World Environmental and Water Resources Congress 2023

Adaptive Planning and Design in an Age of Risk and Uncertainty

Selected Papers from the World Environmental and Water Resources Congress 2022

Henderson, Nevada, USA
21 – 25 May 2023

Part 1 of 2

Editors:

Sajjad Ahmad
Regan Murray

ISBN: 978-1-7138-7393-8

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571

Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2023) by American Society of Civil Engineers
All rights reserved.

Printed with permission by Curran Associates, Inc. (2023)

For permission requests, please contact American Society of Civil Engineers
at the address below.

American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 20191
USA

Phone: (800) 548-2723
Fax: (703) 295-6333

www.asce.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

Contents

Cyber-Physical Security

Enhancing the Reliability of a Contamination Detection Sensors' Network in Water Distribution Systems during a Cyber-Attack.....1
Gopinathan R. Abhijith, Elad Salomons, and Avi Ostfeld

Emerging and Innovative Technologies

Graph Method for Modelling Multiple Pipe Failure Scenarios in Urban Drainage Networks 13
Aun Dastgir, Martin Oberascher, Sina Hesarkazzazi, Mohsen Hajibabaei, and Robert Sitzenfrei

Hydropower Potential at Non-Powered Dams: A Multi-Criteria Decision Analysis Tool Based on Grid, Community, Industry, and Environmental Impacts.....23
Kazi Tamaddun, Sarah Barrows, Muhammad Usama Usman, Jakob Meng, Nathan Woodruff, Ryan Harnish, Devyn Powell, Abigail King, and Thomas Mosier

Landslide Hazard Zonation in the Alaknanda River Basin Using Innovative Techniques.....32
Sachchidanand Singh, Mitthan Lal Kansal, and Aditya Tyagi

Moving Beyond Bulletin 17C with Bayesian Flow Frequency Analysis 45
David Margo and C. Haden Smith

The New Headworks Odor Control Biotrickling Filter Project: Performance Data and Operations and Maintenance Challenges at Hyperion Water Reclamation Plant in the City of Los Angeles, California 59
K. Majid Sadeghi, Sheri Symons, Shahrouzeh Saneie, Nicole McIntosh, Joel Jimenez, Octavio Murillo, Steve Gonzales, Mohamadali Sharbatmaleki, and Hugo Loáiciga

Emerging Contaminants

Adsorption of Sulfamethazine to Biochar.....74
Sebastian Lopez and Dong Hee Kang

© ASCE

Energy

Marginal Cost of Energy Volatility in the Brazilian Interconnected Power System 80
Daniel Lyra Rodrigues, Camila Brandão Nogueira Borges, Renato Carlos Zambon, and William W.-G. Yeh

Small-Scale Physical Model for Studying the Effect of Rock Mass Parameters in the Hydraulic Erosion Process of Unlined Spillways 89
Marie-Hélène Wisse, Aboubacar Sidiki Koulibaly, Ali Saeidi, and Marco Quirion

Environmental

Valorization of Agricultural and Marine Waste for Fabrication of Bio-Adsorbent Sheets..... 99
Salma O. Elshabrawy, Mohammad Mansour, Amal Elhussieny, Shimaa Husien, A. B. Abdel-Aziz, Irene S. Fahim, Lobna A. Said, and Ahmed G. Radwan

Freshwater Systems and Ecology

Temporal and Spatial Variation of Water Quality in an Agricultural/Livestock Setting..... 114
Jake Webb, Bettie Shoemaker, Lorena Chavarro-Chaux, and John J. Ramirez-Avila

Groundwater Symposium

Borehole Yield Estimation from Electrical Resistivity Measurements—A Case Study of Garu-Tempane and Bawku West Districts, Upper East Region, Ghana 124
Albert Acheampong

Lowering of Groundwater Levels and Their Effect on Water, Sanitation, and Hygiene Services in the Savelugu District, Northern Region of Ghana..... 134
Albert Acheampong

Prevention of Thermal Pollution of Groundwater near Open Loop Geothermal Energy Systems 140
R. M. Neupauer, J. Okkonen, and E. Tyson

