2019 National Capital Region Water Resources Symposium

Booklet of Abstracts
(Unedited)

Con-Current and Poster Sessions

American Water Resources Association
National Capital Section

University of the District of Columbia

April 12, 2019

CONTENTS

Con-Current Sessions

Session A. Panel: Data Capture, Analytics, and Visualization for Managing Coastal Cities of the Future

Moderator: Sophia Rodriguez, Lead Associate/ Geospatial Program Manager, Booz Allen Hamilton (Email: Rodriguez_sophia@bah.com)

Panelists:
Troy Gonzalez, Senior Associate & Chief Engineer for Advanced Infrastructure Solutions at Booz Allen Hamilton.
Glady Singh, Vice President of Government/Enterprise Services at PrecisionHawk
Josh Lowe, Co-Founder and Chief Customer Officer at AkitaBox
Federal Agency Representative, TBD.

Abstract

Sea level rise and increased storm intensity present enormous challenges to the infrastructure of coastal cities. Planning, adaptation, emergency response, and resilience will all benefit from better data on both natural and built infrastructure. New tools and methods for data acquisition generate incredible volume, variety, and velocity of data. However, data is rapidly increasing but is largely untapped and utilized inefficiently. This panel will show how massive amounts of data can be effectively analyzed and visualized to guide effective decision making for coastal cities – today and in the future. A focus will be the emerging technology of "digital twin" models, which are highly granular digital replications of large and complex environments such as a campus, a city, or region. Large amounts of newly collected data as well as existing databases and formulas can be embedded in the model for powerful, contextualized visualizations. Simulation of disasters like hurricanes and floods can be realistically demonstrated within the model to evaluate impacts and damages and mitigate these risks with new infrastructure/planning projects put into the model. The panel will present a digital twin of Galveston Bay that was developed for city planners and emergency management to assist in planning and emergency response for extreme weather event flooding in the region. The project team acquired open data imagery from the Hurricane Harvey event and additional real-time data from drones and other sensors to assess and model water levels, water quality, air quality, and other parameters. Artificial intelligence techniques were used to identify people and assess damage. This was coupled with infrastructure data to build out a 3D flood event model, including simulation in a virtual reality environment that allows for multiple stakeholder engagement with the data. The panel will present additional examples and illustrate the key phases of effective data capture and utilization. Automation of the process is becoming essential and will be a key theme. The first phase is automating and accelerating data capture. Unmanned aerial systems, affixed with various sensor platforms, can semi-autonomously, and eventually autonomously, collect a myriad of different imagery types to capture visual, thermal, LiDAR, hyperspectral, and ground penetrating radar data. Strategically placed fixed sensors can then provide continuous real-time data on critical assets. In the second phase, autonomous analytic techniques be performed to assess the imagery and data captured. Machine intelligence algorithms can be developed by training computers on imagery of infrastructure and the environment and identifying objects, defects and anomalies of importance so that the algorithms can learn and eventually perform real-time inspections on collected imagery without human interaction. In the final phase, after data is captured and analyzed in an expedited manner, various visualization platforms can be utilized to enhance decision making through contextualized data aggregation, modeling and simulation capabilities. Finally, the panel will discuss the frontiers of this technology and how they see it evolving.

Session B. Green Infrastructure & Stormwater Management

Modeling and scenario analysis of a long-term monitored rain garden for rainfall-runoff reduction to a combined sewer systematically

A. Massoudieh, Assoc. Prof., Civil and Enviro. Eng. The Catholic University of America, Washington, D.C.
Email: massoudieh@cua.edu

Abstract. The Green Infrastructure Flexible Modeling (GIFMod) environment allows users to take into consideration the physio-chemical processes of interflow (infiltration), evapotranspiration in the catchment's hillslope and exfiltration to the groundwater table, evapotranspiration, and dominant biogeochemical transformations effecting organic carbon and nitrogen species. We used GIFMod to simulate hydraulic and water quality processes in a green infrastructure practice consisting of two rain gardens built in series draining a small catchment (3.41 ac) consisting of a parking lot (0.41 ac) and wooded hillslope (~3 ac) to evaluate the long-term effectiveness of the system at reducing hydrologic and nutrient loads to a combined sewer. We used observed flow and water quality data and built-in GIFMod algorithms (hybrid genetic, Markov Chain Monte-Carlo) to calibrate the model. Next, the calibrated model was used to test the degree to which different design features (e.g., effluent riser height, depth of the storage layer, and expansion of the contributing catchment area) would change overall effectiveness. Our results show that the hydraulic retention time strongly regulates the effectiveness of the rain garden system as flow reduction and retention of nutrients, which are both valuable services to maintain combined sewer operational capacity. Based on the current design and a three year simulation, the rain garden system reduced about 50% of the runoff volume from the site. The rain garden system is more effective in the retention of loads from small to medium rain events than large ones. The results of the multiple design scenarios indicated that adding a riser-type outlet and increasing the storage volume would result in a moderate improvement to the performance of the system.

Quantifying urban tree transpiration across different management contexts. Sarah Ponte Cabral[1], Mitchell Pavao-Zuckerman[1], T. Phillips[1], N. Law[2], N. Sonti[3] [1] Univ. of Maryland, College Park; [2] Center for Watershed Protection; [3] US Forest Service
Email: sponte@umd.edu

Abstract. The hydrological functions of trees and forests can reduce stormwater runoff, mitigate the risk of flood, and improve water quality in developed areas. Tree canopies intercept rainfall and return water to the atmosphere through transpiration, and roots increase infiltration and storage in the soil. However, the amount of stormwater that trees remove through these functions in urban settings is not well characterized, limiting the use of urban forests as practical stormwater management strategies. To address this gap, we introduce a novel research framework that uses ecohydrological approaches to assess the stormwater retention benefits of urban trees in different management settings. During the growing season of 2018, we measured tree transpiration, canopy interception, and soil moisture dynamics in patches of urban forests, a cluster of trees over mowed grass, and single trees over mowed grass and along a street. Here, we present differences in transpiration rates among management contexts, and discuss how key climate and physical drivers of transpiration vary with management. These data help inform guidelines for practitioners using urban forest patches to manage stormwater flows. Our results will contribute to policy and practice by defining a nutrient reduction credit for urban tree canopies in the Chesapeake Bay watershed.

Effectiveness of foam based green roofs/surfaces for reducing runoff pollutant concentrations relative to conventional roofs.

