NATIONAL WATER RESEARCH INSTITUTE

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EVOLUTION OF DRINKING WATER SYSTEMS IS THE FOCUS OF THE 2014 NWRI CLARKE PRIZE LECTURE

FOUNTAIN VALLEY, Calif. – Over the past 2,000 years, humans have engineered complex systems to deliver water to population centers and carry away wastes. Many of these systems are now experiencing stress caused by climate change and population growth, and are in need of replacement. This year's Clarke Prize Lecture, delivered by David L. Sedlak, Ph.D., focuses on strategies for developing and implementing new technologies to provide our cities with a reliable water supply while also protecting public health and the environment.

Sedlak received the $50,000 Clarke Prize and presented a lecture entitled "Delivering the Fourth Water Revolution" at the Twenty-First Annual NWRI Clarke Prize Conference and Award Ceremony, held on Friday, November 7, 2014, in Huntington Beach, California. The Clarke Prize is administered by National Water Research Institute (NWRI) in Fountain Valley, California, and is sponsored by the Joan Irvine Smith & Athalie R. Clarke Foundation, which helped established NWRI. The prize is awarded each year to recognize researchers in the U.S. who solve real-world water challenges and to highlight the need to continue funding this type of research. More than 160 guests from universities, water districts, and consulting firms attended this year's event.

A professor of civil and environmental engineering at the University of California, Berkeley, since 1994, Sedlak is a pioneer in water resource treatment and management. His research group published one of the first papers on steroid estrogens (which are endocrine disrupters) in wastewater and the environment. In 2000, Sedlak's team made a breakthrough when they developed a method to decrease the concentration of the contaminant N-nitrosodimethylamine (NDMA), a carcinogen, in water supplies. More recently, Sedlak has focused his research on natural system processes, such as using engineered treatment wetlands to remove chemicals from wastewater-impacted waters. His efforts have advanced techniques for improving water quality.

As Deputy Director of the National Science Foundation's Engineering Research Center for Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt), Sedlak has helped lay the groundwork for improved water infrastructure. Sedlak also advises an Expert Panel administered by NWRI and California State Water Resources Control Board's Division of Drinking Water on scientific, technical, and public health issues related to the development of criteria and regulations for advanced treatment water reuse.

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Sedlak was selected to receive the 2014 NWRI Athalie Richardson Irvine Clarke Prize because of his pioneering research on advancing the way water resources and urban water infrastructure are managed. His work has served as the foundation for major policy and technical initiatives to reduce the effects of these contaminants and protect public health.

"Dr. Sedlak is an outstanding choice for the Clarke Prize," said Jeff Mosher, Executive Director of NWRI. "He is acknowledged as an expert in water quality and in assessing the efficiency and capabilities of supply infrastructure and treatment processes. He has diligently served the water management and academic communities. In addition to producing high-quality original research and contributing new knowledge to the discipline, he is also training graduate students to become the next generation of leaders that will protect and manage our future water supplies. NWRI is honored to recognize Dr. Sedlak's contributions to society."

Sedlak is the author of a newly published book, *Water 4.0: The Past, Present, and Future of the World's Most Vital Resource*, which discusses the evolution of the urban water system and proposes the steps needed to rebuild the system for the future. Sedlak's lecture at the 2014 Clarke Prize Award Ceremony expands on information presented in his book.

According to Sedlak, the water systems developed more than 2,000 years ago are under stress from a confluence of factors, such as prolonged drought. Urban water systems have responded to these challenges with technological advances and institutional reforms. If water professionals wish to encourage a "water revolution" to adapt to these new conditions, they need to identify the underlying causes of problems in our current water infrastructure, develop solutions, and work within a complex and conservative institutional system to implement changes.

During his lecture, Sedlak identified climate change as the most important driver of the urban water revolution, especially over the long term. He stressed that wet places are likely to become wetter as dry places become drier, pointing out that models predict less precipitation in the American Southwest as ocean currents move much of the region's weather to the north. Also, as more precipitation in the mountains falls as rain instead of snow, our existing supply systems will capture less water. In places like the Sierra Nevada or Rocky Mountain Ranges, we could compensate for the loss of snowpack by expanding reservoirs, which is an expensive endeavor. Sedlak also emphasized that environmental engineers expect global warming will create lower water levels in reservoirs as environmental processes such as evaporation and transpiration increase. As the land becomes drier, the demand for water to irrigate crops will increase.