History and Heritage

EWRI Friends Visit London Water & Steam Museum and Union Chain Bridge–IHCEL 151
William P. Bulloch, Kathlie S. Jeng Bulloch, and Jerry Rogers

© ASCE

Edwin S. Nettleton (1832–1901): Colorado's State Engineer 165
Cole Bedford

Hydraulics and Waterways

Application of CFD Modeling to Improve Calibration of 2D Hydraulic Model.....174
Jie Zeng, Zubayed Rakib, and Matahel Ansar

Applying HEC-RAS to Simulate the Complex Tidal Conditions for Estuaries and Bays: A Case Study of the San Francisco Bay 185
William H. Campbell, Gaurav Savant, Arturo S. Leon, and Linlong Bian

Assessment of the Sediment Deposition at the Port of Port Arthur, Texas, Using HEC-RAS Model.....194
Qin Qian and Jennifer Galindo

Effect of Modeling Setup Parameters in SWMM Predictions of Large-Scale Tunnel Filling.....208
Vitor G. Geller and José G. Vasconcelos

Effect of Dam Height on Breaching due to Overtopping of Non-Cohesive Earthen Dams 219
Heather O'Donal, Matthew Czapiga, Ezzat Elalfy, Enrica Viparelli, and M. Hanif Chaudhry

Floodplain Mapping of Ungauged Watershed Using HEC Models and PERSIANN Precipitation 224
Ajay Kalra, Abhiru Aryal, Amrit Bhusal, and Ritu Gupta

Flow Past: An Artificial Channel Confluence with Mobile Bed.....235
Wahidullah Hakim Safi and Pranab K. Mohapatra

Flow Resistance and Stage-Discharge Relationships in Compound Channels with Composite Roughness 245
Ebissa Gadissa Kedir, C. S. P. Ojha, and K. S. Hari Prasad

Hydrodynamic Flood Modeling with HEC-RAS 6.3: A Case Study of the Pakke River in Seijosa, Arunachal Pradesh, India 259
Ghritartha Goswami and Ram Kailash Prasad

Numerical Modeling of Embankment Failure due to Overtopping.....271
Ezzat Elalfy, Enrica Viparelli, Matthew J. Czapiga, Jasim Imran, and M. Hanif Chaudhry

© ASCE

Physic-Informed Neural Network Approach Coupled with Boundary Conditions for Solving 1D Steady Shallow Water Equations for Riverine System 280
Zeda Yin, Linglong Bian, Beichao Hu, Jimeng Shi, and Arturo S. Leon

Three-Dimensional Numerical Modeling of a Small Pond Outlet Structure 289
Aaron L. Sprague and Donald Baker

Hydro-Climate/Climate Change

Assessment of Rainfall Variability and Drought Characteristics over South India 298
Brij Kishor Pandey

Deep Neural Networks for ENSO Prediction in the Niño 3.4 and Niño 1+2 Regions 307
Kennedy Richard Gomez-Tunque, Eusebio Ingol-Blanco, Abel Mejia-Marcacuzco, Eduardo Chávarri-Velarde, and Edwin Pino-Vargas

Evaluating Rainfall and Temperature Trends in the Small Island Developing State of St. Lucia Using Nonparametric Statistics and Soft Computing 317
Lee P. Leon and Neil Oculi

Examining Precipitation-Based Climate Indices' Trends for Northwest Indiana 328
C. V. Chandramouli and Nolan Rogers

Performance of the GPM IMERG and CMORPH Gridded Precipitation and Rain on Grid Approaches to Reproduce the Pluvial Flood of 2022 in the Lower Indus Basin, Pakistan 336
Babar Naeem and Zarif Khero

Regionalization for Flood Frequency Analysis: Sensitivity to Choice of Clustering Algorithm and Distance Metric 353
Arpita Mondal, Reema Roy, and Chingka Kalai

Relative Sea Level Trends before 1992 in the 20th Century from Seven GPS-Paired Tide Gauge Records along the Coast of the Chesapeake Bay 367
Xin Zhou, Yi Liu, and Sotonye Ikiriko

Simulation of Extreme Precipitation Events Using an Improved K-Nearest Neighbor Model 381
Mohammed Sharif