S. Mucha[1], G. Williamson[2] , S. MacAvoy[1] [1] Dept. of Environ. American University, [2] Amber Real Estate, LLC, Washington, DC
Email: macavoy@american.edu

Abstract. Urban planners have long had an interest in developing green infrastructure. As cities combat flooding, water pollution and increasing heat island effects, green surfaces have been used to combat these problems. Green roofs reduce cooling and heating loads by providing insulation, reduce the urban heat island effect by 13–72%, retain stormwater, and can filter atmospheric and water-borne pollutants. Here we test whether foam-based unplanted and green surfaces (Aqualok™) remove pollutants (total suspended solids (TSS), NO_3, NH_4, total organic carbon (TOC) and total phosphorus (TP)) from direct precipitation and roof runoff passing through the surfaces. The assessments were conducted using unplanted and planted Aqualok™ roof panels and bioswale. During a three-year period, impacts on water chemistry were evaluated by examining overall averages as well as performance over time. Upon installation, all Aqualok™ surfaces released a "pulse" of TSS and NO_3, which decreased over time. Excluding the first three months post-installation, TSS in throughflow from planted and unplanted Aqualok™ surfaces was 88% and 90% lower, respectively, than in runoff from a conventional tar and gravel roof. No significant differences between green surface throughflow and conventional roof runoff for NO_3 or NH_4 were observed. Portions of this work appeared in *Nitrogen* 1:21-33.

Real-time optimization of stormwater infrastructure using continuous monitoring and adaptive control. C. Lewellyn, Ph.D., P.E., Senior Water Resources Eng. OptiRTC
Email: clewellyn@optirtc.com

Abstract. Over the past several years, a new approach to managing stormwater has emerged as a viable alternative to traditional, passively controlled, stormwater management facilities. Known as Continuous Monitoring and Adaptive Control (CMAC), this approach can optimize a stormwater facility for one or multiple objectives and be adapted over time as regulations, land-use, and/or climate changes. CMAC solutions integrate information directly from field-deployed sensors with real-time weather forecast data to directly monitor performance and make automated control decisions to actively manage stormwater. CMAC solutions have been shown to result in significant increases in the performance of a range of existing stormwater best management practices while reducing operational and outcome risk. The CMAC approach can improve environmental outcomes in several ways, including: (1) improving water quality by increasing residence time; (2) restoring pre-development hydrology; (3) increasing the volume retained for water reuse; (4) intelligently detaining flows in combined sewer systems; reducing the frequency of flooding events; (6) being adaptable to future climatic conditions or changes in site characteristics. CMAC technology has been used to meet water quality, flood control, hydromodification, and water reuse objectives at over 130 sites across 21 US states. This presentation will provide an overview and examples of CMAC technology and outcomes.

Session C. Remote Sensing & Modeling Research

Investigating the potential of assimilating satellite-based phenology observations in a land data assimilation system.
A. Rahman[1], X. Zhang[2], V. Maggioni[3], Y. [2], P. Houser[4], T. Sauer[4] [1] PhD Student, [2] Post-Doctoral Fellow, [3]Assistant Professor, [4] Professor, George Mason University
Email: arahma19@gmu.edu

Abstract. This study evaluates the potential of assimilating phenology observations in a land data assimilation system by constraining the modeled terrestrial carbon dynamics with remotely sensed observations of vegetation condition. Specifically, observations of Leaf Area Index (LAI) from the MODIS Terra (MOD15A2H) are assimilated in the Noah-Multi Parameterization (Noah-MP) land surface model within a Land Data Assimilation System (LDAS), forced with the NASA NLDAS-2 dataset across the contiguous United States (CONUS). The open-loop (OL) simulations have been run by perturbing the forcing precipitation and the soil moisture initial condition in two ways: i) the wet condition case (precipitation forcing has been doubled and initial soil moisture content is 0.7) and ii) the dry condition case (precipitation forcing has been halved and initial soil moisture content is 0.1). Then, the data assimilation of MODIS LAI observations is performed using two different methods, Direct Insertion (DI) and Ensemble Kalman Filter (EnKF). The efficiency of assimilating phenology information in a land surface model is evaluated based on water, energy, and carbon states and fluxes (e.g., surface and root zone soil moisture, skin temperature, net ecosys exchange or net CO_2 flux). This work has the potential to help to better interpret model estimates, in-situ and remotely sensed observations, and to evaluate responses to global environmental change.

Estimation of key components of terrestrial water and energy budgets by assimilating SMAP soil moisture and GOES temperature data.
A. Abdolghafoorian, Graduate Res. Assistant; Leila Farhadi, PhD, Assistant Prof. Civil and Environ. Eng. Depart., George Washington University
Email: lfarhadi@gwu.edu

Abstract. Accurate estimation of land surface heat and moisture fluxes is crucial in various hydrological, meteorological, and agricultural applications. The variational data assimilation approach is applied to estimate key parameters of land surface fluxes by assimilating Soil Moisture Active Passive (SMAP) soil moisture data and Geostationary Operational Environmental Satellite (GOES) land surface temperature data into the coupled dual-source energy and water model (hereafter VDA). VDA is focused on the estimation of key parameters which regulate the partitioning of available energy between sensible and latent heat fluxes (i.e. neutral bulk heat transfer coefficient and evaporative fraction from soil and canopy). The uncertainties of retrieved unknown parameters are quantifed through a Hessian-based methodology. The uncertainty analysis on the VDA estimates guides towards a well-posed estimation problem. The performance of VDA is validated over an area in the U.S. Southern Great Plains region (with computational grid size of 0.05 degree) during summer 2017. The land surface flux retrievals are verified against tower-flux field site data.

Assimilation of SMAP soil moisture observations for hyper-resolution land surface modeling. T. Rouf[1], Y. Mei[1], Viviana Maggioni[1], P. Houser[2] [1] Dept. of Civil, Enviro. & Infrastructure Eng. [2]Geography and Geoinformation Science Dept., George Mason University
Email: trouf@masonlive.gmu.edu

Abstract. In this study, we have developed a hyper-resolution atmospheric forcing dataset (temperature, pressure, humidity, wind speed, incident longwave and shortwave radiation) from coarse resolution products using a physically-based downscaling approach. These downscaling techniques rely on correlations with landscape variables, such as topography, temperature lapse rate corrections, surface roughness, and land cover. The hourly NLDAS (North America Land Data Assimilation System) atmospheric variables at 0.125° have been downscaled to 500m during 2015. The Noah-MP land surface model is then forced with both native resolution NLDAS and downscaled one to simulate surface and root-zone soil moisture. Model outputs are compared with in-situ soil moisture observations and SMAP (Soil Moisture Active Passive Mission) products. Then, a data assimilation system is adopted to merge the SMAP products into the land-surface model. SMAP products will critically enhance hyper-resolution modeling for several reasons. First, SMAP products offer a unique look at global soil moisture variability. Secondly, land surface models are well known to be biased and SMAP has the potential to directly help correct these first-order large scale biases. This work will result in a radical improvement over the current state-of-the-art forcing data and will move into the era of hyper-resolution land modeling.

An Introduction to NOAA's National Water Model. Jennifer McGee, PE, CFM, GISP, Water Resources Engineer, Wood E&IS
Email: jenna.mcgee@woodplc.com

Abstract. The National Water Model (NWM) is a relatively new product, development led by the National Oceanic and Atmospheric Administration (NOAA) Office of Water Prediction (OWP) and the National Water Center (NWC). The NWM "is a hydrologic model that simulates observed and forecast streamflow over the entire continental United States (CONUS)". The forecast streamflow is a result of evaluating snowmelt, infiltration and other parameters to determine the volume of rainfall that becomes runoff. The streamflow is calculated for every reach in the National Hydrograph Dataset (NDHPlusV2). That is ~ 2.7 million stream reach forecast points. This greatly expands the streamflow forecast beyond the currently gaged stream locations!
This presentation will provide a general background on the National Water Model, review the forecasts scenarios and associated datasets in a bit more details. We will also explore a few of the online map viewers; compare and contrast their features and possible utilities. By the end of the presentation you will be familiar with the basics of the NWM forecast data and be able to use these online viewers to understand the fundamentals of your local streamflow forecasts.

