2015 National Capital Region Water Resources Symposium: Urban Water Management and Resilience in Uncertain Times

Booklet of Abstracts

Con-Current and Poster Sessions

American Water Resources Association
National Capital Section

University of the District of Columbia

April 10, 2015

SESSION A: CLIMATE CHANGE: ASSESSMENT AND ADAPTATION

Statistical Downscaling of Precipitation in the Occoquan Watershed Using Different Climate Models

Mehdy A. Barandouzi, Doctoral Student, Glenn E. Moglen, Professor, Adil N. Godrej, Research Associate Professor, Occoquan Laboratory, Virginia Tech, Manassas, VA.

Abstract

The Occoquan Watershed, with an area of 570 square miles, is a source of drinking water for more than 1.7 million residents in the Washington, DC suburbs of northern Virginia. Climate change and its impacts on runoff, flooding, and water supply are growing concerns in the US and internationally. One of the future resiliency factors of freshwater resources is the mitigation of climate induced changes. Local utilities' adaptation policies demand assessment of the effects of precipitation, in particular, rainfall at the scale of regional water supply-oriented watersheds such as the Occoquan watershed/reservoir system.

General Circulation Models (GCMs) are widely used to project future climate changes. However, because of the GCMs' low spatial resolution, different downscaling methods have been developed to translate climate information from coarse resolution model outputs to local and regional scales.

This presentation will demonstrate the use of two major statistical methods to downscale precipitation in the Occoquan Watershed. Two methods, the Delta Change method and the Quantile Mapping method, will be compared to each other as well as to observed data. In addition, different climate models will be employed with three diverse greenhouse gas emission scenarios namely A2, A1b and B1. Climate model output from these analyses support the study of characteristics of runoff, mitigation of floods, and the development of future water supply plans and policies.

Climate Change Assessment in the Chesapeake Bay Watershed

Hyunwoo Kang, Graduate Student; Choung Hyun Seong, Postdoctoral Associate; and Venkataramana Sridhar, Assistant Professor, Virginia Tech.

Abstract

The Chesapeake Bay (CB) Watershed, located in the Mid-Atlantic region of the northeastern United States, is about 165,000 km2 in size, consisting of eight major river basins. We present the implementation of Soil and Water Assessment Tool (SWAT) and HSPF for a few basins in the Chesapeake Bay watershed driven by a suite of Coupled Model Intercomparison Project (CMIP5) climate data that are downscaled to 1/8° × 1/8° grid or higher. Multiple climate scenario will be investigated for three time periods of 2015-2040, 2040-2070, and 2071-2099, including their seasonal, spatial patterns and characterizing the associated uncertainty for each of the eight

major sub-basins in the watershed. We will present a robust statistical analysis that could provide a framework for assessing the water resources and energy sustainability of this region in a changing climate.

Design Storm and Climate Change Aanalysis in Northern Virginia

Prasanth Valayamkunnath, Graduate Student, Mirza Billah, Postdoctoral Associate; and Venkataramana Sridhar, Assistant Professor, Dept. Biological Systems Eng. Virginia Tech.

Abstract

Heavy rainfall events due to climate change is expected in many regions around the world. Also, urbanization and resulted land use changes such as reduction in vegetation cover, land surface grading, and increased impervious soil surface area also have profound effects on surface runoff to streams compounded by these precipitation events. We quantify the future precipitation scenarios using CMIP5 climate data and regional downscaling via Weather Research Forecasting Model over Northern Virginia, Maryland and Hampton Roads region. A pilot study of WRF-Hydro and Variable Infiltration Capacity model to simulate flows at multiple gaging locations will be attempted at a high resolution (3 km). The results will be beneficial to delineate flood prone areas so that managers and public are better prepared for anticipating and protecting the infrastructure and property.

Barriers and Opportunities for Local-level Action on Climate Change and Stormwater Management

Britta Bierwagen*, Senior Scientist, Office of Research and Development, EPA; Susan Julius
Senior Climate Change Specialist, Office of Research and Development, EPA; Susan Asam, Principal, ICF International; Dana Spindler, Senior Associate, ICF International.