© ASCE

The 21st-Century Relative Sea Level Rise in Anne Arundel County, Maryland....390
Sotonye Ikiriko, Yi Liu, Sean Qian, and Xin Zhou

Urban Water Infrastructure Design in Climate Change Context: Advances and Challenges in Developing Engineering Practice Guidelines....399
Van-Thanh-Van Nguyen

Using an Urban Growth Model Framework to Project the Impacts of Climate Change on Coastal Populations....405
Becca Naurath, Jennifer L. Irish, and Yang Shao

WEHY Modeling and Its Sensitivity to Precipitation Field Input: A Case Study from Cottonwood Creek Watershed....413
H. Felipe Ulloa, M. Levent Kavvas, and Yoshihiko Iseri

International Issues

Modeling International Rural Low-Cost Water Supply Projects with EPANET: Application and Best Practices—A Case Study....422
Joshua N. Knight, Chandana K. Pradeep, and Eugene W. Lendzemo

Irrigation and Drainage

Crop Water Stress Index for Devising Water Efficient Irrigation Schedules for Wheat Crop....435
Aditi Yadav, Hitesh Upreti, Gopal Das Singhal, and Jyoti Kumar Sharma

Development of Water Saving Strategy for Wheat Crop by Combining Drip Irrigation System with Regulated Deficit Irrigation....447
Gopal Das Singhal, Ghanshyam Giri, Hitesh Upreti, Nayan Sharma, Ravikant Pandey, Praveen Singh, and Vasantha Pyla

Effect of Vertical and Horizontal Hydraulic Conductivity on Soil Moisture Response....456
M. Fayzul K. Pasha, Lubo Liu, Jiangjun Li, and Dilruba Yeasmin

Characteristics of Drought Events That Influence Crop Yield in the Southeastern United States....463
C. Prakash Khedun and Clement D. D. Sohoulande

Possibilities and Considerations for the Integration of Photovoltaic Generation with On-Farm Irrigation Systems....470
Kyle Feist, Sierra Layous, and Stuart Styles

© ASCE

Simple, Economical Measurement Method for Accurate Volumetric Water Accounting in Irrigation District Turnouts 478
Sierra Layous and Stuart Styles

Modeling of Pollution Spreading Problems on Irrigated Lands 493
Serhii Telyma, Olena Voloshkina, Olena Zhukova, and Rostyslav Sipakov

Municipal Water Infrastructure

Understanding Differences in User Preferences across Water Systems in Rural Alaska 509
Nicola Ritsch, Miriam Tariq, Michaela LaPatin, Daniel Armanios, Kasey Faust, and Leif Albertson

Planning and Management

Assessing Linkages to Climate Change in Western States' Water Plans 519
R. Marie Garcia, C. Prakash Khedun, and Ronald A. Kaiser

Collecting At-Home Water Quality Observations through a Citizen Science Project to Characterize Risk of Lead in Drinking Water 527
Emily Z. Berglund, Mohammad Ali Khaksar Fasaee, Danielle E. Lin Hunter, and Caren B. Cooper

Economic Evaluation of Lesotho Investment under Climate Change 534
Tolulope Odunola, Patrick Ray, Casey Brown, Brent Boehlert, Kenneth Strzepek, Jeremy Richardson, and Diego Castillo

Optimization of Urban Water Supply Planning for a Mid-Sized City in the Yangtze River Delta 553
Zihan Zheng, Run Hu, Haocheng Fan, Jianyu Zhou, and Tingju Zhu

The Impacts of Climate Change on Water Availability: A Case Study in the Tietê River Basin, Brazil 565
Lis V. Bentes, Felipe Sgarbi, Bruna Nunes, Priscilla Ghisi, Mathias Ludwig, Melina Amoni, and Douglas Vieira

River Restoration

Improving the Physical and Biological Condition of Urban Stream in the City of Baltimore 579
Jalil Abdul and Dong Hee Kang

Smart Water

An Agent-Based Modeling Approach to Simulate the Performance of Hybrid Water Systems and Rainwater Micro-Trading 587
Elias Zauscher and Emily Berglund

