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Concurrent Sessions: Oral and Poster Presentations

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Concurrent Sessions

*Session No. & Paper No in this document are organized as they appear in the Symposium Program

Session 1. Innovations in Water Resource Management

Moderators: María Torres Cajiao & Jason Giovannettone

1. Regional opportunities for sustainable uses of stormwater runoff. Carlton D. Spirio, Jr., Regional Drainage Engineer, GHD, Tampa, Florida
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Abstract
In the past, little if any, consideration was given to regional water initiatives and other integrated resource opportunities as part of the stormwater management approach for public roadway projects. Instead, the typical stormwater management design strategy involved the acquisition of costly land purchases for the construction of both ponds and floodplain compensation areas intended to mitigate for roadway expansion projects. Although this approach has been successful in the past, the real needs within watersheds and fragile eco-systems have often been over-looked or further impacted by drainage systems that are designed to only comply with the subjective water quality criteria imposed by the various permitting agencies. With Florida's ever increasing demand for the protection and preservation of water supply resources, the need for more integrated water planning is crucial in identifying more worth-while initiatives that address the "Real" needs of the watershed. Similarly, several Water Management Districts (WMDs) and the Florida Department of Environmental Protection (FDEP) have solicited support in creating more innovative stormwater management strategies to create more sustainable solutions that expand the environmental benefits beyond the footprint of the roadway right-of-way. Therefore, this presentation will focus on the types of regional opportunities that exist and the planning efforts needed to develop cooperative partnerships amongst public and private Stakeholders. Likewise, several projects will be highlighted that used innovative approaches to better manage stormwater runoff and flooding, while addressing regional water resource needs to meet future demands.

2. The art of innovative collaborative ecosystem management. David Sale, Human and Natural Systems Ecologist, ECO Resource Group
Corresponding Author Email: daves@ecoresourcegroup.com

Abstract
As John Wesley Powell noted over a century ago, water resources are best managed at a scale that reflects the watershed, basin, landscape, or ecosystem through which the water flows. This requires bridging governance structures, scientific processes, and human dimensions across a variety of organizational entities, social-economic-ecological needs, federal, state, and local legal requirements,

and collaborative strategies. Governance and management across these multiple scales requires an awareness of how to integrate long-term conflict management, multiple sources and perspectives on science, the diversity of cultural and economic perspectives of stakeholders and tribes, multiple points of input and collaboration, layers of decision-making, and the flexibility required to adapt to changing circumstances, to bridge now and later. Navigating these unpredictable waters is as much an art as a science, requiring continual innovation and learning.

3. Investigating the agricultural water reuse adoption by U.S. farmers using a Bayesian Network Model. Farshid Shoushtarian and Masoud Negahban-Azar. Department of Environmental Science and Technology, University of Maryland, College Park, MD
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Abstract
Agricultural water reuse is one of the best methods for alleviating water scarcity worldwide by introducing a reliable alternative water resource. However, despite its merits and the technological advances in wastewater treatment, the adoption of agricultural water reuse is still limited among U.S. farmers. This study investigates the factors influencing U.S. farmers' decision-making in choosing recycled water as their alternative water resource and the best policies to increase the adoption in Southwest and Mid-Atlantic. Using the results of a survey taken from U.S. farmers, this study developed a Bayesian Network model to investigate the perception of U.S. farmers toward agricultural water reuse. First, the survey results were analyzed to build a conceptual map of factors affecting the farmers' perceptions. Then, using the conditional probability tables, the Bayesian Network model was developed to investigate agricultural water reuse adoption by farmers. This model was used to explore various scenarios for identifying the best policies that can potentially increase agricultural water reuse adoption among farmers. Results showed that various factors influence farmers' perceptions, including gender, the importance of water reuse, race, concern about water reuse, knowledge of water reuse, access to recycled water, education level, and age. The results also showed that informing farmers about water reuse benefits and challenges could significantly increase the adoption rate.

4. One Water Cities: Ideas and lessons learned from coast to coast. Inge Wiersema, Vice President, Water Resources Practice Lead & National One Water Director; Jacquelin Reed, One Water Leader, Carollo Engineers, Inc.
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Abstract
One Water is paradigm shift in thinking, and the future of true integrated water management by finding creative inter-disciplinary solutions that break down institutional silos to create more equitable, sustainable, and resilient cities. Three deep dives of very different One Water efforts are presented. The first example summarizes how Los Angeles completed the first major One Water Plan

through strong collaboration multiple City departments, regional agencies, and stakeholders. The presentation will focus on how this Plan was developed and has triggered bold action with progressive water policies, programs, and projects to achieve the City's ambitious Sustainability Plan goals. The second example is the Denver One Water Plan, which is developed through collaboration of 6 different agencies, with input from a broad Advisory Group and community. The plan provides an institutional collaboration framework to manage Denver's urban water cycle more holistically with better coordination of water and land use practices. The third example is Water Research Foundation's effort to develop One Water metrics to help cities measure progress towards achieving One Water goals based on input from utilities throughout the US and abroad. The variety of practical One Water examples will help the audience shape our community's One Water future.

5. Rethinking water supply-demand studies in Utah. Jake Serago PE and Craig Miller, PE, Water Resource Engineer at Utah Division of Water Resources
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Abstract
An integral component of water supply planning is the Water Supply-Demand Study. Traditionally, these studies which compare a fixed quantity of water to projected future demand have served us well. However, these studies have not prevented the myriad water resource problems our civilization now confronts – in some cases, the study assumptions and methods have exacerbated problems or accelerated their urgency. The Water Supply-Demand Study should be modified to better suit a world more complex, uncertain and environmentally damaged than that within which the current planning approaches and study methods were created. We suggest modifications to the Supply-Demand Study which reframe the primary problem as one of demand, rather than supply. With this modification, demand becomes a variable dependent on public values and informed decision-makers, rather than a deterministic quantity. To accomplish this, the order of steps in the supply-demand study should be shuffled to first determine the watershed carrying-capacity. Then impacts on the system of alternative values are assessed by close collaboration with stakeholders and the public representatives. Such a planning approach will require more integration amongst local and regional planners and will rely on demand planning tools that are new or yet unknown to water resource engineers.

6. Partnering with water users and leveraging technology to improve water management outcomes in Nebraska. James C. Schneider, Olsson, Technical Leader, Brian P. Dunnigan, Olsson, Vice President, Mallory Morton, Olsson, Assistant Engineer, Colby Osborn, Olsson, Associate Scientist
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Abstract
Abstract: The Twin Platte Natural Resources District (TPNRD) is developing a water data program utilizing a combination of direct engagement with irrigators and cutting-edge technological solutions. The TPNRD manages groundwater use on approximately 320,000 irrigated acres in central Nebraska. Groundwater use in the TPNRD directly impacts streamflow, and the district is statutorily required to limit those impacts. While the TPNRD has the legal authority to mandate pumping restrictions, they have chosen to take a more cooperative management approach with the irrigators to address these goals.
A data cooperative that specializes in agricultural grower engagement will provide every participating irrigator with a personal water use dashboard. It will provide a customized, comprehensive tool set to help them reduce their overall water usage on their own accord. Each participating grower voluntarily agrees to share this data with the TPNRD, who will in turn utilize the data to demonstrate the program's success in achieving the mandated streamflow goals. Ultimately, the program will be accomplished through development and/or deployment of a suite of cloud-based platforms and IoT devices, all of which will be interconnected for automatic communication of real-time data, analytics, and modeling results, translated into meaningful information for both irrigators and water managers alike.