Abstract

Water resources in the United States are affected by a number of climate stressors, including increasing temperatures, changing precipitation patterns, and extreme events. These changing conditions have implications for stormwater management as local decision makers look to improve existing infrastructure and build new stormwater systems. A number of recent workshops and other community efforts in cities and counties across the Chesapeake Bay and Great Lakes regions have initiated conversations about how projected land use and climate change could impact local water conditions and how adaptation (resiliency) planning can fit into decision-making processes and help meet existing regulatory requirements. These recent efforts provide insights into how climate change practitioners can effectively work with communities to facilitate incorporation of climate change information into local planning and decision making for stormwater management. This presentation will review lessons learned from these adaptation planning experiences, including locally identified barriers to addressing climate change, methods to overcome barriers in the short term, and long term information needs to further assist communities in their stormwater adaptation efforts.

The Use of Robust Decision Making to Address Climate Change Uncertainties in Water Quality Management

Susan Julius, Senior Climate Change Specialist, Office of Research and Development, EPA; Tom Johnson, Senior Scientist, Office of Research and Development, EPA; Jordan Fischbach, Policy Researcher, RAND Corporation, Robert Lempert, Director, Frederick S. Pardee Center for Longer Range Global Policy and the Future Human Condition, RAND Corporation.

Abstract

Robust Decision Making (RDM) explicitly recognizes and incorporates uncertainty into evaluation of alternative management decisions with the goal of identifying those strategies that are robust across the widest range of potential futures. This presentation discusses results of a pilot study focused on the Patuxent River in the Chesapeake Bay to test RDM's usefulness for considering climate change and other key uncertainties in urban stormwater planning. We examined the contribution of stormwater pollutants from the Patuxent to the Total Maximum Daily Load (TMDL) for the Chesapeake Bay under multiple scenarios of land use, climate, and pollutant removal efficiencies for different suites of best management practices (BMPs). Pollutants considered were nitrogen, phosphorus, and sediment. The assessment used the Chesapeake Bay's Phase V watershed to run 12 land use scenarios with different population projections and development patterns, 18 climate change scenarios, several future time periods, and alternative assumptions about BMP performance standards and efficiencies associated with different suites of stormwater BMPs. The goal of this case study was to support the Chesapeake Bay Program in providing climate-related decision support for water quality management, and more generally help EPA assess the effectiveness of RDM to support water quality management.

SESSION B. WATER QUALITY MANAGEMENT

Storm Responses of Culturable and Molecular Fecal Indicators in an Urban Stream

Brian Badgley, Assistant. Prof. Dept. Crop & Soil Environ. Science ; Hehuan Liao, Doctoral Student, Leigh-Anne Krometis, Assistant Prof. W. Cully Hession, Prof. Romnia Benitez, Erin Schaberg, Emily von Wagoner, Undergraduate Students Dept. Biological Syst. Eng. Richard Sawyer, Undergraduate Student, Dept. Crop & Soil Environ. Science, Virginia Tech.

Abstract

Excessive loadings of fecal material in urban waters during wet-weather flows are a considerable public health concern, which is exacerbated by urban sprawl and climate change. However, the fate and transport of fecal indicators during storms is poorly understood. Furthermore, even less is known about molecular fecal indicators, which are expected to replace culture-based indicators in the near future. We quantified concentrations and loading rates of both culturable and molecular fecal indicators in an small urban stream at high-frequency during six storm events. While both concentrations and loading rates of each fecal indicator increased rapidly at the onset of the storm, loading rates provided a better estimate of transport through the stream during the entire storm. Event

loadings of general fecal indicators were most strongly correlated with total runoff volume, maximum flow and maximum turbidity; event loadings of human-specific Bacteroides were most strongly correlated with the time to reach peak flow. Higher frequency sampling during the rising limb is critical to improve estimates of pollutant loadings. In addition, high concentrations of human marker suggest that identification of potential sewage inputs are essential for effective remediation plans, even in watersheds with separate stormwater systems.

Microbial Source Tracking in the Greater Washington D.C. Region

Charles Hagedorn, Prof. Dept. of Crop and Soil Environ. Sciences, Virginia Tech; Michael Powell, Senior Scientist, EA Engineering, Science, and Technology; Martin Chandler, Principal Environmental Engineer, Washington Suburban Sanitary Commission; and Annie Hassall-Lawrence, Dept. Crop and Soil Environ., Virginia Tech.