© ASCE

Stormwater

A 2D Rain-on-Mesh Model for Simultaneous Hydrologic and Hydraulic Computation 594
Ajay Kalra, Balbhadra Thakur, Abhiru Aryal, and Ritu Gupta

A Mass Balance Model of Rubber Crumb Discharge from Sports Fields and Contribution to Zinc Contamination in Motions Creek, New Zealand 607
Daniel Ahn and Matthew D. Davis

A Real-Time Water-Level Sensor Network and SWMM Model for the Design and Assessment of Low Impact Development Techniques 622
G. Cothren, D. Charalampidis, and J. Vu

Analysis of Bioretention Capability in Removing Microplastic Particles from Stormwater 629
R. McDowell, C. McRae, Y. Sangsefidi, K. Bagheri, and H. Davani

Assessing the Impact of Antecedent Dry Period and Storm Volume on Nitrogen Transport in Biochar-Amended and Compost-Amended Roadway Soils 636
Maria S. Rossetti and Teresa B. Culver

Characterization of Stormwater Debris Model Parameters in Southern California's Dense Urbanized Watersheds 648
Kian Bagheri, Hassan Davani, Trent Biggs, and Hilary McMilan

Characterization, Complexities, and Strategic Planning for Urban Flood Management: A Case Study of Gurugram 661
Osheen, Mitthan Lal Kansal, and Deepak Singh Bisht

Developing Green Stormwater Infrastructure Strategies to Reduce Flood Runoff and Improve Water Quality for the Vulnerable Coastal Communities of Houston 675
Afiya Narzis and Jessica Eisma

GIS-SWMM-Based LID Design Evaluation 688
Demetria Christo and Gianna Cothren

Infiltration Rate Assessment of Experimental Rain Garden Using Conventional Models and Machine Learning Algorithms 697
Sandeep Kumar and K. K. Singh

© ASCE

Optimal Control of Combined Sewer Systems to Minimize Sewer Overflows by Using Reinforcement Learning **711**
Zeda Yin, Arturo S. Leon, Abbas Sharifi, and M. Hadi Amini

Remediation of Urban Stormwater Using Best Management Practices and Low-Impact Development Green Infrastructure **723**
Edward Brown and Dong Hee Kang

Assessing the Implementation of Stormwater Utility Fees: A Review of Case Studies **733**
Adriélli B. Pagnoncelli, James Hunter, and Dong Hee Kang

Sustainability

Artificial Turf on Urban Landscapes: An Overview **740**
Tarannum Kalam Khandoker, Abdullah O. Yusufzai, Sajjad Ahmad, and Haroon Stephen

Climate Change and Pavement Performance: An Overview of Current Status and Research Approaches **755**
Jejal Bathi, Maxine Otieno, Mbakisya Onyango, Ignatius Fomunung, and Joseph Owino

Informing Efficient Landscape Watering through Weekly Neighborhood Watering Recommendations in College Station, Texas **767**
Alan C. Lewis, C. Prakash Khedun, and Ronald A. Kaiser

Introducing a Novel Hybrid Agent-Based Framework for Simulating the Adoption of Residential Water Conservation Behaviors **775**
Seyyed Ahmadreza Shahangian, Massoud Tabesh, Masoud Yazdanpanah, Abbas Akbarzadeh, Mohammad Amin Raoof, Tahereh Zobeidi, Mohsen Hajibabaei, and Robert Sitzenfrei

Performance Evaluation of Rainwater Harvesting Structures in Arid and Semi-Arid Regions **789**
Alina Shrestha, Haroon Stephen, and Sajjad Ahmad

Smart Cities Designed by Smart Communities: An Engaged Approach to Develop a Sociotechnical Network **797**
Oswald Jenewein, Michelle A. Hummel, Karabi Bezbourah, Yonghe Liu, and Kathryn Masten

© ASCE

Water Distribution Systems Analysis

A Graph-Theory Based PRV Placement Algorithm for Reducing Water Age in Water Distribution Systems 807
Tomer Shmaya and Avi Ostfeld

A Machine Learning-Based Surrogate Model for Coupled Hydraulic and Water Quality Simulation in Water Distribution Networks 817
Ivo Daniel, Gopinathan R. Abhijith, Leonid Kadinski, Avi Ostfeld, and Andrea Cominola