7. The Water Sustainability Atlas: Leading innovation in water resilience. Jeanna Long, PhD, Senior Project Manager, Woodard & Curran; Lew Moeller, PE, Project Manager – California Water Plan, California Department of Water Resources; Todd Thompson, PE, Retired Annuitant – California Water Plan, California Department of Water resources
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Abstract
The Water Sustainability Atlas (Atlas) is a long-sought innovative tool to track the State's progress toward achieving long-term water resilience and ecosystem health through sustainable water management and multi-benefit approaches. The web-based and GIS-enabled Atlas revolutionizes how local agencies can share accomplishments, value delivered, and lessons learned by communicating their stories of implementing integrated multi-benefit projects through successful partnerships, past and present investments, and future investment needs. Detailed project information communicates specific needs, values, and priorities of regional and local entities to help identify opportunities for local-to-local and State-to-local partnerships. This enables transparent, accountable, and effective investment at all levels through tracking of sustainability indicators and intended outcomes as they drive sustainable and resilient water management. Regional and local entities can also easily report progress toward meeting intended outcomes, showing valuable return on investment, and enabling adaptive management. Progress can also be monitored to provide valuable insight across the State on multiple indicators of resilience to support the ongoing need for resources.

8. Roundtable fosters collaboration among the collaborators: The Benefits and challenges of a voluntary water management network. Lynn Rodriguez, Co-Chair – Statewide IRWM (Integrated Regional Water Management) Roundtable of Regions in California & Manager - Watersheds Coalition of Ventura County IRWM Region; Mark Stadler, Manager, San Diego IRWM Program & Co-Chair, Statewide IRWM Roundtable of Regions in California
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Abstract
California's Integrated Regional Water Management (IRWM) program, created by state legislation in 2002, embodies the integrated nature of the many elements of water resource management. It has resulted in the creation of 48 separate IRWM planning regions that combined serve 99 percent of the state's population and cover 87 percent of the land mass. Public and non-profit stakeholders created each region from the ground up, establishing a governance structure and defining the physical boundaries as they best fit discrete circumstances. Successful implementation of IRWM requires collaboration and integration focused on determining and implementing multi-benefit approaches to water challenges. The resulting relationships and trust are the foundation of IRWM and a valuable asset. A voluntary alliance of IRWM regions across the state formed in 2006 to serve as a collaborative network and a forum for implementing this grand, socio-technical experiment. This alliance, known as the IRWM Roundtable of Regions today is a recognized, effective representative of the regions' interests to the State of California in such areas as planning standards, grant program guidelines and under-served community engagement. The Roundtable's experience also has exposed the challenges of a voluntary collaboration of stakeholders representing different geographic, economic and political circumstances.

9. Stormwater masterplanning for climate change/sea level rise adaptation at the Town of Lake Park, Florida. Raul Mercado, PE, CFM, WRMA Principal Engineer.
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Abstract
The Town of Lake Park with an area of 2.3 square miles and a population of approximately 9000 people is located in South Florida. The Town's aging drainage infrastructure lack of capacity to address flooding conditions has been exacerbated by the ongoing effects of climate change including higher intensity rainfall and Sea Level Rise affecting high tides along 0.8 miles of the Lake Worth Lagoon (LWL) intracoastal waterfront. To address these new challenges, the Town has embarked in the development of a new Stormwater Masterplan (SWMP) with new LiDAR topography, advanced H&H 2-D modeling and applying state-of-the- art planning approaches including Green Infrastructure-based Low Impact Development Best Management Practices (GI/LID BMP's) for stormwater management and climate change abatement town-wide. GI methods include the use of Raingardens, Bioswales, Bioretention, Underground Filtration Storage Chambers of varying size and configuration, instead of traditional conveyance and-end-of pipe

infrastructure. The SMWP goal for Climate Change abatement will be to provide green infrastructure for 10% of the Town's impervious surface area over the next 20 years, capable of capturing one inch of rain during storms. The Town is also undertaking a Vulnerability, Risk and Adaptation Assessment for planning and implementing new climate conscious development strategies.

10. Refining water budgets in small Pacific Island drainage basins: Spatio-temporal variations in runoff coefficients derived from daily rainfall maps. Theodore M. Brennis, University of Hawai'i at Mānoa
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Abstract
The usefulness of water budgets is constrained by the spatio-temporal resolution and accuracy of their components, a limitation that poses challenges to water resource managers in places like Hawai'i, where groundwater meets more than 90% of domestic freshwater needs. Recent improvements in gridded rainfall data have provided an opportunity to examine water budgets with greater spatio-temporal resolution than ever before. This research refines existing water budgets for eight drainage basins across the island of O'ahu by incorporating precipitation estimates from 250m spatial resolution daily rainfall grids into stream baseflow separations, yielding daily runoff and groundwater infiltration volumes. Infiltration estimates suggest that water budgets in some drainage basins could be inflated. Runoff estimates varied by as much as 18% from established values for leeward drainage basins and 33% for windward drainage basins. Precipitation volume-weighted average runoff oscillated strongly with the seasons but this pattern was dampened by interannual climate variability. Maximum runoff variability occurred through dry seasons, in contrast to prevailing estimates. These findings corroborate recent research highlighting the importance of disturbance-based weather patterns in groundwater recharge processes and emphasize the importance of understanding climate variability in assessing water budgets.

11. Integrated water resource & optimization platform addresses competing water interests: A California Irrigation District case study. Steve Elgie and Jens Proche, Regional Sales Manager and National Sales Manager, KISTERS North America
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Abstract
Irrigation districts face complex water management challenges to sustain surface and ground water supply and quality as they serve competing agricultural and urban interests. In addition to flood control or drought response, districts also engage in energy production. Departments often use separate, disconnected IT systems to manage resource data critical to operations such as SCADA, PLCs, historians, and water record accounting. The KISTERS patent-pending Real-Time Optimization (RTO) platform features a priority-based resource optimization engine, which can be integrated with industry-standard data platforms to provide highly efficient and

precise predictions for short-, medium-, and long-term load / dispatch and resource schedules. This new generation of technology is implemented in Europe and Canada to generate hydropower with socially- and environmentally-responsible obligations. The platform gives operators the flexibility to rank priorities, allowing competing constraints or rules to be considered and resolved in real-time. The presentation will provide an example of a fully-integrated RTO platform designed to maximize water use and energy production while complying with all regulations applicable to irrigation districts, hydropower operations and water resource management.