Session D. Adapting to Extreme Weather and Climate

Adapting coastal wastewater and conveyance systems for climate change. B. Wright, PE and E. Rosenberg, PhD, PE. Associate, Hazen and Sawyer
Email: bwright@hazenandsawyer.com

Abstract. Reliable and resilient collection systems are essential for the protection of public health. Extreme storms and flood events can inundate facilities, damage infrastructure, and exceed the treatment capacities of wastewater treatment plants. The combined threat of sea level rise and increasingly severe precipitation extremes is causing coastal communities to question the resilience of existing infrastructure and rethink conventional design standards for future facilities. The USEPA estimates that $300 billion of investment is needed nationwide to address current water quality issues or water quality related public health problems. As the US enters a period of unprecedented reconstruction of its critical infrastructure, wastewater and stormwater utilities require guidance on preparing existing facilities for climate change impacts and incorporating climate change projections into updated design standards for long-term resilience. This presentation will cover a risk assessment framework that 1) provides guidance on projected changes to coastal flooding from both extreme rainfall and storm surge; 2) describes methods for evaluating the failure risk of coastal wastewater and stormwater systems; and 3) presents a methodology for comparing costs and benefits of adaptation options. The presentation will include case studies of the approach from projects for New York City, Miami, and the Washington, DC area.

Using a novel method to map flood susceptibility of the lower Connecticut River Region. J. P. Giovannettone, PhD, PE, Dewberry
Email: jgiovannettone@dewberry.com

Abstract. Awareness of land areas that are currently or will be more prone to flooding in the future due to climatic and non-climatic factors is essential to consider in short- and long-term planning. Additionally, most planning activity related to resilience and climate adaptation focuses on coastal flooding and sea level rise. This study focuses on the Lower Connecticut River Valley Region (LCRVR), within which inland flooding was identified as an area of limited research and where the influence of non-climatic factors on flooding has not been assessed. Flood susceptibility was estimated using a method referred to as logistic regression, which can be used to develop a relationship between several non-climatic flood risk factors and the probability of flooding, the spatial extent of which in the current study was estimated using the 100-year FEMA flood hazard area. Flood risk factors considered included elevation, slope, land shape, distance to water, land cover, vegetation, ground materials, soil type, and percent of paved surface. The LCRVR was first split into three sub-regions (urban, rural, and coastal) and then flood risk factor values were extracted from 4,000 point locations in each sub-region; an equal number of these locations were required to be within and outside of the flood hazard area. Logistic regression was performed and allowed the estimation of coefficients, which express the relative importance of each flood risk factor. It was found that 'elevation' and 'distance to water' have the most influence on flood susceptibility in the urban and coastal sub-regions, while 'distance to water' and 'ground materials' dominate in the rural sub-region. It was also found that the contribution of 'land use' increases by over 200 percent between the rural and urban regions. The coefficients were finally used to develop a model of flood susceptibility that estimates probabilities of flooding throughout the LCRVR. It was found that several areas classified as "very high risk" (80 – 100%) and "high risk" (60 – 80%) were located outside of the 100-year FEMA flood hazard area and included several types of critical infrastructure that prior to this study were assumed to be safe from the effects of a 100-year flood event.

Future changes in the coastal road overtopping depths controlled by joint probability of tide-stream flows. K. Zomorodi, PhD., PE, CFM
Dewberry
Email: kzomorodi@dewberry.com

Abstract. Roadway bridges and culverts in coastal area may be exposed to excessive flooding due to both tidal activities and instream flooding. The roadway flooding risk could be controlled by a joint probability of tidal elevations and stream flows. An example analysis of a culvert crossing over a coastal stream in Virginia showed that several pairs of stream flow-tide elevations that represent the same overall flood probability could result in different flooding depths over the road. Sea level rise and climate change can amplify the future flood risks by increasing the tide elevations and stream discharges. The calculations of road overtopping depths were repeated for the future 50-year time horizon by accounting for changes in design tide elevations and stream discharges. Plotting the expected range of road overtopping at each risk level for present and future conditions clearly indicated more frequent road overtopping and larger overtopping depths in future. Moreover, comparing the cumulative probability of flooding for present and future revealed the range of road overtopping depths that will become considerably more frequent. The solution approach presented here may also be applied to other coastal areas to assist in sustainability planning of coastal roadways.

Perspectives on adaptation and resilience of urban stormwater management in a changing climate. M. Pavao-Zuckerman, Assistant
Professor, Environmental Science and Technology, University of Maryland, College Park
Email: mpzucker@umd.edu

Abstract. Urban impacts on hydrologic processes are increasingly being addressed through decentralized approaches such as green infrastructure (GI). Climate change models predict shifts precipitation frequency and intensity through the 21st century, potentially increasing stormwater runoff in urban areas. GI is often proposed as a possible climate adaptation measure for urban areas; however, there has been limited consideration of how effective a tool GI may be for adapting to climate change. We conducted a systematic literature review to assess the potential climate resilience of GI. Studies report potential negative impacts of climate change on watershed hydrology and nutrient retention, and that mitigating this requires significant investment in GI to enhance climate resilience. Most studies do not address the feasibility of or barriers to enhanced implementation of GI or explicitly connect adaptation and resilience goals to planning and design needs of GI. To address this gap, we discuss a research framework that draws on urban resilience and social-ecological perspectives, and consider absorptive, adaptive, and transformative capacities of GI in urban watersheds. We discuss how to characterize climate resilience in terms of the ecohydrologic services it supports, considerations for transformation, and the beneficiaries and decision makers involved in resilience planning.

Climate change challenges for water resources management in Panama. M. C. Larsen, Director, Smithsonian Tropical Research Institute, Panama
Email: larsenmc@si.edu

Abstract. Global air temperature data show that 16 of the 17 warmest years since 1880 have been recorded since 2001. A warmer atmosphere contributes to more evaporation and convective storms, and to deeper and more prolonged droughts. What climate conditions can Panama expect in the coming decades? What extremes of droughts and floods? How might climate change affect El Niño frequency and intensity and associated droughts? We live in an age of increasing uncertainty with respect to air temperature and precipitation distribution and accumulation. Past norms for seasonality and annual variability of these climate variables are unreliable. In our 21st century "non-stationary" world, natural resources managers must be increasingly adaptive. For water availability and quality, this requires more efficient water use. For land resources, it means minimizing human-caused disruption of natural systems, by planting and maintaining endemic tree species that are adapted to local environmental conditions and disturbances. It also requires collaborating with economists and social scientists to find ways that incentivize effective stewardship by private and public land owners. Good stewardship assures that the benefits we receive from natural systems, (ecosystem services), continue to accrue into the future in spite of the vagaries of climate change. Well managed watersheds provide numerous ecosystem services, such as high quality water, reduced peak river flow during storms, increased availability of groundwater and base flow in streams during seasonal dry periods and droughts, reduced soil erosion and landslide probability, enhanced resilience to wildfire, pathogens and invasive species, biodiversity, genetic resources, and recreation.

