

World Environmental and Water Resources Congress 2016

Watershed Management, Irrigation and
Drainage, and Water Resources Planning
and Management

Selected Papers from the Proceedings
of the 2016 World Environmental
and Water Resources Congress

West Palm Beach, Florida
May 22–26, 2016



Edited by

Chandra S. Pathak, Ph.D., P.E., D.WRE



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WORLD ENVIRONMENTAL AND WATER RESOURCES CONGRESS 2016

*WATERSHED MANAGEMENT, IRRIGATION AND
DRAINAGE, AND WATER RESOURCES PLANNING
AND MANAGEMENT*

PAPERS FROM SESSIONS OF THE PROCEEDINGS OF THE 2016
WORLD ENVIRONMENTAL AND WATER RESOURCES
CONGRESS

May 22–26, 2016
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Environmental and Water Resources Institute
of the American Society of Civil Engineers

EDITED BY
Chandra S. Pathak, Ph.D., P.E., D.WRE
Debra Reinhart, Ph.D., P.E.



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Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia, 20191-4382
www.asce.org/publications | ascelibrary.org

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Errata: Errata, if any, can be found at <http://dx.doi.org/10.1061/9780784479858>

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ISBN 978-0-7844-7985-8 (PDF)
Manufactured in the United States of America.

Preface

We are excited to offer an engaging and challenging array of technical sessions, posters, and accompanying published papers at our Environmental and Water Resources Institute's (EWRI) 16th annual Congress in West Palm Beach, Florida. This meeting is a leading venue for professional interaction among engineers and scientists, covering disciplines relating to the needs of critical infrastructure in water and environment. As is pointed out in the American Society of Civil Engineers' Report Card for America's Infrastructure, an investment of over \$3.6 trillion is needed to return the nation's infrastructure to a state of good repair. This Congress contributes in many ways to innovative solutions to this critical problem. We proudly host the meeting under the auspices of the American Society of Civil Engineers (ASCE).

Within the five (5) collections of papers in the proceedings of the Congress you will find nearly 300 written technical papers from more than 700 oral and poster presentations dealing with the subject areas of the EWRI Councils; a list of subject area tracks is included in the acknowledgements below. Our profession advances through presentations in special state-of-knowledge tracks represented at the Congress. We hope these proceedings serve to enhance your knowledge in these areas and encourage you to follow up with more detailed publications by the same authors, typically found in ASCE technical journals.

World Environmental and Water Resources Congress 2016: Watershed Management, Irrigation and Drainage, and Water Resources Planning and Management contains papers organized by the following EWRI Councils:

- **Watershed Council** whose purpose is to advance scientific and engineering principles for the collection, coordination, and dissemination of knowledge of watersheds from the standpoint of hydrologic, hydraulic, water quality and environmental processes.
- **Irrigation and Drainage Council** whose purpose is to promote responsible use of water resources and protection/enhancement of the environment through the development, collection and dissemination of information regarding the use and application of irrigation and drainage systems.

- **Planning and Management Council** whose purpose is to create, organize, and manage the activities of various technical committees dealing with water resources planning and management.

Acknowledgments

Preparation and planning for this Congress strongly depends on the dedication of those who plan track subjects, solicit abstracts and papers, oversee reviews of all this material 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
Symposium Hydro-Climate/Climate Change	Levent Kavvas
13th Urban Watersheds Management Symposium	Shirley Clark
14th Symposium on Groundwater and Hydraulic Fracturing	Antonella Sciortino, Teresa Culver, Amy Chan Hilton
18th Annual Water Distribution Systems Analysis Symposium	Jakobus van Zyl
Education and Research	Cassie Klump
Emerging Technologies	David Hill
Environmental	Marge Bedessem
History and Heritage	J. David Rogers
Hydraulics and Waterways	David Weston, Weiming Wu
International	Kevah Madani
Irrigation and Drainage	Garry Grabow
Planning and Management	Mashor Housh
New Professionals/Professional Development	Jeanne Van Briesen
Standards	Kathlie Jeng-Bulloch
Student	Monica Palomo
Sustainability	Ashlynn Stillwell
Water, Wastewater, and Stormwater	Sri Kamojjala
Watersheds	Levent Kavvas, Don Frevert

We also acknowledge the Congress Organizing Committee members, without whose time and efforts the event would not be possible. We also thank others not mentioned here.

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Finally, we acknowledge and thank the staff of the EWRI of ASCE who, in the end, makes it all happen. Most particularly, 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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Contents

Irrigation and Drainage

The Use of an Analytic Element Model to Assess the Ground Water Impacts of Canals in Southern Florida	1
M. M. Wilsnack	

The Use of an Analytic Element Model to Evaluate the Effects of Proposed Seepage Management Facilities in Southern Florida	11
M. M. Wilsnack	

Influence of Irrigation Patterns on the Effectiveness of Furrow Irrigation of Cotton.....	21
E. D. Vories and A. S. Jones	

A Novel Bio-Inspired Pressure Compensating Emitter for Low-Cost Drip Irrigation Systems.....	30
Ruo-Qian Wang, Pulkit Shamschery, and Amos G. Winter V	