12 Quantifying irrigated landscape at a statewide scale: California's approach and results. Andrew Brenner[1], Bekele Temesgen[2], Aron Boettcher[1] and Wayne Tate[3 1] – Quantum Spatial Inc; California Department of Water Resources. [3] Eagle Aerial Solutions. Corresponding Author Email: abrenner@quantumspatial.com

Abstract
The State of California is just completing the first step in a major water conservation initiative: an irrigated landscape analysis of all 12 million single and multi-family residences in California. This initiative is in support of the legislation (SB 606 and AB 1668) requiring equitable, district level water budgets. The California Department of Water Resources, working with Quantum Spatial and Eagle Aerial Solutions, has now mapped irrigated landscape area of the majority of the water districts in the state. The mapping was developed using 1 ft summer imagery captured in 2018 and remote sensing approaches that integrate contextual modeling and machine learning. These approaches have shown to be able to develop estimates that are > 95% accurate of outdoor irrigated landscape area. The presentation will provide an overview of the approach, outline the challenges encountered by the project and the solutions developed in order to overcome them. Results from the project will be provided including magnitude of estimate and their accuracy assessment. The presentation will also show how these data can be used for managing the ever increasing demand for water from California's urban areas.

Session 2. Advances in Data Management & Emerging Technologies

Moderator: Alaina Armel

1. Watershed delineation outcomes based on LiDAR and ASTER geospatial datasets. Emmanuel U. Nzewi, PhD, PE and Uchenna S. Igwe, Department of Civil & Environmental Engineering, Prairie View A&M University
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Abstract
Digital Elevation Models (DEM) can be obtained from LiDAR (Light Detection and Ranging) and Advanced Spaceborne Thermal Emission and Reflection Radiometer Global Digital Elevation Model (ASTER GDEM). In this study, geospatial datasets from these sources are used to provide the three-dimensional (3-D) ground elevation dataset for delineating the boundary of a watershed. ArcGIS Pro (Geographic Information System software) and other appropriate analysis tools are employed in the delineation process. The watershed delineation outcomes based on the two datasets are compared. The impetus for using ASTER GDEM to support preliminary watershed characterization is discussed.

2. An experiment of updating more state variables with the assimilation of LAI in a land surface model over the global domain. Azbina Rahman[1], Viviana Maggioni[2], Xinxuan Zhang[3], Paul Houser[4], Timothy Sauer[5]; Graduate Research Assistant[1], Associate Professor,[2] Postdoctoral Fellow[3], Professor[4,5], George Mason University
Corresponding Author Email: arahma19@gmu.edu

Abstract
This experiment combines satellite-based observations of vegetation with land surface model simulations in a data assimilation (DA) system to improve the estimation of water, carbon, and energy variables. Specifically, Leaf Area Index (LAI) data are assimilated and more than one model state variable (i.e., both LAI and leaf mass) is updated at each assimilation step. The efficiency of updating the two state variables is analyzed and compared to the experiment in which LAI is assimilated without updating the leaf mass. The Global Land Surface Satellite (GLASS) LAI product is used as the satellite observations and the Ensemble Kalman Filter is chosen as the DA technique. Preliminary results show that by updating LAI and leaf mass at a location in Florida, the estimation of several land surface variables is improved compared to updating LAI alone. The correlation between ground observations of evapotranspiration and corresponding model estimates from the open loop run (no DA), DA without updating leaf mass, and DA with updating leaf mass are 0.76, 0.77, and 0.78, respectively. Assimilating vegetation information within a land surface model may not only enhance our

ability to monitor and forecast extreme hydroclimatic events, but also enhance crop production monitoring and water resources management.

3. Reliable drought prediction using long short-term memory (LSTM) recurrent neural network. Nian Zhang, Professor, Department of Electrical Engineering and Tolessa Deksissa, Director, Water Resources Research Institute (WRRI), University of the District of Columbia, Washington, D.C.
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Abstract
As streamflow quantity and drought problem become increasingly severe, it's imperative than ever to seek next generation machine learning models and learning algorithms which can provide accurate prediction. Reliable prediction of drought variables such as precipitation, soil moisture, and streamflow has been a significant challenge for water resources professionals and water management districts due to their random and nonlinear nature. We propose a long short-term memory networks (LSTM) based deep learning method to predict the historical monthly soil moisture time series data based on the MERRA-Land from 1980 to 2012. The proposed LSTM model learns to predict the value of the next time step at each time step of the time sequence. We also compare the predication accuracy when the network state is updated with the observed values and when the network state is updated with the predicted values. We find that the predictions are more accurate when updating the network state with the observed values instead of the predicted values.

4. Flood watch monitoring and observations for a high hazard dam – a Microsoft O365 solution. Jennifer McGee, PE, CFM, GISP, Water Resources Engineer, Wood PLC
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Abstract
A 'High Hazard' dam is expected to cause loss of human life if there was a failure of the structure. These structures require regular monitoring and specific observations during flood watch alerts and other high-risk events per the Emergency Action Plan. To make sure a relevant flood watch isn't missed, we wanted to develop an automated way to monitor the National Weather Service API and notify our on-call team. Then we built out a full digital solution to allow us to easily record observation measurements, log everything in a central location and immediately notify our client POC of the results so additional actions can be taken if needed.
This presentation will review how we are using the Microsoft Power Platform and Azure Logic Apps to monitor the NWS API for Flood Watch Alerts and coordinate our on-call team to perform safety observations. This is a modular build concept where each piece can be updated as needed to add new functionality. While I am using our high hazard dam monitoring as an example project, this

presentation will provide a general overview of the Office 365 suite of applications and provide some ideas for how you might adapt these ideas for your own projects.

5. Comprehensive predictive analytics and causal inference framework for water main breaks with spatiotemporal data.
Babak Aslani and Shima Mohebbi, Department of Systems Engineering and Operations Research, George Mason University, Fairfax, VA
Corresponding Author Email: baslani@gmu.edu; smohebbi@gmu.edu

Abstract
Water main breaks are a significant threat to water infrastructures by disrupting standard services of distribution networks and endangering public health. This study proposes a comprehensive framework based on advanced analytics to gain an improved understanding of main breaks. First, we adopt the physical features of pipes, environmental factors, spatiotemporal data, and machine learning approaches to design a predictive analytics module. The second component of the proposed framework is a causal inference approach using observational data. The water main breaks documented from 2015 to 2020 in Tampa, Florida, is the dataset used in this study. Spatial clustering and time series analyses are used to explore the spatiotemporal aspect of data and inform the predictive models. We then compare the performance of predictive models and present predicted failure rates to facilitate preemptive decisions at the city level. In the causal inference module, statistical models and causal search algorithms are employed to explain the relationships between various sets of features in the dataset. We implement The Really Fast Causal Inference (RFCI) algorithm to infer causal relations. This study can provide insights to decision-makers in designing operational modifications and targeted investments to mitigate the ramifications of main breaks.