Abstract

Microbial Source Tacking (MST) refers to a group of emerging technologies designed to help determine the host sources of fecal bacteria in environmental samples. Although the concepts of MST are fairly simple, the details of microbial physiology, genetics, ecology, and analytical methodologies are complex. There are three broad categories of MST: (1) molecular methods (genotyping or "DNA fingerprinting"), (2) biochemical methods, and (3) chemical. We have been conducting fecal indicator and MST monitoring in surface water since 2007 at 26 sewersheds within the greater Washington D.C. region for the Washington Suburban Sanitary Commission (WSSC). The purpose is to determine the impact on surface water quality and to characterize long-term water quality trends in pathogen indicators from human versus non-human sources associated with improvements made to the WSSC's sewer collection system. The monitoring data from 23 rounds of BST monitoring at 46 regional stream locations was evaluated to characterize the sources of bacterial contamination and evaluated to identify surface water locations that had the highest probability of being adversely impacted. Spatial and long-term temporal trends in the MST data were evaluated. An overview of the results from the multi-year study will be presented.

Innovative Removal of Agricultural Related Water Pollutants in the Chesapeake Bay Watershed

William E. Roper, Kelly P. Rock, and Howard E. Sorber III, Micronic Technologies Corporation, Wise, VA

Abstract

This research evaluated the reliability and reproducibility of the MicroDesalTM system for removing agricultural related pollutants from the water of the Chesapeake Bay watershed. Preliminary testing has indicated effective removal of heavy metals and other contaminants, including phosphorous and bacteria. These contaminants create significant issues for water resources impacted by agricultural operations. Third party test results to date have shown the removal of these contaminants to non-detect levels. A goal of the study is to conduct more robust testing from a variety of streams (Shenandoah River, Upper Potomac River, Chop Tank River, and

the Nanticoke River) in agricultural settings located throughout the Chesapeake Bay watershed with contaminants related to agricultural operations. This research was conducted in cooperation with the River Keeper's organizations for the Shenandoah, Upper Potomac, Chop Tank and Nanticoke Rivers. Phase I involves the treatment of water samples with the MicroDesalTM bench prototype unit from the sighted rivers. Pollutants of particular interest that showed significant reductions using the Micronic Technologies water treatment system included: potassium, nitrate, nitrite, phosphorus, arsenic and bacteria. Additional data analysis and discussion of results will be added to this paper following completion of the fall water sample collection, processing and analysis.

Uncertainty Analysis of Activated Sludge Model Parameters: A Case Study at the Blue Plains Wastewater Treatment Plant, Washington, D.C.

Jamal Alikhani, Dept. Civil Eng., The Catholic University of America; Ahmed Al Omari, Sudhir Murthy, DC Water and Sewer Authority; Imre Takacs, Dynamita, France; and Arash Massoudieh, Dept. Civil Eng. The Catholic University of America.

Abstract

Evaluating the uncertainty associated with the predictions of Activated Sludge Models (ASMs) is essential in designing and optimization of biological wastewater treatment systems and to determine the appropriate design safety factors. Various sources can contribute into the uncertainties in ASM predictions including the uncertainties in the influent flow and characteristics, environmental factors, parameter uncertainty and epistemic uncertainty due to the model abstraction. In this study, observed data obtained from nitrification-denitrification processes at the Blue Plains advanced wastewater treatment plant is used to quantifying the uncertainty associated with the parameters of an ASM model developed for this process. The posterior distributions obtained for parameters are then used in a Monte Carlo simulation to assess the uncertainties of predicted effluent constituents expressed as the 95% credible intervals of effluent concentrations. Using the outcome of the parameter estimation step, two scenarios of methanol loading scheme including one based on flow-rate (baseline) and the second one based on the total nitrogen in the influent were evaluated. The treatment performance of the system was quantified based on the probability distributions of effluent violation with respect to certain water quality standards. The results show that methanol loading based on influent flow-rate is less effective compared to determining methanol loading based on total nitrogen loading in the influent.

Aquaponic System as a Sustainable Water and Food Management Strategy

Yacov Assa, Laboratory Technician, William Hare, Associate Dean for the Land Grant Programs, CAUSES, and Tolessa Deksissa, Director, Water Resource Research Institute, University of the District of Columbia.

