

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

Groundwater, Sustainability, and
Hydro-Climate/Climate Change

ASCE

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

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ENVIRONMENTAL &
WATER RESOURCES
INSTITUTE

WORLD ENVIRONMENTAL AND WATER RESOURCES CONGRESS 2018

*GROUNDWATER, SUSTAINABILITY, AND
HYDRO-CLIMATE/CLIMATE CHANGE*

SELECTED PAPERS FROM THE WORLD ENVIRONMENTAL AND
WATER RESOURCES CONGRESS 2018

June 3–7, 2018
Minneapolis, Minnesota

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

EDITED BY
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: Groundwater, Sustainability, and Hydro-Climate/Climate Change* contains papers organized by the following EWRI Councils:

- **Environmental Council** whose purpose is to establish a focal point and provide a forum for civil engineers and scientists to participate and exchange ideas on the full range of innovative and emerging environmental engineering topics.
- **Symposium: Groundwater (Council)** whose purpose is the dissemination of knowledge on many aspects of groundwater including groundwater hydrology, ground water planning and management, and groundwater quality.
- **Sustainability Committee (Interdisciplinary Council)** whose purpose is to promote sustainability as a central discipline of EWRI by helping coordinate and optimize sustainability initiatives throughout EWRI, and with external organizations seeking to promote a more sustainable built environment.
- **Symposium: Hydro-Climate/Climate Change (Committee)** whose purpose is to provide a formal organizational structure within ASCE/EWRI for addressing the various engineering problems that are created by hydroclimate phenomena and climate change, fostering their science-based engineering solutions.

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
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Education	Cecilia Elmore
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-Bulloch
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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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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