6. Evaluating multiple, innovative forecast-informed reservoir operation (FIRO) alternatives at Lake Mendocino in the Russian River Basin.
Michael Konieczki, PE, D.WRE, Senior Hydrologic Engineer, HDR and Chris Delaney, PE, Sonoma Water
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Abstract
Unique opportunities exist in at Lake Mendocino for improved water management with forecast informed reservoir operations (FIRO) because atmospheric rivers (ARs) are a major source of inflows and there have been reductions in diverted inflows for spring refills. In recent years, gaging networks, data acquisition, hydrologic and hydraulics analysis, weather modeling, and computational power have dramatically improved in the basin and correspondingly so has forecast skill. Accordingly, reservoir managers are leveraging this increase in forecast skill to inform their operational decision-making within the regulatory constraints of water storage permits and established storage rules and “curves.” To better leverage improved forecasts for decision support, operational rules at Lake

Mendocino may need to be reconfigured and this led to many FIRO alternatives based on how the forecasts are used. Innovative FIRO alternatives for Lake Mendocino include use of a probabilistic approach and a 5-day deterministic forecast. Evaluating these FIRO alternatives objectively was challenging. Here, analysis of multiple criteria was completed using agreed-upon methods that garnered the support of stakeholders and agencies that could be affected.
In this presentation, we provide an overview of the analysis completed and assessment framework used to evaluate different FIRO alternatives at Lake Mendocino.

7. Recent advances in water temperature modelling and climate change for water resources management. André St-Hilaire, INRS-ÉTÉ; Anik Daigle, Professor, CEGEP Garneau and Research Associate, INRS-ETE; Claudine Boyer, Research Associate and Normand E. Bergeron, Professor, INRS-ETE, Quebec City, QC, Canada
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Abstract
While hydrological extremes (floods and droughts) have been investigated in the context of climate change for many decades, it is only in the last twenty years that river temperature has been the focus of similar research. The development of a number of water temperature models, both deterministic and statistical, has allowed researchers and practitioners to generate future thermal scenarios using climate change scenarios as inputs, thereby providing managers with important additional information on possible future river habitat conditions. The presentation provides an overview of some of the recent work in Canada and the U.S., with an emphasis on the research that focused on the potential impacts of climate change on rivers that are host to salmonid populations. Recent advances in statistical models include the implementation of the Generalized Additive model (GAM), functional regression, Multivariate Adaptive Regression Splines (MARS) and Artificial Intelligence (AI). Deterministic models have been used to generate thermal ensemble scenarios on some watersheds and to investigate mitigation techniques such as cold water releases from dams.

8. Today's climate resilient stormwater management infrastructure turns to the Cloud. Robert "Bob" Bathurst, PE, D.WRE, Century Engineering, Inc.
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Abstract
The developed world has fundamentally changed the hydrologic cycle by permanently converting natural areas to roadways, parking lots, and buildings. These impervious surfaces generate significant volumes of stormwater runoff, which in turn cause downstream flooding and erosion. Stormwater runoff carries pollutants such as nitrogen, phosphorous, bacteria and sediment that reduce the water quality and biodiversity in receiving streams and water bodies. Surprisingly, all traditional stormwater management (SWM) modeling

approaches utilize a “unit” hydrograph routing methodology. Essentially, the design of all traditional SWM practices assumes that all precipitation events last exactly 24 hours with a temporal rainfall distribution like that of a bell curve. This uni-storm distribution/duration design approach has caused unexpected/undesirable SWM facility performance during virtually all storm events. With climate change being our new reality, it is critical that we implement adaptable SWM systems if we are to have a sustainable future. Fortunately, the state of wireless connectivity and microcomputer technology make it now practical to precisely control the timing, volume, and rate of discharge from SWM facilities; thereby drastically increasing their performance. Smart SWM systems utilize artificial intelligence in the form of software to adapt SWM facility behavior to achieve desired performance goals, whether they be water quality, flood control and/or any combination of objectives. Smart SWM cloud-based control software ingests hyper-local precipitation forecast data (both rainfall quantity and temporal distribution) and adjusts SWM facility behavior in real time, including accounting for changes in forecast. Likewise, smart SWM facilities can maximize the opportunity for runoff reduction (via infiltration/evaporation) by retaining the runoff volume for the entire period of time between storm events. In so doing, smart SWM facilities also maximize pollutant reduction performance and opportunity for aquifer recharge and/or stormwater reuse. During most storm events smart SWM facilities release stored water in advance of the forecasted precipitation event in a volume equal to that necessary to fully capture the inflow from the storm event and at the lowest discharge rate possible. The timing of releases from smart SWM facilities are thereby offset from that of other portions of the watershed, which helps to reduce downstream erosion, flooding, and CSOs. During extreme precipitation events smart SWM facilities optimize their flood mitigation potential by actively managing their storage and discharge volumes in order to minimize discharge rate and total released volume during the wet weather event.
In the pursuit of smarter, climate resilient stormwater management practices, Bob Bathurst, PE, and his team at Century Engineering, Inc. developed the SmartSWM™ cloud-based control system.

Session 3. International Research & Global Perspectives

Moderator: Arash Jalalibarsiri

1. Food-Energy-Water Nexus in the Mekong Basin impacted by anthropogenic activities. Venkataramana Sridhar, Virginia Polytechnic and State University, Blacksburg, Virginia
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Abstract
The Mekong River Basin (MRB) is among one of the largest transboundary basins in the world. It shares its boundaries with six countries, viz. China, Myanmar, Thailand, Lao People's Democratic Republic, Cambodia, and Viet Nam. Due to varied types of human activities carried out within and by adjacent countries associated with efforts to provide food and water demands for increased population, the hydrology, agriculture, ecosystem, and other watershed functions are continuously changing. We present a holistic view of how varying priorities such as hydropower, water management, fisheries and water supplies for domestic consumption, irrigation, and industries can be integrated into a single system modeling framework using water, food, energy, and ecosystem linkages and their associated constraints to determine sustainable quantities of water supplies for various beneficial uses. In addition to determine sustainable water supplies for various beneficial purposes, optimal reservoir operation strategies will be determined using optimization to develop a sustainable water resources development and management plan for this basin.