Abstract

Aquaponics is considered as a solution to address both water and food insecurity in 2050 when the world has to hold more than 9 billion people. Aquaponics is the coupling of fish culture and hydroponic plant production. The fish culture system requires large

amount of high quality water and produces large amounts of solid waste high in nitrogen and phosphates, which are highly detrimental to aquatic ecosystem. Coupling fish production with plant production can circumvent the high water requirement and waste production by removing nutrients from the effluent water and reusing the water. Therefore, understanding the dynamics of nutrient production from the aquaponic system at different fish growth stages is essential. In this study, we monitored the quantity and quality of water along with fish yield in two aquaponics systems at the UDC Muirirk Research Farm. The systems are designed as "Closed Loop"; one loop is the fish growing system, and the other loop is the plant growing system. The two systems are connected by the discharge of effluent water into a storage tank that is used to irrigate the crops. We found that the system has the potential to supply crop's nutrient demand in both nitrogen and phosphorous. The EC of both the fish system water and effluent water stayed within the range suitable for plant growth, but water pH was too high to be suitable for soilless plant production. The main challenge in this system was maintaining suitable water pH for the fish and for the biofilter conversion of NH4 to NO3. Also, large amount of NO3 was lost due to denitrification when stored before being used for plant production. These findings suggest that, if it is properly designed and maintained, the aquaponics systems can address both water use efficiency and food security.

SESSION C. URBAN INFRASRUCTURE: RESILIENCE

Resilient Infrastructure – Preparing for our Future

Joe Manous, Manager, International Activities, Institute for Water Resources, USACE

Abstract

Resilient infrastructure and sustainability have become key terms within the infrastructure design and governance communities over the past decade. This presentation will address key issues related to resilience, sustainability, and water resources professionals by identifying the corresponding responsibilities required by practitioners, academicians, and professional organizations to chart a course for the long term.

Discussions on resilient infrastructure and sustainability began much earlier than 2001, but the 2011 terrorist attacks on the United States galvanized the discussion and, more importantly, provided funding for practitioners and academics to explore novel ideas and methods. The consequences of Hurricanes Katrina and Rita in 2005 further shaped these discussions with an increased focus on water infrastructure.

With more than 12 years since the 2001 attacks, multiple critical incidents since, and significant investments of time, energy, and funding during the interim, now is the time to evaluate directions forward in the identification of fundamental skills, responsibilities, and career paths related to sustainable and resilient water resources planning, water infrastructure design, and infrastructure risk assessment.

It is important to recognize that efforts in these areas have begun, but the efforts are independent and do not have consistency of direction. There is a need for national-level leadership, but the source of such leadership is not clear. This paper seeks to address key issues needed to chart a course for this future.

Resilience Decision Support Tools
Mathew Mampara, PE, CFM, Senior Associate, Dewberry, Fairfax, Virginia

Abstract
In the resilience sphere, efforts to quantify the Return on Investment for reducing risk exposure have been limited. Tools to help stakeholders navigate through the decisions needed to make resilience-increasing investments are greatly needed.

In the aftermath of Hurricane Sandy, impacted residents in New York and New Jersey faced a significant challenge in understanding how to evaluate costs for flood mitigation measures (risk reduction) against insurance premium costs (risk transferal). Dewberry led the development of a web-based prototype tool to help Sandy survivors understand options by integrating hazard identification, risk reduction, and insurance information in a single place. This presentation will present the prototype application and discuss areas for further refinements and enhancements.

Climate Ready Water Utilities: Helping the Water Sector Prepare for and Adapt to Climate Change
Curt Baranowski and Steve Fries, US EPA, CSC

Abstract
Water utilities face many challenges due to variable climate conditions and resulting impacts on water resources, including infrastructure damage due to flooding and sea-level rise, water quality degradation, water shortages and combined sewer overflows. Each challenge can compromise the ability of utilities to provide clean and safe water to communities. In 2011, the National Drinking Water Advisory Council (NDWAC) delivered the Climate Ready Water Utilities (CRWU) report to the U.S. Environmental Protection Agency. Based on the recommendations included in this report, the CRWU initiative was established to provide resources to help the water sector adapt to climate change impacts by promoting a clear understanding of climate science and adaptation options. During this session, we will provide an overview of existing CRWU tools, resources and activities.

Among the available tools, we will highlight the Adaptation Strategies Guide, the Climate Resilience Evaluation and Awareness Tool (CREAT) and the scenario-based projected changes map. CREAT is a guided software program that provides a means to organize climate and utility data and leads users through a process of identifying threats, vulnerable assets and adaptation options. EPA is currently conducting over twenty CREAT assessments with individual utilities throughout the country.

http://www.epa.gov/climatereadyutilities

A Programmatic Analysis of Leak Detection at Water Systems

Erin Ress, Intern and Alan Roberson, Director of Federal Relations, American Water Works Association, Washington, D.C.

