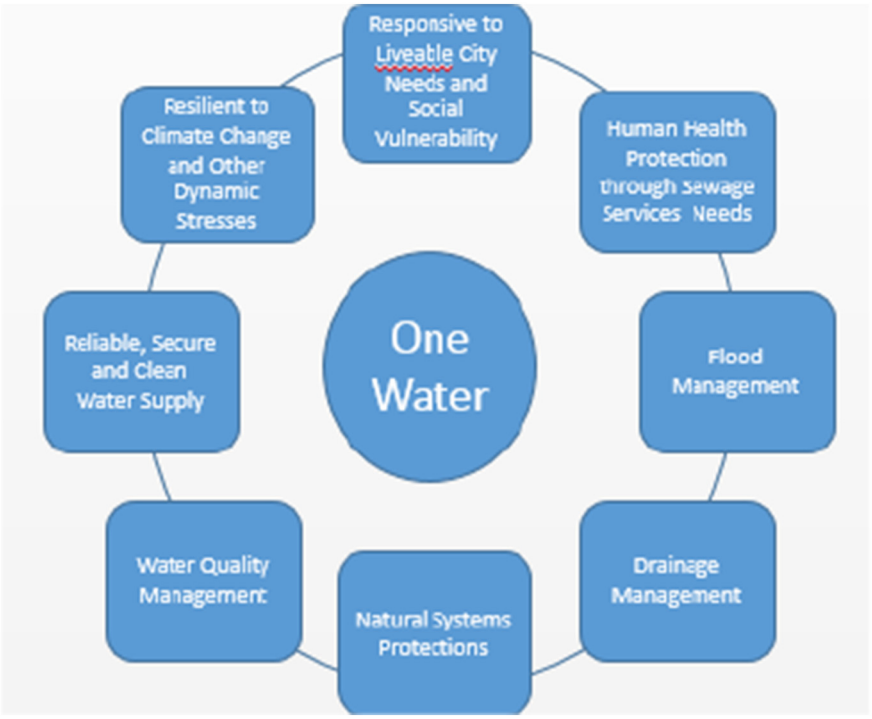

Fig. 1. The One Water approach for Exeter NH.
(Adapted from Mukheibir and Currie (2016).)

- "All parts of the water cycle — natural and man-made, surface and subsurface, and recognizes them as an integrated system
- The full range of demands for water, both anthropogenic and ecological requirements
- The impact of water cycle management on the overall planning and management of cities
- The full range of water supplies available over time
- The practices which can provide water fit for purpose both in quality and quantity, and reduce the demand for potable water
- The sustainability of water service provision
- The local context and stakeholder views
- The scale, engineering, and functional aspects of the water system
- The means by which transition from current practice can be achieved" (page 1).

The United Nations World Water Assessment Programme (2015) recommends IUWM as part of the solution to urban water management challenges.

IUWM is also part of Ecosystem Based Management, Integrated Flood Management (IFM), the current public health paradigm focused on the social determinants of health, and the analysis of the urban Water-Food-Energy nexus (http://ecosystems.noaa.gov/EBM101/WhatisEcosystem-BasedManagement.aspx, August 16, 2016; World Meteorological Organization, 2009; Wilson and Bond, 2007; Centers for Disease Control, 2017; United Nations Educational, Scientific, and Cultural Organization, 2012; Gondhalekar and Ramsauer, 2017).

Fig. 1 summarizes the IUWM approach from the viewpoint of our case study in Exeter NH.

Tools exist to assist in the application of IUWM such as the Watershed Management Optimization Support Tool (WMOST, Detenbeck et al., 2016) based upon the research of Zoltay et al. (2010). A more planning-level tool is the US EPA's CREATE tool primarily designed to help water utilities manage the threats of climate change. It lets users select a range of green and gray options to manage various levels of risks from present and future climate. Various cities in the US are employing some of the concepts of IUWM including Philadelphia, Seattle, New York, Boston, San Francisco, Las Vegas, Aurora, and Denver (Whitler and Warner, 2014; Boston Water and Sewer Commission, 2013; New York City, 2013). Other recent examples include Singapore, Melbourne, Sydney, Windhoek, and Sao Paulo (Bahri, 2012; Mukheibir and Currie, 2016; Onyango et al., 2014). A review of the literature indicates that there are no small size municipalities such as our case study site, Exeter New Hampshire USA, employing many IUWM techniques besides green infrastructure for stormwater management.

IUWM is a solution for cities facing singular or multiple water management stresses. As is well documented in many places (e.g. Intergovernmental Panel on Climate Change, 2014), water stresses in many cities globally will increase over time due to anthropogenic climate change causing more riverine and coastal floods, higher temperatures, changes in flow regimes, more salt water intrusion, and more intense rainfall. Climate changes will be compounded by demographic, land use, technological, and other