The second most significant stress on existing water supplies, according to Sedlak, is population growth. In the United States, people have been moving to cities with the least secure water supplies for the past 40 years, and water managers will not be able to keep up with demand in the future. Providing new sources of water for growing cities will be difficult because water rights have already been fully allocated. For instance, cities such as Mexico City, Sao Paolo, Singapore, Perth, and Delhi are looking for new solutions to water shortages exacerbated by the

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rapid growth in population. The traditional solutions of increasing water imports, drilling new wells, and increasing water use efficiency will not meet future demands for water, so innovation is necessary.

Sedlak emphasized that many research teams have proposed ideas for making urban water infrastructure more efficient and resilient. However, implementing new water management systems is a slow and challenging process for a number of reasons, such as the concern that new technologies must be protective of public health; the meager profit margins associated with public sector projects; and the long lifetimes of investments in urban water infrastructure. Sedlak suggested that the best way to make progress is to advocate for sensible reforms and then use the knowledge gained from technology demonstration projects to accelerate the rate at which new ideas are adopted.

Sedlak pointed to a project undertaken by the ReNUWIt Center was as an example of the obstacles to using innovative technologies to secure urban water supplies. The ReNUWIt research team designed a system that is capable of converting wastewater effluent or water collected from the roof of a building to drinking water without sending it to a centralized treatment plant. However, the team encountered resistance related to public health risks and the challenges associated with managing hundreds of remote treatment systems. This outcome was another reminder of the difficulty of implementing a new type of water management system.

Sedlak then talked about recent developments in the use of wetlands in urban water systems as an example of evolution in thinking about how natural systems can be integrated into water infrastructure. For decades, wetlands were neglected: people thought of them as swamps needing to be drained or as garbage dumps. Then, beginning in the 1960s, environmental engineers began designing treatment wetlands containing a diversity of habitats to remove nutrients from agricultural runoff or as a final stage in the municipal wastewater treatment process. These approaches led to the creation of attractive wetlands that provided excellent habitat and recreational opportunities, but often failed to achieve the full potential of natural systems to purify water. The next generation of wetlands was built by environmental engineers who were driven by a need to improve treatment efficiency. Through the efforts of ecological engineers, wetlands evolved into a viable option for removing nitrate from wastewater effluent and for the treatment of stormwater and industrial waste. Today, treatment wetlands offer engineers an attractive alternative to conventional pollution control infrastructure. Sedlak went on to describe a new kind of treatment wetland that he and his research team have invented for efficiently removing pharmaceuticals, waterborne pathogens, and nitrate from polluted rivers. He predicted that wetlands and other types of natural treatment systems will play a major role in the fourth generation of urban water systems.

At the conclusion of his lecture, Sedlak urged researchers and water professionals to focus not only on basic science, but to also consider the practical issues involved with identifying

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opportunities to create and implement improvements. "Working in the laboratory to create a new technology or studying a treatment plant or wetland with the latest scientific tools is only a small part of the solution," he said. "To overcome the many problems facing our water systems, we need to understand their underlying causes, the processes through which change comes about, and the small roles that we all play in improving these remarkable and essential systems."

Sedlak is the twenty-first recipient of the NWRI Clarke Prize, which is named after NWRI co-founder Athalie Richardson Irvine Clarke, a Southern Californian philanthropist who helped establish the City of Irvine and the University of California, Irvine. Her grandson, Morton Irvine Smith, presented Sedlak with the Clarke medallion and a check for $50,000 on behalf of the Joan Irvine Smith & Athalie R. Clarke Foundation.

More information about the Clarke Prize, including downloadable copies of the 2014 Clarke Lecture, is available at www.clarkeprize.com.

A 501c3 nonprofit, the National Water Research Institute (NWRI) was founded in 1991 by a group of California water and wastewater agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect the freshwater and marine environments through the development of cooperative research work. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

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