Abstract

Managing non-revenue water (NRW) is an important part of water management due to rising electricity costs and systems' aging infrastructure. Water Losses such as leaking pipes are a major component of NRW and once detected and repaired can result in more available water, reduced operation costs, increased pressurization, reduced potential health risks, and reduced number of water outage events. A detailed water audit and subsequent cost benefit studies are needed to determine the extent of the leak detection program needed by a utility. These studies would look at a number of performance indicators: apparent losses, real losses, and Infrastructure Leakage Index (ILI).

This paper will present the results of a literature search on water loss and related economic issues from Journal-AWWA and Water Research. This paper will present the results of a historical analysis of AWWA's audits and the state of Georgia's validated audits from 2011, 2012, and 2013 by looking at trends of the performance indicators for different sizes of utilities and geographic distributions. This paper will also present the results of water system case studies, using a return on investment (ROI) approach for an improved leak detection program.

To Green or Not to Green: Modeling Incentive-Based Programs for Green Infrastructure Investment on Private Properties

Seth Brown, PE, Stormwater Program and Policy Director, Water Environment Federation; Pradeep Behera, Professor and Chairman, Department of Civil Engineering, University of the District of Columbia; Celso Ferreira, Assistant Professor, Department of Civil, Environmental and Infrastructure Engineering, George Mason University; and Mark Houck, Professor , Department of Civil, Environmental and Infrastructure Engineering, George Mason University.

Abstract

Communities are in need of cost-effective and innovative strategies for stormwater management infrastructure investments. This need is driven by the fact that stormwater pollution is the only major source of increasing water pollution across much of the country including sensitive waterbodies such as the Chesapeake Bay. In reaction to this significant and growing source of water pollution, regulations at the Federal, State and local level continue to become more stringent, the level of treatment for runoff continues to increase. This reaction by the regulatory sector is driving an increase in stormwater infrastructure investment needs. The use of green stormwater infrastructure (GSI) and retention-based standards is on the rise across the U.S., but it is still considered a novel or innovative approach in many areas. The basis of the interest in GSI from the stormwater and wet weather sector is based upon the premise that retaining water on-site is more cost-effective in addressing issues such as combined sewer overflows (CSOs), treats the pollution within runoff while replenishing groundwater resources, and provides co-benefits water quality and quantity treatment, such as improved air quality, enhanced property values, and improved social well-being.

Considering that the goal of GSI is to retain runoff on-site, which is a decentralized approach to stormwater management that impacts significant segments of the landscape, the issue of treating stormwater on all types of properties, including private property is on the rise. This issue is multiplied for regulated entities who cannot meet regulatory requirements by implementing GSI on publically-owned land alone. For this reason, some municipalities are investigating the use of incentive-based programs to address the significant amount of stormwater runoff treatment required in permits. Understanding how incentive-based programs function requires a method of analysis reflecting the disaggregated and varying nature of decision-making by individuals, which can be irrational, inconsistent and driven by both monetary and non-monetary factors. Unlike idealized and mechanized systems, the dynamics associated with large populations of individual decision-makers is inherently non-deterministic. The field of computational social science has arisen to simulate how large populations of decision-makers behave, and what patterns emerge based upon varying initial conditions by using tools such as cellular automata and agent-based modeling (ABM). This approach is consistent with the investigation investment policies and strategies associated with the GSI adoption at the site level by private property owners, which is at the heart of the proposed research associated with this presentation.

The presentation will provide an overview of a methodology developed to simulate the amount and distribution of GSI investment in a given area based upon the use of incentive-based frameworks, such as a traditional fee/credit approach as well as non-traditional approaches, with an example being the Stormwater Retention Credit program established recently by the District Department of Environment (DDOE) that proposes to trade retention "credits" across the District to take advantage of cost heterogeneity and generate GSI implementation in area that can stand to benefit the most from the environmental, economic and social benefits associated with this infrastructure. Policies and strategies associated with these approaches, such as subsidies, project aggregation and escalating fee and rebate scales, will be discussed as well.

SESSION D. URBAN HYDROLOGY AND WATER MANAGEMENT IN COASTAL ENVIRONMENTS

Effects of Urbanization on Shallow Hydrogeologic Systems: Specific Examples from Washington, D.C. and Austin, Texas

John M. Sharp, Jr., Professor, Department of Geological Sciences, The University of Texas, Austin, Texas.

Abstract

Urbanization affects shallow hydrogeologic systems because it levels land surfaces and fills in low areas; increases "impervious" cover; creates a network of subsurface conduits, tunnels, and utility lines; requires structures to control flooding; imports surface waters; and alters vegetation.