2. **Dying Yamuna River in Delhi.** Dr. Nawal Prasad. Singh, Asst. Professor, Department of Geography and Shaheed Bhagat Singh, University of Delhi, New Delhi, India
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Abstract
Space of water is one of the serious problems in Delhi. Water problems are experienced in Delhi. Delhi is the third largest metropolitan city of the India. There are four source of water in Delhi, Yamuna River, the Ganga, ground water and rain water River Yamuna originates at Yamunotri glacier in Uttarakhand . Delhi Jal Board takes out 3,000 MLD of water for treatment and supply to Delhi for domestic use. Delhi discharges polluted water to Yamuna River from 22 drains. The functional capacity of Delhi sewage treatment plants (STP) has come down by 40 percent because of blocked trunk sever and large part of the sewerage network. Around 22 drains discharge sewage into the river in Delhi. 3,800MLD sewage generated in Delhi (2009-10). 1,600 MLD polluted water amounts is reaching the sewage treatment plants (STP) due to poor drainage system 0f the city. 57 percent of raw sewage and untreated industrial pollutants flowing directly into the Yamuna river.Apart from planned area Delhi have unauthorized colonies,

urban villages, resettlements colonies, rural village, and regularized colonies. Policy of treatment of 22 sewerage shows interesting feature in Delhi. It Cleary shows great nexus among Polluter, policy makers and implementer. If Yamuna cleaned, the trade of nexus will not survive. Yamuna Action Plan is ever green project will never completed will never clean. Drainage System of Delhi have been divided into six zones; (I) Northern Zone, (II) Central North West and South East zone, (III)Western zone, (IV)Central South and South East zone, (V)East Zone and (VI)South Zone. The length of natural drain in Delhi is 350 km. It carries 1000 m3 pollution in River Yamuna. Yamuna in Delhi is considered as study area. Policy and impact of YAP have been analysed with implementation and result. Water quality and quantity of sewer is analysed in the study as well as water quality of Yamuna river of Delhi. Primary surveys have been conducted to draw conclusion of pollution.

3. The economics of sustainable water supply solutions for Regional NSW. Australia. Valerie Seidel, The Balmoral Group, USA.
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Abstract
Recycling of treated wastewater for potable use is not currently supported as a water security infrastructure option in rural areas of New South Wales (AU) at a time when drought conditions are causing emergency situations in multiple catchments. This study examines the feasibility of recycled drinking water plants using a Cost-Benefit Analysis (CBA) framework for model towns of diverse sizes facing a range of water supply deficiency scenarios. The results of the CBA illustrate that, in comparison to reasonable alternatives for water security projects, recycled drinking water plants have superior Benefit Cost Ratios in select cases. For towns larger than 7000, potable reuse is competitive with options such as pipelines and groundwater bores. The study demonstrates that direct water recycling should be considered in future analyses of water security options for regional towns to ensure that value for money is achieved. In some cases, advanced water treatment plants are the most beneficial option to society. The results are also discussed in the context of public resistance to wastewater recycling for potable use and how decision-makers can interpret and engage with the not insignificant Willingness-To-Pay to avoid water recycling schemes.

4. Water governance and climate change: Perspective SW region in Bangladesh. Zahid Hossain[1], Dr. Imrul Kayes Muniruzzaman[2], Prof. Dr. Ghulam Murtaza[3] [1]Consultant-water supply and sanitation, UNICEF Bangladesh , [2]Director-Fundraising and Learning, [3]Ex Professor, Dept. Urban & Reginal Planning, WaterAid Bangladesh, Khulna Univ.
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Abstract
Bangladesh coastal area is vulnerable to the changing climatic condition because of its geographic location and low-lying topography, and this vulnerability has been acute due to reducing upland flow during dry period and sea level rise contributing to saline intrusion

and inundation of coastal freshwater resources. Both primary and secondary data have been used to carry out the study which found that the coastal communities in southwest region have adopted a range of strategies tapping into local resources and knowledge to cope with climate change induced water scarcity. The most common measures include rainwater harvesting and pond sand filter (PSF). But neither harvested rainwater nor PSFs ensure long term water security as both systems are largely susceptible to seasonal variation. Besides this, study also observed that ponds are often inundated by tidal surges and cyclones leaving the water contaminated. Shrimp cultivation is also responsible to increasing salinity into drinking pond due to poor monitoring system. Eventually for both tidal surge and shrimp cultivation, ponds for PSF are being abandoned due to salinity. Indeed, Bangladesh has ample number of policies and governing bodies related to water issues, which is impressive, but they have yet to make an effective impression on integrated water governance, which has been find out through examines different relevant policies, strategies, rules, regulations and their implementation procedure in Bangladesh.

Session 4. Social Equity & Human Dimension of Water Management

Moderator: Keara Moore

1. Leveraging sustainable water investments to build social equity and climate resilience. Cynthia Koehler, Executive Director, Caroline Koch, Water Policy Director, WaterNow Alliance; Ed Harrington, Commissioner, San Francisco Public Utilities Commission
Contact Email: cy@waternow.org

Abstract
The next wave of water infrastructure investments can prioritize solutions that build social equity and climate resilience while providing environmental, economic, and social benefits at the community level. Cities and utilities are increasingly turning to sustainable, localized solutions—green stormwater infrastructure, private lead service line replacements, onsite water reuse, and emerging technologies—to complement grey infrastructure. These solutions offer faster, more affordable ways to bring infrastructure improvements to underserved communities disproportionately affected by sewer overflows, flooding, and drought. They also provide environmental, economic, and social benefits like local job creation, green space, reduced heat island effect, and better air quality. Water agencies typically fund localized infrastructure out of operating cash, not capital dollars, which limits reach and impact. WaterNow launched the Tap into Resilience initiative to help utilities access capital to finance and scale up investment in these strategies. This innovation has the capacity to transform water resources management and is more equitable in how it distributes costs and benefits among water utilities' stakeholders. This presentation will explain how localized infrastructure helps meet water management challenges while building equity and climate resilience; demonstrate how to capitalize innovative decentralized strategies and technologies; and provide resources to scale investment in these strategies.

2. Social equity in climate change adaptation programs: A statistical analysis of participation in the NYS Climate Smart Communities Program. Jude Leape, Undergraduate Student, Environmental and Sustainability Sciences and Kristen Hychka, Research and Outreach Specialist, NYS Water Resources Institute, Cornell University
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Abstract
As outlined in the United Nations Sustainable Development Goals, climate change poses the greatest threat to the most vulnerable in society. Social equity and justice must be at the heart of climate adaptation. The New York State Climate Smart Communities (CSC) Certification program supports NY municipalities in reducing greenhouse gas emissions and increasing climate resiliency--with water

resources management central in the resilience actions. Our work focuses on equitable access to public resources through analyzing demographic disparities in participation in the CSC certification and grants programs. We ask, do certain demographic characteristics of a community influence the likelihood that the community will participate in the CSC program? How are the resources provided by the program (grants, technical assistance) distributed among municipalities in NYS? Are community size, income characteristics, racial makeup, or political leanings associated with participation in the program? Our approach uses bivariate and multivariate statistical analysis of CSC certification and grant participation data against Census demographic data. The analysis focuses on three outcome variables—CSC certification level, whether a community applied for a CSC grant, and, of those that applied, whether a community received a grant—and a series of demographic predictor variables that describe community size, racial makeup, economic distribution, and political leaning. We outline next steps for addressing equity in the program, including examining CSC and municipal leadership and remediating inequitable impacts of the CSC actions within communities. The results and recommendations from this project have been presented to CSC leadership.