Session E. Sustainable Water and Environmental Management Strategies & Tools

Water quality trading in the Chesapeake Bay Watershed. P. Gleason, USEPA Region 3 Trading and Offset Program Lead
Email: gleason.patricia@epa.gov

Abstract. The Unites States Environmental Protection Agency (EPA) believes that market-based approaches such as water quality trading provide greater flexibility and have the potential to achieve water quality and environmental benefits greater than would otherwise be achieved under more traditional regulatory approaches. Water quality trading is an approach that offers greater efficiency in achieving water quality goals on a watershed basis. It allows one source to meet its regulatory obligations by using pollutant reductions created by another source that has lower pollution control costs differentials among and between sources. Three case studies will be presented from across the Chesapeake Bay Watershed that illustrates different water quality trading approaches.

Optimizing water reuse in the Potomac River Watershed. J. Mattingly, K. VandenHeuvel, The Water Research Foundation; S. Kaushal, PhD, Associate Professor, University of Maryland
Email: jmattingly@waterrf.org

Abstract. An ongoing research project from the Water Research Foundation is investigating the impact of water reuse on discharges of nutrients and endocrine disrupting compounds in the Potomac River watershed. This project, funded by the U.S. EPA, is also investigating stormwater and agricultural best management practices to determine their impact and how such practices can support integrated management of water resources. Water samples are being collected throughout the watershed in coordination with the U.S. Geological Service in sub-watersheds both with and without water reuse and with and without best management practices for stormwater and agriculture. This will allow for the quantification of how effective such practices are in managing nutrients and other compounds of interest. Preliminary results indicate that waterbodies under the influence of planned potable reuse show a lower concentration of estrogenic compounds, although additional sampling and analysis is planned to better characterize the impacts. The full impact on nutrient concentrations is still being investigated and is expected to be largely completed in early 2019. In addition, stormwater and agricultural best management practices also show a positive impact on nutrients and estrogenic compounds. This research will culminate in a cost-benefit analysis to develop a framework communities can use to determine the most beneficial ways to manage nutrients and other compounds of interest.

An application of remote sensing to the protection of a regional water supply.
Shaifali Prajapati, William Patrick Frier, NASA Langley Research Center; Paul Koch, PhD, PE, Technical Advisory Committee, Patuxent Reservoirs Watershed Protection Group
Email: william.p.frier@nasa.gov

Abstract. In early 2019 the Technical Advisory Committee of the Patuxent Reservoirs Watershed Protection Group participated in the NASA DEVELOP Program to investigate what ongoing earth observations can reveal about land cover trends in a watershed that is a key source of drinking water in the Washington, D.C. metropolitan area. DEVELOP coordinators assembled a team of students and young professionals to

undertake the work under the supervision of NASA personnel at the Langley Research Center. Algorithms for land cover classification and change detection were executed using modest desktop computers and readily available software, and the process was thoroughly documented so that changes in future years could be assessed in precisely the same way. Results of the project demonstrate the costs and benefits of routinely analyzing publicly available satellite data to monitor the condition of the watershed.

Using NASA remote sensing for water resources and disasters monitoring and management. Amita Mehta[1], Erika Podest[2], Ana Prados[1]
[1]NASA-UMBC-Joint Center for Erath Systems Technology (JCET), [2]NASA - Jet Propulsion Laboratory.
Email: amita.v.mehta@nasa.gov

Abstract. The NASA Applied Remote Sensing Training Program (ARSET), a part of NASA's Applied Sciences Capacity Building program, empowers the global community through online and in-person trainings. The program focuses on helping policy makers, environmental managers, and other professionals, both domestic and international, applications of remote sensing data. Since 2011, ARSET has provided more than 30 trainings in water resource, flood and drought monitoring and management. This presentation will include an overview of the ARSET program, examples of case studies of using remote sensing for 1) estimation of water budget at a watershed level, 2) monitoring algal bloom in costal and in-land water bodies, and 3) monitoring tropical storms and urban flooding. This presentation will also outline how ARSET can serve as a liaison between remote sensing applications developers and users in the areas of water resource and disaster management.

Balancing environmental sustainability and infrastructure investments. J. Escurra* PhD, Adjunct Faculty, UDC & World Bank Consultant; A. Bassi, Founder & CEO, KnowlEdge Srl and Extraordinary Professor of System Dynamics at Stellenbosch University, South Africa
Email: jescurra@worldbank.org, jorgejoseescurra@hotmail.com

Abstract. Colombia has a commitment to infrastructure development as a crosscutting strategy that contributes to the peace and equality in the country. In this regard, El Departamento Nacional de Planeacion (National Department of Planning) presented a Master Plan of the Orinoquia in 2016. The plan states that the Government of Colombia would invest a large portion of US$ 7.7 million in infrastructure development in the department of Vichada where the watershed of the Bita River is located. As a way to support the local government in balancing between the environmental concerns and the economic growth, a Stakeholder-Driven Future Score Card was implemented in the Bita River Basin for analyzing the impacts of actions (such as infrastructure development, consideration of RAMSAR sites, and expansion of the tourism activity, among others) on hydrological, environmental, social, and economic indicators. Based on their impact to these indicators, the prioritization of actions was accomplished using scores. This participative process consists of (i) development of workshops in the basin where the selection of the actions, development of the four cycles (economic, environmental, social, and hydrological cycles) and discussions around the results took place; and (ii) implementation of a simple mathematical model in which the interactions of the indicators with the activities of the four cycles were represented qualitatively and quantitatively.

Session F. Water and Waste Treatment Research

Mathematical modeling of deep-bed biofiltration to describe contaminant control and head loss development for potable water reuse.

Yewei Sun[1], Wendell Khunjar[2], Erik Rosenfeldt[3], Meric Selbes[4], Zhi-Wu Wang[5*]
[1]PhD Student, Occoquan Laboratory, Department of Civil and Environmental Engineering, Virginia Tech
[2]Associate and Director of Applied Wastewater Research, Hazen and Sawyer
[3]Director of Drinking Water Process Technologies, Hazen and Sawyer
[4]Principal Scientist, Hazen and Sawyer
[5]Assistant Professor, Occoquan Laboratory, Department of Civil and Environmental Engineering, Virginia Tech
Email: wzw@vt.edu

Abstract. Deep-bed biofiltration technology has been broadly applied in water industry for decades. Biofiltration can effectively remove contaminants using biofilms and their supporting media (e.g. GAC) through particle deposition, adsorption and biodegradation. During operation, biofilm growth and particle deposition will increase headloss across the filter, and periodic backwash is typically triggered in response to headloss buildup. At many full-scale facilities, backwash has been a significant energy and maintenance burden. Thus, there is a need to develop strategies that optimize filter design and operation (D&O). However, the industry still currently lacks a systematic tool for biofilter D&O. In this study, we developed a biofiltration process kinetic model to predict headloss development while simultaneously quantifing contaminant removal. Applications of the model to pilot- and full-scale biofilter data were performed. Analyses indicated that the contributions of particle deposition on headloss accumulation were negligible in potable reuse system with low turbidity. It was also found that increasing the GAC size appears to be the best strategy to improve the biofiltration performance by significantly reducing headloss accumulation and maintaining sufficient contaminant removal. The outcome of this study will shed light on optimization of headloss accumulation as well as contaminant control in deep-bed biofiltration for potable reuse.