Small streams and springs are commonly buried and subsurface infrastructure can lower water tables and decrease both spring and stream flows. None of the DC's 40 historic identified springs currently flow; old stream courses are rarely discernable, but the alluvial deposits remain in the subsurface. Impervious cover and storm drains make stream flows flashier and increase flooding, but

recharge in urban areas is documented to increase in general. Direct recharge and evapotranspiration decrease, but artificial, localized, and indirect recharge commonly increase, which can maintain urban streams during low-flow conditions. Construction (particularly the utility network) enhances secondary porosity and creates a highly anisotropic and heterogeneous permeability field that can both provide recharge or serve as drains. Current and abandoned utility lines make flow and transport modeling difficult. The effects of urbanization on shallow hydrogeologic systems should be considered in the context of water supply, public health, and environmental protection.

Integrating Rivers Discharge into Coastal Flooding Modeling Along Baltimore Harbor

Juan Luis Garzon Hervas, Graduate Student, Seth Lawler, Graduate Student, Jana Haddad, Graduate Student, Mithun Deb, Graduate Student, Celso Ferreira, Assistant Professor, Department of Civil, Infrastructure and Environmental Engineering, George Mason University.

Abstract

Hurricanes are one of the most costly natural disasters impacting the US coastal areas and the State of Virginia and Maryland have historically faced severe impacts from these storms (e.g., Isabel [2003] and Sandy [2012]). Although coastal areas are predominantly at risk from storm surge flooding, areas along the Chesapeake Bay and its tributaries are also extremely vulnerable to hurricane flooding. In this study, we investigate the impact of stream flow and urban runoff to coastal flooding along the Baltimore Harbor, by evaluating the interaction of the three main rivers discharge, astronomical tides and storm surge on the harbor hydrodynamics. Our analysis is based on a depth-averaged hydrodynamic Advanced Circulation Model (ADCIRC) and the SWMM urban rainfall-runoff model. A parametric asymmetric wind model will be used to create the storms wind and pressure fields based on the usual meteorological conditions of storms extracted from the National Hurricane Center (NHC). Storm surge simulations include historical events such as Hurricane Isabel, Floyd and Irene. Stream flows simulations include both the historical events and also design storms derived from several return periods and the maximum probable precipitation. Results will be presented in terms of inundation anomalies in the harbor due to river inflows.

Assessment of Coastal Vulnerability to Storm Surge Hazards in the Bay of Bengal Region: A Case Study for Bangladesh

Mithun Deb, Graduate Student and Celso Ferreira, Assistant Professor, Department of Civil, Infrastructure and Environmental Engineering, George Mason University.

Abstract

The coastal areas of Bangladesh are recognized by the UN as the most vulnerable zones in the world to tropical cyclones. In Bangladesh, cyclone-generated storm surges have resulted in the deaths of over 700,000 people since 1960. Storm surges up to 10.6 meters were reported in coastal areas surrounding the bay during 1970 Bhola cyclone. Due to highly dense populated coastal areas and

lack of efficient warning systems it has always been a challenge to avoid loss of lives during catastrophic events. This analysis provides insight into categorizing vulnerable coastal zones of Bangladesh depending on extreme event scenarios. Storm surges were calculated using a hydrodynamic model (ADCIRC) coupled with wave model (SWAN) under a High Performance Computing environment. A high resolution unstructured mesh has been developed with GEBCO global 30 arc-second bathymetric and topographic data for this region. The modeling framework was validated using data from historic storms and buoy data from the University of Hawaii Sea Level Center (UHSLC). Multiple model simulations were performed based on different categories of cyclones to create flood inundation maps. The accumulated result of this research contributes to support future management actions, policy and practice that help in understanding of the future risk of storm surge hazards.

A Geospatial Framework for Characterizing the Interaction of Wetlands, Storm Surge Flooding, and Critical Infrastructure in the Chesapeake Bay

Jana Haddad, Graduate Student and Celso Ferreira, Assistant Professor, Department of Civil, Infrastructure and Environmental Engineering, George Mason University.