3. **Transforming changes in water management with systems thinking: A Decision framework for economic and conservation harmony.** Craig Bienz, David Peter Stroh,[2] and Kalaena Rosendaul[3] , [1]Director Sycan Marsh, The Nature Conservancy, [2] Author and Partner of Bridgeway Partners, [3]Partner, LuLaRoe
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Abstract
At the heart of almost every water resource management debate in the Klamath Basin, where the roster of stakeholders and their values are as diverse as the landscape itself, is the attention to conserve biological diversity and human wellbeing. This often places managers with multiple, and sometimes contradictory, management policies and alternatives. Management decisions may focus on the "trade-offs" that are made between environmental and economic objectives. A decision framework with accountability for individual decisions and clarity on the potential impacts to economic and conservation from proposed actions is needed. Several approaches have been developed to conduct and evaluate projects in which scientists, policymakers and other actors cooperate directly, and where a plurality of knowledge sources is combined to address real-world issues. Here, we initially describe the definition of Systems Thinking, the program and process of integrating all relevant societal stakeholders as partners and provide archetypal models that show how their diverse values and positions affect through distinct yet interacting stakeholder feedback. Secondly, we use System Thinking to compare and assess the societal outcomes of these interactions and other associated impacts on policy, science, and society. Thirdly, we illustrate why including social participants is critical to affect social change.

4. Human-centered selection of sustainable WASH solutions to challenges on water and sanitation access in underserved communities in the US and abroad. Diana Rodriguez, Water and Sanitation Collaborator and Cat Shrier CEO, WaterCitizen Foundation.
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Abstract
One of the most common and the most critical challenge facing the development and implementation of water, sanitation and health projects in underserved communities, both overseas and within the US, is whether these projects receive community acceptance and continue to be used and maintained after installation. WaterCitizen Foundation surveyed dozens of WASH experts and volunteers for their perspectives on successful WASH projects, culminating in a March 2021 Virtual Summit with several WASH organizations to discuss the major issues highlighted by this survey. Issues identified include the following: 1) In addition to the typical technical challenges, Water Leaders across the globe show concern for the ability of WASH projects to draw in local community participation, acceptance and cooperation in developing, implementing and maintaining solutions provided or supported by hydrophilanthropic organizations; 2) Establishing collaboration with local governments and securing funding is a common challenge requiring local communities to adopt novel financial strategies to ensure sustainable project design, implementation and maintenance; 3) Finally, organizations responsible for designing, sponsoring and/or implementing these WASH projects must heavily consider the socio-economic and socio-cultural factors as well as applicable local policies and regulations which highlights the essential role of local partnerships to achieve successful, sustainable results.

5. Incremental retreat: Leveraging checkerboard buyouts in flood prone neighborhoods. Isaac W Stein, PLA, ASLA Dept. Co-Founder, Design Director and Maggie Tsang, RA Dept**.** Co-Founder, Managing Director
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Abstract
FEMA can only fund buyouts on a voluntary basis. This results in what many call a ‘checkerboard pattern’ where buyouts are unevenly scattered throughout flood prone neighborhoods. This pattern is prevalent throughout floodplains in the United States. Often discussed as inefficient when compared to large scale land reclamation projects, this phenomenon is an unavoidable reality due to multiple ownership in communities. In this presentation, we look to the checkboard pattern not as an obstacle to adaptation, but as an opportunity to initiate the process of incremental and preemptive retreat. Through a recent case study and pilot project on ‘Repetitive Loss’ properties in North Miami, this presentation demonstrates the ecological, social, and infrastructural value and potential of lot-by-lot approaches. While these strategies do not resolve flood risk at a large scale, they are valuable in creating public awareness, mitigating nuisance flooding, and modeling a method of retreat.

Session 5. Advances in Water Education & Outreach

Moderator: Shane Putnam

1. Mobilizing local-level building characteristic data for better water resource planning and floodplain management. Susanna Pho and JT White, Co-Founders, Forerunner
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Abstract
Local governments are crucial to enabling adaptation and safer development in floodplains through the enforcement of building codes and the education of residents. While they play a huge role in promoting more sustainable water management and decreasing flood risk, these municipalities often face several barriers to success, including the lack of resources, internal capacity, and adequate information to inform decision-making. Increasingly, communities of all sizes are investing in better data to drive more efficient workflows and outreach as well as to enable more intelligent planning. While proprietary datasets and predictive models are becoming more and more accessible, granular on-the-ground data documenting building characteristics is still hard to come by. As a result, governments frequently operate at hyper-local levels with non-local, or abstracted, information.In this session, we'll delve into the problem-space of local-level building characteristic data and present case studies from our work with municipalities across the country with data applications ranging from long-range water resource planning to community risk education. We will share technical insights around extracting and mobilizing structured elevation data and discuss challenges to implementation as well as transferrable lessons learned.

2. Human-centered design for virtual water education – How to create, validate, and launch online programs and events in the virtual Water Education Lab. Cat Shrier, PhD, CEO, WaterCitizen Foundation
Corresponding Author Email: cat@watercitizen.org

Abstract
Historically, adult education programs related to water have been decided by committees of experts, licensing boards, or the somewhat random selection of conference abstracts. The Virtual Water Education Lab uses a Human-Centered Design approach to virtual water education programs and events that is developed through: 1) a clear scoping of the target market, topic, and problems to be solved;

2) identifying and conducting face-to-face (on Zoom) interviews with individuals interested in the topic; 3) design of the program to address the wants and needs of the students and produce an impactful result; and 4) launch of a Beta program. This paper presents an

overview of the WaterCitizen Academy methodology and programs developed by our Beta students, representing a wide arrange of topics (e.g. greywater, groundwater, drought planning, WASH projects) and target markets (e.g. utility leadership, operators, homeowners, tradespeople, parents and other adult mentors).

3. Educating water utility leaders on the need for, approaches to, and funding opportunities for water asset management – a human-centered design approach to virtual water education. Rizwan A. Siddiqi, PE and Cat Shrier, PhD, CEO, WaterCitizen Foundation
Corresponding Author Email: rizwan.siddiqi@ebaengineering.com

Abstract
In order to maintain, repair and replace public water infrastructure in a timely and cost-effective manner, Asset Management processes have been developed and are encouraged both through regulations and funding incentives. Specific components vary widely depending on the focus of the agency or utility (drinking water, wastewater, stormwater, flood control), facility size, age, population served, hydrology, geography, and finances. To support development and implementation of Utility Asset Management – particularly for small and mid-sized utilities that may not have internal staff or large consulting firm contractors - EBA Engineering has partnered with WaterCitizen Foundation's Virtual Water Education Lab to develop and deliver an interactive online program for water utility leaders to complete an initial assessment of their asset management needs, ways to get funding to develop and implement their Asset Management Plan, and how to determine whether and to what extent they have the internal resources to develop their own Asset Management Plan. This program was co-created with water utility leaders on the basis of face-to-face Zoom-based psychographic surveys using the Virtual Water Education Lab method; the results of this survey will be shared in this presentation.