A Hybrid Approach for Considering Topography in Graph-Based Optimization of Water Distribution Networks 831
Robert Sitzenfrei, Mengning Qiu, Avi Ostfeld, Dragan Savic, and Zoran Kapelan

Asset Management Perspective in Long-Term Rehabilitation of Aged Water Distribution Networks 842
Amin Minaei, Mohsen Hajibabaei, Adell Moradi Sabzkouhi, Sina Hesarkazzazi, Soliman Abusamra, Enrico Creaco, and Robert Sitzenfrei

Black-Box Modeling of Water Quality in WDS: A Case Study.....858
Laura González, Dominic L. Boccelli, and Juan Saldarriaga

Conjunctive Optimal Operation of Power and Water Networks.....867
Tomer Shmaya, Mashor Housh, Filippo Pecci, Kyri Baker, Joseph Kasprzyk, and Avi Ostfeld

Coupling Machine Learning and Agent-Based Modeling to Characterize Contamination Sources in Water Distribution Systems for Changing Demand Regimes 881
Emily Berglund, Brent Vizanko, Leonid Kadinski, and Avi Ostfeld

Effect of Skeletonization on Energy Consumption of Water Distribution System 891
M. Fayzul K. Pasha, Luis Perez, Matthew Weathers, and Brennan Smith

Effects of Key Water Quality Parameters on Lead Leaching from Water Service Pipelines.....900
Timothy Grgec and Jianpeng Zhou

Impact of Data Preparation on the Performance of Pipe Break Status Prediction Models 908
Rebecca Dziedzic

© ASCE

Inferring the Stochasticity Associated with Modeling the Biological Stability of Drinking Water within Distribution Networks 918
Gopinathan R. Abhijith and Avi Ostfeld

Investigating a Diversified and Decentralized Water Distribution System to Enhance Water Supply Resilience to Disruptive Events 941
Amrit Babu Ghimire, Utsav Parajuli, Amrit Bhusal, Anjan Parajuli, Mandip Banjara, and Sangmin Shin

Optimal Booster Chlorination Scheduling in WDS under Uncertainty: A Robust Counterpart Approach 952
Sriman Pankaj Boindala, G. Jaykrishnan, and Avi Ostfeld

Optimal Operation of Water Distribution Systems under Uncertainty 963
Gal Perelman and Avi Ostfeld

Optimal Reorganization and Extension of an Existing Water Distribution Network Using the Thevenin Equivalent Network 974
Raman Balireddy, Anjan Chakravorty, Soumendra Nath Kuiry, and S. Murty Bhallamudi

Optimization Techniques for Chlorine Dosage Scheduling in Water Distribution Networks: A Comparative Analysis 987
Mohammadreza Moeini, Lina Sela, Ahmad F. Taha, and Ahmed A. Abokifa

Pipe and Isolation Valve Replacement Prioritization in an Urban Water Distribution Network 999
Bahar Adem Beker and Mitthan Lal Kansal

Reconstruction of Missing Information in Water Distribution Networks Based on Graph Theory 1015
Mohsen Hajibabaei, Sina Hesarkazzazi, Aun Dastgir, Amin Minaei, and Robert Sitzenfrei

Short-Term Water Demand Prediction Using Machine Learning Techniques—A Case Study of Telford Borough in Pennsylvania 1027
Oluwabunmi M. Iwakin and Faegheh Moazeni

Teaching Pipe and Pump Hydraulics: Hands-On Laboratory Exercises Using the Aqualibrium Model 1037
Jakobus E. van Zyl, Colin N. Whittaker, Naser Mostashiri, Kelly Cokorudy, Zoe Martin, Santiago Carrillo Trivino, and Claire Donald

© ASCE

Toward Digital Twins for Emerging Contaminants in Water Distribution Systems 1047
Gopinathan R. Abhijith, David B. Steffelbauer, and Avi Ostfeld

VisWaterNet: Visualization of Water Distribution Networks 1058
Meghna Thomas, Tyler Trimble, and Lina Sela

What's Next in Water Distribution Systems Management? 1071
Gal Perelman and Avi Ostfeld