Abstract

The role of wetlands as a natural coastal defense against costly storm surge inundation has been investigated in recent years, with preliminary research indicating that there is potential for attenuation, dependent on vegetation, storm, and other characteristics. Here, a framework is presented for the Chesapeake Bay, integrating three components: a hydrodynamic model in a high performance computing environment, geospatial characterization of wetlands, inventories of populations and infrastructure in the regions affected by the storm surge. The hydrodynamic model (coupled ADCIRC and SWAN), using the FEMA region 3 mesh and forced by an asymmetric wind field, computes maximum surge levels, which are compared against NOAA storm tide data to obtain uncertainties in the storm simulation for various historical storms, driving the generation of inundation maps. Spatial identification of Chesapeake Bay wetlands is derived from the National Wetlands Inventory (NWI), National Land Cover Database (NLCD), and the Coastal Change Analysis Program (C-CAP). Inventories of population and critical infrastructure are extracted from US Census block data and FEMA's HAZUS-MH geodatabase. Geospatial analysis is conducted on the interactions of these three components. The outcome is a database of wetland areas in the Chesapeake Bay thought to be relevant for future studies of the impact of wetlands on reducing storm surge damage to critical infrastructure.

Water Quality Classification of Potomac River Using Principal Component Analysis Method

Tilaye Alemayehu, Graduate Student, Nian Zhang, Assistant Professor and Pradeep Behera, Professor, University of the District of Columbia.

Abstract

It has been recognized that urban stormwater pollution can be a large contributor to the water quality problems of many receiving waters. The development of the District over the years has increased its impervious area significantly which combines with inadequate drainage capacity of the sewer system results in combined sewer overflows (CSOs) and stormwater discharges to the Potomac River. Water quality monitoring has one of the highest priorities in environmental monitoring. The quality of water is identified in terms of its physico-chemical parameters. The challenging problem in the water quality monitoring is the complexity associated with analyzing the large number of measured variables. The water data contain rich information about the behavior of the water resources. The classification, modeling and interpretation of monitoring data are the most important steps in the assessment of water quality. A principal component analysis method will be proposed to classify the water quality parameters and to describe the variation in water quality of Potomac River.

The principal component analysis (PCA) approach is capable to derive hidden information from the data set about the possible influences of the environment on water quality. The original data can be reconstructed from the original data and reveals the underlying patterns in the data. It is often useful to measure data in terms of its principal components rather than on a normal x-y axis. They're the underlying structure in the data. They are the directions where there is the most variance, the directions where the data is most spread out. First we deconstruct the set into eigenvectors and eigenvalues. An eigenvector is a direction to indicate how much variance there is in the data in that direction. The amount of eigenvectors equals the number of dimensions the data set has.

Principal Components will help transform the data to the largest variance. It is worthwhile to investigate the PCA algorithm because it allows us to exploit the correlation of most significant eigenvectors and water quality parameter types. It will also identify the most important gradients in the water. Prior to the analysis, the data will be standardized to produce a normally distribution of all variables. Since water quality parameters had different magnitudes and scales of measurements, which if not taken into account would have given more weight to certain variables due to their respective variance. The k-means clustering algorithm will be combined with the PCA method to cluster the water quality parameters and classify them into several classes.

POSTER SESSION

Development of a Storm Event Analysis Software Tool for Water Resources Engineering

Bharath Kumar Reddy Arikatla, and GeetanjaliSuribhatla, Computer Science Major, Pradeep K. Behera, Professor,and Dong H. Jeong, Assistant Professor, University of the District of Columbia, Washington, D.C.

Abstract

Precipitation analysis is a key input for any water resources engineering related projects such as flooding, water supply, water quality, stormwater management, wastewater management etc. Understanding precipitation with respect to time and space is a necessary for existing water related infrastructure as well for future projects. In this research paper, the precipitation analysis is examined. The emphasis has been placed on the statistical analysis of storm events. The long-term rainfall record is discretized into independent storm events by defining an Inter Event Time Definition (IETD) and each event is characterized by different characteristics (e.g., rainfall event volume, duration, intensity, and inter event time).

The Objective of this research is to design and build a software utility for engineers and professionals which will perform the aforementioned statistical storm event analysis. The research methodology is as follows: (1) various sources of freely accessible rainfall records were explored such as (NOAA and NCDC web sites); (2) Class and relationship diagrams were developed for the overall system architecture (note that the system is separated into a back-end parsing engine, and a series of front-end applications); (3) The data which we get from the mentioned sources is not in a format that we could do IETD analysis. So, we have developed a stored procedure in mysql that converts the data into the required format; (4) the PHP programming language was selected for development of the web-based interface; (5) to decrease the overhead of the network traffic and increase the overall system's performance, we decided to develop stored procedure in mysql to calculate IETD analysis from the rainfall data; (6) a series of tests were performed to assess the proper functionality of the system; (7) some interactive features like Bar graph and Line graph were developed to provide the user more interactivity. This tool can be helpful for any location in the United States that has a viable rainfall record, and could be used to generate a comprehensive atlas.