4. Bridging the gap of water and land use. Danielle Dolan, Program Director, Emily Finnegan, Project Manager, and Atley Keller, Project Manager, Local Government Commission, Sacramento, California
Corresponding Author Email: akeller@lgc.org

Abstract
Since 1980, LGC has advanced strategies for resource-efficient California communities alongside those on the front lines of decision-making: local elected officials and staff. LGC's approach to thriving, resilient communities is integrating civic engagement with environmental, social and economic priorities. LGC initiated bringing water and land-use together in 2005, with the Ahwahnee Water

Principles: essentially a planner's guide to protecting and efficiently using watershed resources. The AWP demonstrate that connecting water management and land use planning decisions can generate significant public benefit. In 2019, LGC evaluated the

equitable integration of water and land-use across the state; it is evident that far more work is needed to break down the barriers between the land-use planning and water management sectors, especially in the face of a new generation of challenges: climate change, population growth, and aging infrastructure. LGC is bringing a new curriculum program to CA — "Growing Water Smart" — to do just that. With success already demonstrated in both Colorado and Arizona, LGC has completely overhauled the curriculum for CA communities. LGC hopes to bridge the gap by helping local communities collaborate across sectors on long-term water and land-use planning that emphasizes water conservation, watershed health, and community resilience.

5. Hack the Bay: Leveraging citizen science for an innovative approach to Chesapeake Bay restoration. Caroline Sgaglione, Kate Dowdy, Valeria Gonzalez, Booz-Allen-Hamilton
Corresponding Author Email: Dowdy_Katherine@bah.com

Abstract
In September 2020, under the leadership of Women in Data Science and the Water CoP, Booz Allen concluded Hack the Bay: a 7-week, virtual hackathon designed to help solve some of the toughest challenges facing the Chesapeake Bay watershed. This was an entirely volunteer-led collaboration between Booz Allen Hamilton, the Chesapeake Monitoring Cooperative (CMC), and nearly thirty other partnering organizations. This effort was a year in the making, and ultimately drew 430 participants from 37 countries, 172 cities, and 103 universities and organizations. This session will outline the process, results, recommendations, and next steps from our team on leveraging a virtual hackathon format for sourcing novel solutions for social and environmental good initiatives. See the website: https://hack-the-bay.devpost.com/ for more information.

Poster Displays

Facilitator: Devan Mahadevan

1. COVID-19 wastewater surveillance at Siena College: Lessons from the field. Kate Meierdiercks, Department Chair and Associate Professor of Environmental Studies and Sciences, and Cassidy Hammecker, Biology Major, Siena College, Loudonville, NY
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Abstract
Many communities are monitoring wastewater for the presence of SARS-CoV-2 to aid public health efforts during the COVID-19 global pandemic. Colleges and universities, including Siena College, are using wastewater surveillance programs in conjunction with clinical testing to help avoid COVID-19 outbreaks, monitor infection rates, and identify and isolate infected individuals. Siena College is one of the few small colleges (~3000 students) with active wastewater surveillance programs in the country. The "grassroots" program at Siena began as a result of an undergraduate summer research project and has developed into a collaborative program between faculty, students, staff and administrators, though the field collection of wastewater is still largely managed and run by undergraduate students. Siena's wastewater surveillance program has been successful with modest expertise and funding largely due to its ability to grow and adapt, dedicated core team, and strategic partnerships. The lessons learned from surveillance programs like those at Siena may be particularly useful for smaller communities and those with limited capacity and resources.

2. Improvements to an urban campus rain garden. Felicia Armstrong, Associate Professor; Colleen McLean, Associate Professor, Department of Physics, Astronomy, Geology and Environmental Science, Youngstown State University, Youngstown, Ohio
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Abstract
The Youngstown State University sits on a 145-acre urban campus with significant impermeable surfaces. To address excess runoff, a rain garden was installed in 2005 in an effort to treat water runoff from adjacent parking lots. In 2007, the biofiltration unit was evaluated for removal efficiency. Total suspended solids efficiency was 80%, although nutrients (phosphorus and nitrogen) had much lower removal rates (. Since that time, the rain garden has not been maintained, much of the topsoil had washed away and the plants

have become weedy. In 2017 the student group, Youngstown Environmental Sustainability Society (YESS), initiated restoration of the rain garden. Using the previous research, several potential improvements were identified (and implemented?); increase the water

holding capacity, slow the overload drainage, and increase the amount of native and facultative wetland plants. In addition, educational signage with information about green infrastructure was needed. The students have done much of the moving of soil and addition of rocks and boulders to address the water retention, erosion, and overflow. Some native and wetland plants have been established but there are still issues with weedy species. In fall 2021, students plan to resume monitoring water treatment efficiencies to compare to previous research.

3. Estimating future precipitation extremes in Ellicott City, MD: Temporal downscaling, uncertainty quantification, and implementation in urban stormwater infrastructure design. Mofan Zhang, Master Student & Research Assistant; Rui Shi, Ph.D. Student; Benjamin Hobbs, Theodore and Kay Schad Professor of Environmental Management, Department of Environmental Health and Engineering, Whiting School of Engineering, Johns Hopkins University, Baltimore, MD
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Abstract
Analyses of recent precipitation records together with downscaled general circulation models (GCM) projections indicate a significant possibility that climate change is increasing the frequency of extreme storms. Stormwater infrastructure design should account for this possibility. However, projections are uncertain due to unavailability of sub-daily precipitation projections and inherent limitations of downscaled GCM scenarios. We undertake statistical temporal downscaling of projections by 16 combinations of GCMs, downscaling methods and emissions scenarios and examining their implications for estimates of the frequency of sub-daily precipitation extremes for Ellicott City for two future periods (2020-2049, 2070-2099) relative to a historical period (1983-2012). We also compare the contribution of six sources of uncertainty (assumptions concerning GCM, downscaling method, emissions scenario, gaging station, and fitted distribution, as well as sample error). Magnitudes of extreme storms (e.g., 100 yr-3 hr storms) are significantly affected by modeling assumptions and sample error. Choice of GCM is the most important uncertainty for all return periods examined. Second is sample error in parameter estimates, and its impact increases for longer return periods. There is a significant likelihood of an increase in future extreme storm magnitudes based on consideration of all the uncertainties. Decision tools for urban stormwater planning that are robust to future uncertainties are needed.

