Environmental Science & Technology

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A Changing Framework for Urban Water Systems

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Urban water infrastructure and the institutions responsible for its management have gradually evolved over the past two centuries. Today, they are under increasing stress as water scarcity and a growing recognition of the importance of factors other than the cost of service provision are forcing a reexamination of long-held ideas. Research and development that supports new technological approaches and more effective management strategies are needed to ensure that the emerging framework for urban water systems will meet future societal needs.

INTRODUCTION

Over the last few decades, society has become increasingly aware of the vulnerability of urban water infrastructure as well as the water supply catchments and surface waters where sewage effluent and urban runoff are discharged. It is apparent that many of the centralized water supply and treatment strategies developed in Europe and North America during the period of industrialization in the nineteenth and twentieth centuries will not be able to meet future challenges. In industrialized countries, these challenges include climate variability, changing population densities, and the need to protect or improve ecosystems affected by infrastructure development. Existing systems in many industrialized countries are also reaching the end of their design lifetimes. Cities are thus facing seemingly insurmountable financial challenges related to replacing water distribution pipes and sewers while simultaneously upgrading treatment plants to address threats and legal requirements posed by nutrients, wastewater-derived organic compounds, and other pollutants.[1] In developing countries, the challenges posed by lack of capital to invest in large centralized water and sanitation infrastructure and rapid urbanization are often complicated by semiarid climates that are poorly suited for water-based sewage conveyance.[2]

Coincident with the growing realization of the inadequacy of our current approach to managing the urban water cycle, rapid developments in biotechnology, materials science, sensors, and computing are giving rise to technologies that have the potential to revolutionize urban water systems. In addition, an improved understanding of the ability of managed natural systems (e.g., constructed wetlands, managed aquifer recharge) to function as components of urban water infrastructure is opening up options that are more attractive to the public and less expensive to operate than conventional treatment plants. The existence of these alternative approaches is creating a new institutional framework, informed by decades of operational experience and strategies pioneered in the energy and transportation sectors, that supports a fundamental shift in the management of urban water systems.

In recent years, industrialized countries, such as Australia, Israel, and Singapore, and arid regions, such as the Southwestern United States, have made major technological and institutional improvements in their urban water systems. These changes have been motivated mainly by the need to increase water availability in the face of severe shortages.[3] In many Central and Northern European countries, where water shortages have been less of a problem, efforts to apply the principles of integrated urban water management, driven by a growing societal interest in promoting sustainability, have fostered changes.[4]

For a new framework for urban water systems to become fully established industrialized countries and to serve as a model for future water management in developing countries, sweeping changes will be needed in the ways that engineers and mangers of urban water systems approach the planning, design, and operation of urban water infrastructure. For this change to take hold, it will be necessary to embrace not only new technologies but also innovative management strategies that can create more resilient, economically sustainable water systems that will better serve society's future needs. Public acceptance, particularly for new technologies and unfamiliar practices (e.g., greywater recycling), will require more effective communication about

Special Issue: Design Options for More Sustainable Urban Water Environment

Published: May 8, 2013

   dx.doi.org/10.1021/es4007096 | *Environ. Sci. Technol.* 2013, 47, 10721−10726