Granulation of aerobic granules performing nitrification in continuous flow air-lift bioreactors without hydraulic selection pressure

Zhaohui An[1, 3], Charles B. Bott[2, 4], Zhi-Wu Wang[1, 5, *] [1] Department of Civil and Environmental Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA, [2] Hampton Roads Sanitation District, VA, [3] Ph.D. student, [4] Director of Water Technology and Research, [5] Assistant professor
Email: wzw@vt.edu

Abstract. Aerobic granules possess advantages over activated sludge for their excellent settleability, high biomass retention, and the ability to simultaneously pollutants removal. However, evidence showing ability of aerobic granules to be long-term stabilized within continuous flow reactors (CFRs) is limited. In contrast, almost all aerobic granules were cultivated in sequential batch reactors (SBRs) with hydraulic selection pressure. Interestingly, anammox granules maintain stable within CFRs without hydraulic selection pressure. Therefore, we inoculated ammonia-oxidizing bacteria containing anammox granules into CFR, and then gradually suppressed anammox activity. Results showed that the aerobic granules have maintained excellent structure integrity and partial nitritation performance during the first 5 months with effluent turbidity as low as

3 NTU, indicting that hydraulic selection pressure was not necessary. After intentionally turned partial nitritation granules into nitrification granules by phasing out anammox activities, results over the past 3 months showed that the nitrification granules still maintained structural stability and performance robustness. Then, ultrafiltration membranes were applied to eliminate hydraulic selection pressure. So far, we have not observed any granule disintegration. By the time of this presentation, we will have even longer-term experimental data to further confirm the stability of nitrification granules in CFRs without hydraulic selection pressure.

Free ammonia resistance of NOB over long-term operation in continuous flow aerobic granulation reactor performing partial nitritation

Zhaohui An[1, 3], Tim R. Kent[1, 4], Charles B. Bott[2, 5], Zhi-Wu Wang[1, 6,] , [1] Department of Civil and Environmental Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA, [2] Hampton Roads Sanitation District, VA, [3] Ph.D. student, [4] Master student, [5] Director of Water Technology and Research, [6] Assistant professor
Email: wzw@vt.edu

Abstract. Suppression of nitrite oxidizing bacteria (NOB) is a prerequisite for successful application of anammox, and free ammonia (FA) inhibition can limit NOB growth. However, the long-term effectiveness of FA inhibition on NOB growth has not been well understood. In this study, two continuous flow bioreactors were operated for 9 months. Aerobic granules have been stabilized throughout the entire experimental duration (effluent turbidity < 3 NTU). Results revealed that good suppression of NOB by FA (1.0 $mg\text{-}N \cdot L^{-1}$) and dissolved oxygen around 0.73 $mg \cdot L^{-1}$ were achieved during the first 5-month operation with 50% of influent ammonia nitrogen converted to nitrite and little nitrate accumulation (NO_3^-/NO_2^- ratio < 0.1). However, the NO_3^-/NO_2^- ratio started to rise after 5 months to 111.7 despite the same high FA level, implying the resistance of NOB to FA inhibition. ammonia oxidizing bacteria (AOB):NOB ratio tends to increase with the decrease of the granule size because of the FA diffusion limitation in larger granules. However, this granule size dependence disappeared due to the resistance of NOB to FA inhibition. Therefore, FA inhibition may not be a reliable strategy for NOB suppression, and its effectiveness can be quantified by the dependence of AOB:NOB ratio on the granule size.

The control of recalcitrant dissolved organic nitrogen production from the thermal hydrolysis of biosolids

Dian Zhang[a*], Zhi-Wu Wang[a], Wendell Khunjar[b] [a]Occoquan Laboratory, Department of Civil and Environmental Engineering, Virginia Tech, Manassas, VA; [b]Hazen and Sawyer, Fairfax, VA
Email: dianz@vt.edu

Abstract. Thermal hydrolysis is a proven pretreatment technique for enhanced the anaerobic digester treatment capacity by improving the biodegradability and viscosity of the biosolids. However, a hidden risk of using thermal hydrolysis lies in its production of recalcitrant dissolved organic nitrogen (rDON) through the well-known Mailard reaction under high temperature. rDON poses threats to the normal operation of wastewater treatment plants by raising effluent total nitrogen concentration and blocking the UV during disinfection. This study related rDON production to the Maillard reaction during the thermal hydrolysis of biosolids. Based on our in-depth understanding of the mechanism of Maillard reactions, this study further investigated approaches to harnessing rDON production. Results showed that the rDON production during thermal hydrolysis will decrease with the decrease of pH and ferric ion concentration. Hence, pH adjustment and the use of non-ferric coagulant/flocculant should be considered as two effective strategies for rDON control prior to thermal hydrolysis pretreatment.

Process intensification of anaerobic digestion: A comparative assessment of temperature phased anaerobic digestion and thermal hydrolysis pretreatment

Dian Zhang[a], Tom Broderick[b], Mary Strawn[b], Hari Santha[c], Zhi-Wu Wang[a]
[a]Occoquan Laboratory, Department of Civil and Environmental Engineering, Virginia Tech, Manassas VA; [b]Arlington County Water Pollution Control Bureau, Arlington, VA; [c]Alexandria Renew Enterprises, Alexandria, VA
Email: dianz@vt.edu

Abstract. Rapid urbanization in metropolitan area resulted in drastic increase of sewage sludge production and other related challenges such as the added cost of biosolids disposal, the land limitation for treatment facility expansion, and the increase of odor nuisance complaints from the neighbor communities. Certainly, the best choice for urban wastewater treatment plants to cope with these challenges is to seek process intensification technique to accommodate the increased biosolid treatment loading within their existing infrastructure. In this study, advanced sludge anaerobic digestions by using temperature phased anaerobic digestion (TPAD) and thermal hydrolysis pretreatment (THP) were comprehensively compared against the conventional mesophilic anaerobic digestion from the standpoints of digester startup, biogas production, pathogen destruction, system stability, foaming potential, biosolids dewaterability, odor emission, and emerging containment destruction. Results of the study exhibited that the mesophilic anaerobic digesters with TPAD or THP performed much better than the control without. Furthermore, TPAD showed the highest biogas production and organic reduction while the THP showed superior dewaterability improvement, odor reduction, and pathogen destruction. However, the thermophilic phase of TPAD turned out to be more liable to volatile fatty acid accumulation and thus digester upset than other digestion processes investigated in this study.