Water Quality Modeling and Restoration

A Historical Review of Water Quality Conditions in Lake Erie Watershed from 1928 to 2022 1077
William F. Ritter and S. Rao Chitikela

Assessment and Modeling of Groundwater Quality Using GIS and Machine Learning Techniques for Drinking Purpose 1092
Hemant Raheja, Arun Goel, and Mahesh Pal

Lake Michigan Beaches' *E. Coli* Prediction Tool Using Artificial Neural Network 1113
Chandramouli V. Chandramouli, Michael Ozeh, and Mitra Khanibeseri

Optimization of Water Quality Sensor Placement in Sewer Networks 1119
Aly K. Salem and Ahmed A. Abokifa

Pollutant Source Identification and the Impact of Land Use and Land Cover in the Upper Yamuna Basin in India 1127
Mitthan Lal Kansal and Neenu

River Inflows' Impact on Summertime Circulation and Biogeochemical Behavior of Southern Green Bay 1140
Sajad A. Hamidi, Bahram Khazaei, Hector R. Bravo, and Fuad B. Nasir

Utilization of Machine Learning Models and Satellite Data for the Estimation of Total Dissolved Solids in the Colorado River System 1147
Godson Ebenezer Adjovu, Tahir Ali Shaikh, Haroon Stephen, and Sajjad Ahmad

Water, Wastewater, and Stormwater

Numerical Modeling Study of Stratified Flow and Related Air Exchange in Large-Diameter Water Collection Systems 1161
J. Laanearu

© ASCE

Optimization of the Mixing in a Produced Water Storage Tank with CFD **1175**
Wangshu Wei

Pond-in-Pond (PIP)—An Upgraded Pond Design toward Water Sustainability **1185**
Luis Carlos Soares da Silva Jr. and Clifford B. Fedler

Review of Flash Flood Susceptibility Modeling Derived from Machine Learning Algorithms with Input Data from Remote Sensing Sources **1195**
Abdullah O. Yusufzai, Haroon Stephen, and Sajjad Ahmad

Using Rain-Garden Bands for Rainwater Drainage from Roads **1207**
Tetiana Tkachenko, Olena Voloshkina, Viktor Mileikovskyi, Rostyslav Sipakov, Roman Hlushchenko, and Oleksii Tkachenko

Watershed

Review of Remote Sensing Techniques Used for Mapping Flood Extent, Flood Monitoring, Flood Hazard, Exposure and Damages, and Flood Resilience in Pakistan **1215**
Abdul Tauqeer, Haroon Stephen, and Sajjad Ahmad

Advancing Watershed Modeling for TMDL and Holistic Watershed Management Including Climate Change Impacts **1227**
Harry X. Zhang, John J. Ramirez-Avila, Deva K. Borah, and Zhonglong Zhang

Case Study: Surface Runoff Simulation Using HMS for Arid Watershed **1242**
Kun Qi and Jennifer G. Duan

Comparing HEC-HMS, PCSWMM, and Random Forest Models for Rainfall-Runoff Evaluation to Extreme Flooding Events **1250**
Utsav Parajuli, Amrit Bhusal, Amrit Babu Ghimire, and Sangmin Shin

Empirical Evidence Shows That Curve Numbers Vary from Event to Event **1263**
Jonathan David D. Lasco

Impacts of Urbanization on Watershed Hydrology and Runoff Water Quality of a Watershed: A Review **1271**
Tahir Ali Shaikh, Godson Ebenezer Adjovu, Haroon Stephen, and Sajjad Ahmad

© ASCE

Probabilistic Tropical Cyclone Surge Hazard under Future Sea-Level Rise Scenarios: A Case Study in the Chesapeake Bay Region, USA 1284
Kyutae Kim, Jun-Whan Lee, and Jennifer L. Irish

Total Maximum Daily Load Implementation Modeling, Planning, and Design: A Synthesis of Resources for Watershed Stakeholders.....1298
Deva K. Borah, Harry Zhang, Moira Zellner, Ebrahim Ahmadisharaf, Meghna Babbar-Sebens, Nigel Quinn, Saurav Kumar, Navaratnam Leelaruban, and Craig Lott

© ASCE