

# World Environmental and Water Resources Congress 2018

Selected Papers from the  
Proceedings of the World  
Environmental and Water  
Resources Congress 2018

Minneapolis, Minnesota  
June 3-7, 2018

International Perspectives, History  
and Heritage, Emerging Technologies,  
and Student Papers

**ASCE**

Edited by  
Sri Kamojiala, P.E., D.WRE

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ENVIRONMENTAL &  
WATER RESOURCES  
INSTITUTE

# WORLD ENVIRONMENTAL AND WATER RESOURCES CONGRESS 2018

*INTERNATIONAL PERSPECTIVES, HISTORY AND HERITAGE,  
EMERGING TECHNOLOGIES, AND STUDENT PAPERS*

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SELECTED PAPERS FROM THE WORLD ENVIRONMENTAL AND  
WATER RESOURCES CONGRESS 2018

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June 3–7, 2018  
Minneapolis, Minnesota

SPONSORED BY  
Environmental and Water Resources Institute (EWRI)  
of the American Society of Civil Engineers

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Sri Kamojjala, P.E., D.WRE



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## Preface

We are excited to offer the proceedings of the 2018 World Environmental and Water Resources Congress. The proceedings include published papers from an engaging and challenging array of technical sessions, posters, and workshops at the Environmental and Water Resources Institute's (EWRI) 18th annual Congress, held in Minneapolis, Minnesota, June 3-7, 2018. This conference is a leading venue for professional interaction among engineers and scientists, covering disciplines related to water and environmental resources and infrastructure.

Within the five (5) volumes of the proceedings, nearly 200 written scientific and technical papers from nearly 800 oral and poster presentations focusing on the subject areas of various EWRI Councils are included. A list of subject area tracks is included in the acknowledgements below. We hope these proceedings serve to enhance your knowledge and encourage you to follow up with more detailed publications by the same authors, and related papers, typically found in ASCE technical journals.

The collection of papers in this book, *World Environmental and Water Resources Congress, 2018, International Perspectives, History and Heritage, Emerging Technologies, and Student Papers* contains papers organized by the following EWRI Councils:

- **Students Council** whose purpose is to draw students in to the field of civil and environmental engineering through presentations, activities, technical sessions and other activities at EWRI conferences.
- **History and Heritage Committee** whose purpose is collecting, organizing, and disseminating information related to the history and heritage of water resources and environmental engineering.
- **Emerging and Innovative Technologies Committee (Interdisciplinary Council)** whose purpose is to develop and apply emerging and innovative technologies to support the functioning of EWRI, to advance the development, knowledge, and application of emerging and innovative technologies for the planning and management of water resources and the protection and enhancement of the environment; to encourage the reporting, discussion of technical and social issues, and information transfer of applications of emerging and innovative technologies; and to foster the multidisciplinary use of these technologies.
- **International Council** whose purpose is to undertake and facilitate a variety of technical and liaison activities in support of international collaboration and international promotion of the role of the Institute.
- **Education & Research Council** whose purpose is to facilitate education and outreach to all current and potential EWRI members beginning with the precollege years and specifically including under-represented groups in science and engineering.

## Acknowledgments

Preparation and planning for this Congress strongly depends on the dedication of those individuals who plan session topics, solicit abstracts and papers, oversee reviews of all submissions and then “encourage” all authors to provide their material in a timely manner! We are deeply grateful to all who have provided this considerable effort, especially the track chairs listed below:

Track	Chairs
16th Groundwater Symposium	Paul Mathisen
Desalination Symposium	Bridget Wadzuk
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Emerging & Innovative Technologies	David Hill and Barak Fishbain
Environmental	Wendy Cohen and Lisa Hayes
History & Heritage	Larry Magura
Hydraulics & Waterways	Fabian A. Bombardelli
Hydro-climate/Climate Change Symposium	Levent Kavvas
International Issues	Ali Mirchi and Erfan Goharian
Irrigation & Drainage	Tom Ley
Planning and Management	Mashor Housh and Kaveh Madani
Professional Practice	Greg Scott
New Professionals	Colleen Bronner
Smart Water Symposium	Sudhir Kshirsagar and Branko Kerkez
Standards	Kathlie S. Jeng-Bullock
Stormwater Symposium	Bill Hunt, Ruth Hocker and Bridget Wadzuk
Student Competition	Wes Lauer
Sustainability	David Cowan
Watershed	Don Frevert and Levent Kavvas
Water Distribution System Analysis (WDSA) Symposium	Regan Murray
Water, Wastewater and Stormwater	Bridget Wadzuk

We also acknowledge the members of the following Congress Organizing Committees, without whose time and efforts the event would not be possible.

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Veronica Webster, Ph.D., M.ASCE

Finally, we acknowledge and thank the staff of the EWRI and ASCE who, in the end, makes this conference a reality. In particular, we thank Gabrielle Dunkley, EWRI's Manager, whose patience, perseverance, good humor, and great organizational talent ensure yet another successful EWRI Congress!

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