Poster Session

A Reduced-adjoint variational data assimilation for estimating soil hydraulic parameters. Parisa Heidary and Dr. Leila Farhadi, Civil and Environmental Engineering Department, George Washington University, Washington, D.C.
Email: parisaheidary@gwu.edu

Abstract. Soil hydraulic parameters play a critical role in the terrestrial water and energy cycle. They control the movement of water in the soil. This movement governs the partitioning of the soil moisture between evaporation and infiltration fluxes. Therefore, accurate estimation of soil hydraulic parameters and hence soil moisture profile is of critical importance for land surface and land- atmosphere interaction modeling. Numerous methods have been developed to estimate soil moisture profile and the unknown soil hydraulic parameters. Variational approaches and specifically adjoint techniques namely variational data assimilation (4DVAR), is a well-known method for estimation of the unknown parameters of a physical system. This method improves a model consistency with available data by minimizing a cost function measuring the model–data misfit with respect to some model inputs and parameters. Associated with this type of method, however, are difficulties related to the coding of the adjoint model, which is needed to compute the gradient of the 4DVAR cost function. Proper orthogonal decomposition (POD) is a model reduction technique, which can be used to approximate the gradient calculation in 4DVAR. The goal of this study is to utilize POD to reach a reduced-order approximation of the gradient calculation. Two distinct approaches are proposed and developed in this study when using POD in 4DVAR. In the first approach, an optimization algorithm is applied in order to minimize cost function entirely in the POD-reduced space. The second approach uses POD to approximate only the adjoint model. The accuracy and feasibility of the proposed approaches will be investigated through a synthetic study. The main goal of this study is to use these two techniques to retrieve initial soil moisture profile and estimate the unknown parameters of the soil by solving the nonlinear Richard's equation.

Nanoparticles infused mesoporous material for water treatment processes. Michael Kamen[1], Highqueen Sarpoma[2], Vu, Trinh[1], Tolessa Deksissa[2], Jiajun Xu[3] [1]Department of Biology, Chemistry & Physics, DC [2] Water Resources Research Institute, [3]Department of Mechanical Engineering, University of the District of Columbia
Email: jiajun.xu@udc.edu

Abstract. Water pollution is a fundamental and critical problem for human health and the environment, and it remains one of main threats and challenges humanity faces today. In particular, heavy metals in drinking water are a big concern because they are toxic and can cause death. These metals can get into water through corrosion of the pipes and plumbing system, erosion of natural deposits, or runoff from old paints. Some of the effects heavy metals cause to human are damages in skin, brain, lungs, circulatory system, kidneys, livers, and eventually leading to cancer or death. While there are many polluted water pretreatment and remediation technologies available today, most of them very often are costly and/or time consuming, particularly pump-and-treat methods. Recent advances suggest that many of the issues involving water quality could be resolved or greatly ameliorated using nanostructure materials resulting from the development of nanotechnology.
In the current study, a new method was developed to synthesize the hybrid mesoporous material with metallic oxides, MCM-48 with TiO_2, at an improved efficiency and reduced cost. The results have shown an over 95% adsorption efficiency for trace metals for the hybrid MCM-48 with

TiO_2 materials, and a significantly improved maximum adsorption capacity compared to pure MCM-48. Its unique hybrid structured allows the polluted water to pass through the strong yet highly permeable structure of mesoporous material, while gives enough time for the pollutants to react with the TiO_2 infused on the porous structure so that the polluted water can be treated without introducing secondary pollutants. The microstructures of the MCM-48 with and without TiO_2 are characterized using SEM with EDS and Porosimiter. The effectiveness of wastewater treatment is measured using Inductively Couple Plasma-Mass Spectrometer (ICP-MS). The significant improvements observed here is likely due to the infused TiO_2 to the base MCM-48 structure, which also agree with the authors' previous finding. It is noticed that, while the higher concentration of TiO_2 has a positive impact on the adsorption of trace metals, the higher concentration of Ti source does not necessarily yield significantly higher concentration of TiO_2 in the final product. Future study is needed to further explore this hybrid mesoporous material for other pollutants treatment, and to obtain a further understanding of its mechanisms.

Hyper-resolution mapping of atmospheric variables in northern Virginia. Ishrat Jahan Dollan[1], Dr. Viviana Maggioni[2]
[1] Graduate Teaching Assistant, [2]Assistant Professor, George Mason University
Email: idollan@gmu.edu, vmaggion@gmu.edu

Abstract. Northern Virginia is one of the most rapidly growing urban and coastal regions in the United States and its population growth is still on the rise, as reported by the 2010 census data. The population growth predicted by the Northern Virginia Regional Commission for year 2040 together with multiple climatic stressors poses increasing challenges in the region. Analyzing past atmospheric and hydrological data, e.g., temperature, pressure, and humidity, is critical for better understanding these changes and predicting future trends. This study uses physically-based downscaling technique to map atmospheric variables (including air temperature, air pressure and specific humidity) at spatial hyper-resolution across Northern Virginia. Specifically, the NASA North American Land Data Assimilation System (NLDAS) dataset, available since 1979 to present at hourly/12km temporal/spatial resolution, is adopted. Several physically-based downscaling algorithms are then applied to the NLDAS data to study the variability of atmospheric variables at 1 km spatial resolution in one of the most vulnerable regions in the country.

Effects of Anacostia River water on growth and development in larval zebrafish (*Danio rerio*). VP Connaughton[1], W Jessup[1], R Wilken[1], and S MacAvoy[2] [1]Department of Biology and [2]Department of Environmental Science, American University, Washington, DC
Email: vconn@american.edu

Abstract. We assessed the impact of exposure to Anacostia River water on fish early life stage development and correlated those results with water quality analyses to determine potential biological impacts of identified contaminants. Water was collected from two different sites: a downstream Anacostia site opposite Washington Navy Yard (WNY; "poor" historical water quality scores) and Bladensburg Waterfront Park (BWP), a midstream site with "moderate" historical water quality scores. Collected samples were filtered prior to extraction of organic contaminants by GC/MS. Siloxanes (volatile organic silicone compounds) were found to be a major contaminant at BWP and one of several contaminants at WNY. Fertilized zebrafish eggs (0-24hr) were reared in petri dishes containing either filtered Anacostia or control water for 2-4wk. Survival did not significantly differ between Anacostia-treated fish and controls at either site. However, fish reared in WNY water hatched earlier, were larger in size, and displayed increased thigmotaxis. These stress-related effects developed over time, with significant differences

emerging at 3-4wk. In contrast, fish reared in BWP water hatched at the same time as controls, with no stressful behaviors observed after 2wk of treatment. These results identify differences in the biological impacts of surface water contaminants along the lower Anacostia River.