4. In-tree stem water potential innovations. Michael Davidson PhD, CEO and Avishai Avni-Maya PhD, Chief Agronomist, Saturas USA
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Abstract
Stem water potential (SWP) is considered the "gold standard" for determining water requirements for fruit trees and vines. SWP is a direct measurement of plant water stress and communicates the biological need for water and takes into account the physiological responses and the leaf and plant levels of stomatal conductance, vegetative growth, fruit growth and composition. The standard tool for measuring SWP has long been the pressure bomb. However, over the past decade, pressure bomb use has declined significantly due to more cost-effective approximations of water need and the extent to which pressure bomb readings are labor intensive. This paper examines the utility of SWP sensors, which are embedded into the vascular tissue of trees and automatically transmit SWP data to web apps. This paper illustrates the automated process of SWP data monitoring and analysis by way of four case-studies in citrus orchards in various global locations.

5. Hardness removal from the extremely hard LRGV tap water using electrically conductive concrete. Mirza Addaito Billah, Graduate Research Assistant; KIM Iqbal, Graduate Student; Jongmin Kim, Assistant Professor; Phillip Park, Lecturer, Civil Engineering Department, The University of Texas Rio Grande Valley (UTRGV)
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Abstract
Water hardness is the concentration of calcium (Ca^{+2}) and magnesium (Mg^{+2}) in water. Hard and very hard water exceeding the hardness concentration of 100-300mg/l as $CaCO_3$ is unpleasant to drink per the United States Environment Protection Agency. Scaling and corrosion in pipes and metal surfaces due to hard water has been a problem in the water supply industry for decades. The evolving necessity for high quality and safe water demands efficient and chemical-free systems to soften hard water. In this research, we have studied the electrochemical process to remove hardness from extremely hard water like Lower Rio Grande Valley (LRGV) tap water. The process has involved different combinations of environment-friendly graphite concretes as cathodes and Titanium as a anode A tangible engineering approach and optimal operating conditions of the electrolytic soluble metal removal process are expected from the research, which includes graphite percentage in the concrete, water acidity, electrical potential, and processing time.

6. Assessing the Effect of Clean River Projects on the downstream tributaries of the Anacostia River in Washington DC: A case study of *Escherichia coli* . R Mudiyanselage Rathnayake[1], Sania Rose[2] and Tolessa Deksissa[3] [1]Graduate Research Assistant, [2]Project Assistant, [3]Director of Water Resources Research Institute College of Agriculture, Urban Sustainability and Environmental Sciences, University of the District of Columbia
Corresponding Author Email: sania.rose@udc.edu

Abstract
Anacostia River is the largest receiver of combined sewer overflows (CSOs) in the District of Columbia (DC). Consequently, it became one of the most polluted rivers in the nation. To address this challenge, DC Water has invested $2.6 billion in clean river projects which include the Anacostia River tunnel. Nevertheless, there is a lack of field data to measure the effectiveness of these costly restoration and remediation projects. The objective of this research project is to improve our understanding of the effect of the clean river projects in the E. coli contamination on the water quality of downstream tributaries of the Anacostia River. Duplicate grab water samples were collected from six locations at the downstream tributaries of the Anacostia Rivers before and after a rainy period. The samples were analyzed and quantified for E coli using Quanti-tray and Coliert-18 method. Based on the Most Probable Number (MPN)/100 ml, the results showed that the clean river projects have a significant impact in the reduction of CSOs the main tributaries of the Anacostia River. This finding is very useful for the enhancement of the river restoration plan of the District.

7. Assessing Priority Pollutant Polycyclic Aromatic Hydrocarbons and Metal Elements in the Downstream Tributaries of the Anacostia River in Washington DC. Sania Rose[1], Mudiyanselage Rathnayake[2], Efrain Mauricio Pena Valasquez[2], Sebhat Tefera[3] and Tolessa Deksissa[4] [1]Project Assistant, [3]Graduate Assistance [3]Project Specialist, and [4]Director of Water Resources Research Institute and Professional Science Master's Program, [1,2,3]College of Agriculture, Urban Sustainability and Environmental Sciences, UDC
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Abstract
Anacostia River is one of the rivers that is highly contaminated with priority pollutant polycyclic aromatic hydrocarbons (PAHs) and metals in the nation. The objective of this research project is to address the knowledge gap related to these priority pollutants in the downstream tributaries of the Anacostia River in DC and its implication in possible on-site remediation techniques. Both PAHs and metals occur naturally but anthropogenic activities are the major sources. They can be accumulated in sediment and aquatic organism. Especially, PAHs are potentially carcinogenic and can be bio accumulated through the food chains. Grab samples of surface sediment were collected from the downstream location of six tributaries of the Anacostia River located in Washington, DC, including Watts Branch, Hickey Run, Lower Beaverdam, Fort Dupont, Pope Branch, and Kenilworth Marsh. Subsequently, samples were analyzed for the PAHs and metal pollutants using Gas Chromatography and Mass Spectrometry, and Inductive Couple Plasma Mass Spectrophotometer, respectively. The result showed that there is a strong correlation among organic matter content and priority pollutants. The finding of this research project has significant contribution to the restoration effort in identifying the most contaminated tributaries and feasibility study of on-site remediation techniques including capping and dredging.

8. COVID-19 pandemic and water demand. Matthew Sweeney, Undergraduate Student and Juneseok Lee, Associate Professor, Department of Civil and Environmental Engineering, Manhattan College, Riverdale, NY.
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Abstract
Most countries have adopted social distancing and a remote working model to prevent transmission of the SARS-CoV-2 virus. These new lifestyles have affected many economic sectors, including water industries. In this vein, water utilities have been significantly affected by changes in their daily operations and management. This research will explore the impacts of the COVID- 19 Pandemic on water use. The specific objectives of the research are to (i) understand trends in water usage based on comprehensive literature reviews and (ii) develop a set of recommendations for improved water demand management practices under emergencies. A deeper understanding of drastic water use changes during the Pandemic will help society to support emergency planning and policy developments in the future.

9. Statistical analysis of water demand changes. Robert Sullivan, Undergraduate Student and Juneseok Lee, Associate Professor, Department of Civil and Environmental Engineering, Manhattan College, Riverdale, NY
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Abstract
Supplying water when and where it is needed is a critical task given today’s rapid population growth, fluctuating water use patterns, climate change, new environmental awareness, and increasing expense for water infrastructure projects. Accurate water demand analysis and associated modeling efforts are vital for designing and operating water distribution networks and treatment systems. This research will perform an in-depth review of various statistical modeling of water demand patterns. The specific objectives of the research are to (i) elaborate core statistical modeling techniques in describing water demand patterns and (ii) tabulate the strengths and weaknesses of statistical modeling efforts. With more detailed water use data quality, we can perform thorough water demand program evaluations. It is critical that we have a deeper understanding of the water demand domains' statistical modeling efforts.