Designing In-Field Water Storage and Sub-Irrigation for an Agricultural Drainage System	37
J. Kjaersgaard, A. Janz, and M. Wagner	

Planning and Management

Attitude-Based Negotiations for Resolving Water and Environmental Conflicts	47
S. Yousefi, S. M. Hajimirzaie, and E. Z. Hosseini pour	

A Hydro-Economic Perspective into South Florida's Water Resource Management Tradeoffs under Climate Change	57
Ali Mirchi and David Watkins	

Temporal Disaggregation of Seasonal Forecasting for Streamflow Simulation.....	63
Chia-Jeng Chen	

Risk-Based Performance Assessment of Stormwater Drainage Networks under Climate Change: A Case Study in the City of Kingston, ON	73
Michael G. Nanos and Yves Fillion	

Impacts of the 2012–2015 Drought on the Brazilian Hydropower System	82
Renato C. Zambon, Mario T. L. Barros, and William W.-G. Yeh	
A New Water Mains Integrity Management Program for California.....	92
Andrea Bautista, Juneseok Lee, and Jonathan Keck	
Double-Mass and SWAT Analysis of Land Use Pattern Change Effects on Rainfall-Runoff and Runoff-Sediment Relations in Yom River Basin.....	99
Aksara Putthividhya and Thao Ngo	
Assessment of Drought Impacts on Agricultural Water and Energy Uses in the Central Valley of California	111
M. Fayzul K. Pasha, Dilruba Yeasmin, and Seshnag Kamuni	
Performance Assessment of a Water Utility in California.....	123
Gamze Güngör-Demirci, Juneseok Lee, and Jonathan Keck	
Modeling Floodplain Inundation for Monument Creek, Colorado	131
Pratik Pathak, Manahari Bhandari, Ajay Kalra, and Sajjad Ahmad	
Coupling Agent-Based and Groundwater Modeling to Explore Demand Management Strategies for Shared Resources	141
Shams Al-Amin, Emily Z. Berglund, and Kumar Mahinthakumar	
Estimating Hourly Water Temperatures in Rivers from Air Temperatures	151
Gang Chen and Xing Fang	
Determination of CSO Volume for Impact Assessments under Extreme Flooding Conditions: A Case Study	162
Mohammad Karamouz and Helieh Abbasi	
Enhancing the Performance of Multiobjective Evolutionary Algorithms for Sanitary Sewer Rehabilitation Problems.....	171
Olufunso Ogidan, Bruno Itaquy, and Marcio Giacomoni	
Use of a Cellular Automata Model to Assess Land Use Change and Its Effects on the Hydrologic Flow Regime.....	181
Vahid Zarezadeh and Marcio Giacomoni	
A Streamlined Approach for Estimating the Energy Efficiency of a Water Distribution System	189
Brett Snider and Yves R. Filion	
Modeling Variable Speed Pumps for Optimal Pump Scheduling.....	199
Ruben Menke, Edo Abraham, and Ivan Stoianov	

Modeling Interstate Runoff with a Physics-Based, Spatially Explicit Model (GSSHA) Using High-Resolution DEM Data and Measured Field Data	210
Mitchell F. Moore and Jose G. Vasconcelos	
A Multi-Core Parallel Genetic Algorithm for the Long-Term Optimal Operation of Large-Scale Hydropower Systems	220
Benxi Liu, Shengli Liao, Chuntian Cheng, and Xinyu Wu	
Web-Based Decision Support Tool to Aid in Early Drought Detection for Water Suppliers	231
Kathryn Booras, Richard N. Palmer, W. Josh Weiss, and Clark Howells	
Multi-Purpose Reservoir Operation: A Tradeoff Analysis between Hydropower Generation and Irrigated Agriculture Using Hydro-Economic Models	241
José M. González, Marcelo A. Olivares, Josué Medellín-Azuara, Rodrigo Moreno, and G. Marques	

Watershed

Bioremediation of Eutrophic Water by the Controlled Cultivation of Water Hyacinths	251
Yingying Zhang, Zhiyong Zhang, Zhi Wang, Haiqin Liu, Xuezheng Wen, Hongjie Qin, Shaohua Yan, and Bruce E. Rittmann	
Improvements to SIU's Engineering Campus Parking and Walkways along Campus Lake	262
Melissa Peterein, Gilles-Arnaud A.-D. Kandissounon, Ajay Kalra, and Sajjad Ahmad	
Antecedent Snow Covered Area Analysis for Inflow Design Floods	272
Steven F. Daly and Angela Duren	
WaterTowns and Green Infrastructure—Improving Watersheds through Community Engagement and Planning	285
D. D. Carpenter, R. L. Pieschek, A. Vaara, and A. Oparka	
Case Studies of the Sponge City Program in China	295
Xiaoning Li, Junqi Li, Xing Fang, Yongwei Gong, and Wenliang Wang	
Non-Stationary Estimation of the Return Period of Shallow Landslide Triggering	309
Antonino Cancelliere and David J. Peres	
Efficiency Assessments of a City's BMP in a Cold Region	319
Yeo Howe Lim, Abbie M. Beaudry, Nicholas Lindstrom, and Ryan Hanson	