Application of electrical conductivity for nutrient measurement in the hydroponic System. Victoria Mirowski, Project Assistant, Candidate of Professional Science Master's in Urban Agriculture and Tolessa Deksissa, Director, Professional Science Master's Program, College of Agriculture, Urban Sustainability and Environmental Sciences, University of the District of Columbia.
Email: tdeksissa@udc.edu

Abstract. The magnitude of agricultural threats to our freshwater resources is multiplying, and finding alternatives is an imminent action. Previous studies showed using hydroponic systems, soilless growing systems, mitigate pressure off of our freshwater resources through recycling of water and nutrients, and allow urban and rural areas to produce nutritious produces. However, water quality monitoring for nutrient management is expensive. The objective of this study is to assess the application electrical conductivity (EC) as surrogate for the nutrient level in the hydroponic system. In this study, the effect of different level of EC on the productivity of the hyroponic system was investigated at the UDC's urban food hubs. The results show that the performance of the system depends on the salt tolerance of the plant and does not allow effective nutrient management. EC provides a general estimate of ions in the water- not the type or amount. By knowing sensitive tolerance of plants, and using a more individualized method to understand nutrient management, more research to be conducted relying on a mixture of saltwater and freshwater to effectively grow lettuce, and other crops in the Nutrient Film Technique System.

Effectiveness of green infrastructure in retention and nutrient removal. Brandon Hunt and Theresa Christian, Professional Science Master's in Water Resources Management, Tolessa Deksissa, Director, Professional Science Master's Program, College of Agriculture, Urban Sustainability and Environmental Sciences, University of the District of Columbia.
Email: tdeksissa@udc.edu

Abstract. Managing stormwater quantity and quality is the main focus of many cities to improve urban water quality. Treating and containing stormwater runoff safely can prove challenging with traditional stormwater management systems if they become overloaded during extreme events. The effects of stormwater runoff can be mitigated through the use of Green Infrastructure (GI) systems, including rain gardens and green roofs. Although GI can alleviate the effects of stormwater runoff volume, its effectiveness in retaining and removing nutrients is in question. The objective of this synthesis paper is to assess the effectiveness of GI not only in storing water volume, but also in retention and removal of nutrients. The research questions include do deeper green roof depths and varied soil structures and compositions yield greater nutrient removal? Can rain gardens be designed to effectively remove nitrates from stormwater runoff? Should green roofs of greater depths be eligible for greater stormwater credit discounts? The result shows that altering the specifications of the design, varying different plant species, soil media types, and soil media depths on green roofs and rain gardens, creating aerobic and anoxic condition in bio-retention, may improve the retention and removal of nutrients by the GI.

Design and construction of demonstrative green roof systems at Van Ness Campus, UDC. P. Sanchez[1], S. Tait[2], S. Alhuwayshil[2]; J. Badal[2], P. K. Behera[3], Professor, Civil Eng. [1]MS PSM, Water Resource Management; [2]BS Civil Eng.; [3]Professor, Civil Eng., University of the District of Columbia.
Email: pbehera@udc.edu

Abstract. Urban stormwater management has been a very critical issue for most of the metropolitan cities in the United States. Often high impervious cover in cities resulting in higher runoff volume along with faster velocities to local receiving waters through CSOs and polluted stormwater discharges. The sewer system in the District of Columbia is comprised of both combined and separate sewer systems which contribute significant pollution to the Anacostia and Potomac Rivers and Rock Creek through Combined Sewer Overflows (CSOs) and Storm Sewer discharges during wet-weather events (i.e., rainfall and snowmelt). These overflows and associated pollutant loads can adversely impact the quality of the receiving waters. A cost effective and sustainable way to reduce the impacts of stormwater quantity and quality has been implementation of best management practices such as low impact developments, rain barrels, green roofs, bio-retention ponds and structural runoff control etc. However due to the high cost of land in dense urban areas such as the District of Columbia it is highly desirable to minimize the land occupied by these facilities by optimizing their performance. In last few years, District has been emphasizing not only implementation of green roofs as means of runoff quantity control but also utilization of availability of number of flat roofs. The goal of the this research is to design and built two mobile green roof systems that will demonstrate the visualization of efficient stormwater runoff control from impervious roof surface and pervious green roof surfaces. The project has planned, designed and built two green roof systems with each having 50 square feet of roofs which will be placed at the central quadrangle within the Van-Ness campus of University of the District of Columbia. One roof is comprising of traditional shingles depicting the impervious surface of roofs and associated runoff generation and other roof is comprising of the green roof system depicting the conversion of impervious to pervious surface for volumetric runoff control. The systems will be equipped with runoff collection systems to visualize and understand the green roof systems. The proposed mobile green roof systems will be used for academic demonstration of stormwater runoff volume control for elementary to high school students, university students as well as public. The outcomes of this research include understanding of impact of green infrastructure such as green roof systems on the storm-water quantity and quality in the District of Columbia.

Assessing spatial distribution of water quality contamination in Washington, DC: A case study of coliform, trace metals and polycyclic aromatic hydrocarbons. Mudiyanselage Rathnayake, Candidate of Professional Science Master's in Water Resources Management Maryam Sabur, Candidate of Professional Science Master's in Water Resources Management, Sania Rose, Project Assistant, Water Resources Research Institute, Sebhat Tefera, Project Specialist, Water Resources Research Institute, Tolessa Deksissa, Director, Professional Science Master's Program, College of Agriculture, Urban Sustainability and Environmental Sciences, University of the District of Columbia.
Email: tdeksissa@udc.edu

Abstract. DC water ways are impacted and do not meet the designated water quality standards, which are fishing and swimming. Main water quality contaminants include E. Coli, trace metals and Polycyclic Aromatic Hydrocarbon (PAH). When E Coli is the indicator organism for the presence of pathogenic organisms in an aquatic environment, PAHs have carcinogenic and mutagenic properties, PAHs have been a major concern

regarding public health and environmental impact. Stormwater runoff and combined sewer outfalls are the major sources, especially the main cause of microbial contamination is combined sewer overflows, whereas the cause of PAH contamination is stormwater runoff. The objective of this study is to assess the spatial distribution of water quality contamination in Washington, DC based on Coliform, Trace Metals and PAHs. Grab samples of water and sediment samples were collected from the lower branches of Rock Creek and Anacostia River, and their tributaries. The microbial analysis was conducted using Colilert® 18 and quant tray; the trace metals were analyzed using ICP-MS; and the polycyclic aromatic hydrocarbons were analyzed using GC-MS. Spatial distribution of each water quality variable were analyzed using ArcGIS. This paper will present the research findings.

Constraints when designing in developing countries. Christa Lash, PE, Civil Engineer
Email: Christa.lash@woodplc.com

Abstract. In a developed country, it is easy for an engineer to start the project by setting up the spreadsheets, create the project schedule, and go on the initial site visit. Throughout the project, variables may change and curveballs may be thrown, but the process to reach the design finish line is pretty much the same. During construction, there is an expectation that the contractor will follow the contract documents, and the project will be in compliance with all pertaining regulating agencies. However, when designing in a developing country, many things that are taken for granted during the design and construction process in a developed country become ambiguous in a developing country. In addition, many obstacles and unknowns come up that do not have a clear answer as they would in a developed country. For instance, when performing a site visit of an undersized channel that cannot handle the rainy season peak flows in a small village in rural Guatemala and you do not have adequate survey or rainfall data, it becomes important to get the locals' opinion of how high the water gets in the channel during rainy season. But can you get adequate information from someone who speaks a different language that you do not completely understand, and only rough measurements can be gleaned? Another example of possible design constraints is related to water well placement. A well for a site is proposed to be placed in an ideal location in regards to adequate pressure head, distance from wastewater features, and proximity to proposed infrastructure. However, after talking to the neighbor upstream of the project site, you find out that he is in the process of building a chicken farm. Since the proposed well location is directly downstream of the neighbor's property, what should be done to protect the project site's water source? This poster will list a few constraints that can be encountered during the design process in a developing country, and possible solutions to these constraints.

Monitoring nutrient leaching in noncirculating hydroponic systems at an active urban farm in Washington, DC. Daniel Weisshaar, Research Assistant, Candidate of Professional Science Master's in Urban Agriculture, Tolessa Deksissa, Director, Professional Science Master's Program, College of Agriculture, Urban Sustainability and Environmental Sciences, University of the District of Columbia
Email: tdeksissa@udc.edu

Abstract. Agricultural activities impact water quality. Hydroponic Urban Farms are not excluded. One popular method for growing commercial crops is using a combined media of coco coir, compost, and rice hull, while adding water soluble nutrients to supplement nutrient deficiencies in the growing media. While porous containers prevent flooding and over watering, leaching of nutrients is a concern. The objective of this study is

to monitor the nutrient leaching from the Noncirculating Hydroponic Systems at an Active Urban Farm in Washington, DC. Working with Cultivate the City in Washington, water quality was tested for nitrogen and phosphorous before and after nutrients were added into the hydroponic system. In this study, crops of spring varieties were grown in porous containers in a media of coco coir, compost, and rice hull. Samples were collected and analyzed during seeding, early growth, and maturation, as nutrients and dosage changes throughout the life cycle of the plant. Water that has not been treated with nutrients and applied to plants was also tested to mimic wet weather events. The result shows that base line data is crucial to determine the potential risk of nutrient leaching from the hydroponic growing method on urban water quality.

The urbanization plastic connection. Jessica Barthel and Dr. Kathy O'Neill, Environmental Sciences Program, Roanoke College, Salem, Virginia
Email: jmbarthel@mail.roanoke.edu

Abstract. Global plastic consumption is untamed and increasing. More than 8,000MT of plastic enter oceans each year, forming the primary component of litter and aquatic debris (Lytle, 2017). Yet current research primarily focuses on ocean plastics, and additional attention needs to be given to streams and rivers which are the main contributors to ocean plastic. Quantifying fluxes of plastic in urban stream systems is vital for understanding and combating the issue of plastic pollution, reducing inputs into watersheds, and preventing further degradation of marine ecosystems. This study investigates the prevalence of plastic pollution within stream systems of the Roanoke and New River Valleys of Virginia to develop approaches for reducing plastic inputs. Three stream reaches were chosen along an urban gradient to assess the quantity of plastics in and within the respective floodplain to understand the impact of development. Plastics were collected for both quantity and categorization, with bedload traps used to capture microplastics and calculate plastic loading. Data will provide insights on the local plastic pollution issue to inform education and management initiatives to reduce plastic debris and serves as the foundation for community outreach efforts at Roanoke College to raise awareness and reduce the plastic footprint of the college.

Application of Rough Set Theory to water quality analysis: A case study. Maryam Zavareh and Dr. Viviana Maggioni, Dept. of Civil, Environmental and Infrastructure Engineering, George Mason University.
Email: mzavareh@masonlive.gmu.edu

Abstract. This work proposes an approach to analyze water quality data that is based on rough set theory. Six major water quality data indicators (temperature, pH, dissolved oxygen, turbidity, specific conductivity, and nitrate concentration) were collected at the outlet of the watershed that contains the George Mason University campus in Fairfax, VA during three years (October 2015 – December 2017). Rough set theory is applied to monthly averages of the collected data to estimate one indicator based on the remainder indicators and to determine what indicators (conditional attributes) are essential (core) to predict the missing indicator (decision attribute). The redundant attributes are identified, the importance degree of each attribute is quantified, and the certainty and coverage of any detected rule(s) is assessed. Possible decision making rules are also assessed and the certainty coverage factor is calculated. Results show that the core water quality indicators are turbidity and specific conductivity. Particularly, if pH is chosen as a decision attribute, the importance degree of turbidity is higher than the one of conductivity. If the decision attribute is turbidity,

the only indispensable attribute is specific conductivity and if the specific conductivity is the decision attribute, the indispensable attribute beside turbidity is temperature.

Managing for the future: Certified stormwater student class. Sarah A. Hughes, Environmental Studies Student at Roanoke College & Program Development Intern at The National Stormwater Center
Email: sahughes@mail.roanoke.edu

Abstract. Managing for the Future: Certified Stormwater Student Class Coastal cities face unique challenges with regards to infrastructure, specifically related to stormwater. Without effective stormwater infrastructure, coastal cities may experience increased flooding, soil erosion, and sediment build up. Future leaders need the knowledge and skills to address these emerging challenges. This presentation describes a newly developed Certified Stormwater Student Class that explores stormwater, NPDES, illicit discharges, reporting of discharges, and stormwater stewardship. This class was first implemented at Roanoke College and will be taught as a webinar at other colleges and universities. The Certified Stormwater Student Class provides needed and specific training to students who will become our future regulatory authority leaders, NPDES permittees, environmental engineers, and environmental consultants.

Measuring Runoff from Urban Gardens in the D.C. Area. Jalen Jones, Undergraduate Student American University; Anna Spiller, M.S. in Agricultural Sciences and Resource Management University of Bonn Germany; Abigail Dias, Undergraduate Student American University; Harrison Hyde B.S. in Environmental Science American University; Keeli Howard M.S. in Environmental Science American University; Dr. Karen Knee Assistant Professor of Environmental Science American University
Email: jj8323a@student.american.edu

Abstract. Urban gardening and farming is increasing in popularity in the Western world. Proponents claim that it offers numerous benefits to health, communities, economic development and environmental protection. They could have positive or negative effects on the quality of nearby bodies of freshwater. Gardens could reduce runoff pollution by promoting rainfall infiltration and nutrient uptake, but soil disturbance and fertilization could also lead to increased erosion and nutrient concentrations in runoff, especially compared to other types of green space such as grass. This study aims to improve understanding of community gardens' contribution to storm water management in the Washington DC area and explore whether community gardens should be acknowledged as green infrastructure. We used a rainfall simulator and runoff collector to estimate runoff coefficients at three Washington DC area urban farms, comparing them to grassy plots and green roofs located at American University. Additionally, runoff was captured after natural rainfall events. We measured both the magnitude of runoff and the concentrations of dissolved nitrates, phosphate and ammonia. The results of this study could help quantify the ecosystem services provided by urban gardens and help environmental managers assess how they fit into a city's green infrastructure profile.