Advanced Removal of Nitrates and Nitrites from Contaminated Delaware Well Water

William E. Roper, Kelly P. Rock, and Howard E. Sorber III, Micronic Technologies Corporation, Wise, VA.

Abstract

In this program Micronic Technologies' bench prototype MicroDesalTM demonstrated the capability to significantly reduce nitrate and nitrite levels from eight selected nitrate and nitrite contaminated wells in central and southern Delaware. Water samples from each well were collected, processed, and evaluated for the summer, fall and winter seasons. Third party test results of the treated water achieved reductions of >95% of the amount of nitrates and nitrites substantially below EPA drinking water standards. The research

conducted in this project demonstrated the MicroDesalTM system's effectiveness, reliability, and reproducibility of removing nitrates and nitrites from well water polluted by agricultural operations in central and southern Delaware. These contaminants create significant issues for water resources impacted by agricultural operations. Third party test results proved the Micronic's system very capable of removing nitrates and nitrites to levels from up to 30 mg/L to below 0.4 mg/L to non-detectable. The eight wells selected for water testing during the summer, fall, and winter, time periods were known to be contaminated with nitrates and nitrites. Micronic Technologies coordinated closely with Tidewater Utilities and the State of Delaware's Office of Drinking Water in selecting the sites and establishing protocols for collecting, transporting and processing the water.

Analysis of Trace Metal Contamination and Nutrient Loading in Urban Gardens

Siaka Nuah, Harold Yapuwa, Rahil Fofana1 and Ulrich Bazemo, Graduate Assistants and Tolessa Deksissa
Director, Professional Science Master's in Water Resources Management, College of Agriculture, Urban Sustainability and Environmental Sciences, University of the District of Columbia

Abstract

Over the past few years, there has been increased interest in sustainable agriculture. In the District of Columbia urban gardens now provide access to fresh produce; reduce the environmental footprint of food production associated with long-distance food transportation; and provide educational, social and financial benefits. On the other hand, urban gardening puts the local gardeners in contact with urban soils, which are likely to contain trace metal contaminants due to various anthropogenic activities. Further to this, excessive nutrients from urban gardening are a contamination threat to the District's water ways. The purpose of this project is to determine nutrient loads and trace metal levels in soils in urban gardens in the District of Columbia. We analyzed soil samples collected from the community and home gardens in the District and analyzed for extractable Arsenic, Cadmium, Chromium, Nickel, Lead, Zinc and Copper using a Perkin Elmer NexIon 300 Inductively Coupled Plasma Mass Spectrophotometer. Nutrient analysis was done using a HACH DR 2800 Spectrophotometer. The results showed that while most of the soil samples analyzed fell below US EPA action levels, high trace metal levels were recorded in some gardens especially for Arsenic and Lead. Similarly, excessive nutrient levels were observed in some of the gardens in the study. In the absence of proper best management practices in urban agriculture, there is a threat of these trace metals and excessive nutrient in these urban soils being washed into the District's water ways through erosion and run-off. As such there is need to investigate the status of best management practices that are being employed to support sustainable urban agriculture.

Chlordane in Anacostia Fish

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Abstract

Anacostia River fish caught at Washington DC can have technical chlordane levels higher than the USFDA Action Level. There is considerable fishing with over 75% consumed In spite of posted warnings. Chlordane in DC fish is considered due to Washington's highly contaminated sediments. Extensive and expensive dredging of Anacostia's toxic sediment "hot spots" near Washington is planned for control. Four legacy sources of chlordane were identified in Anacostia MD subtributaries. Chlordane contaminated minnows were found in the Anacostia Northeast and Northwest Branches, Larger fish caught at tidal Bladensburg Marina had double the chlordane concentration. Chlordane is called an EPA Contaminant of Concern because it is a PBT (Persistent, Bioaccumulated and Toxic) pollutant that can build up the food chain to high levels in fish-eating animals such as birds, fish and man. We hope to analyze more Anacostia fish to examine the possibility of the food chain as a major source of the high chlordane in Washington, DC fish.

Identifying Factors that Contribute the Most to Flooding Conditions of Washington, DC's Bloomingdale and Ledroit Park Neighborhoods Using a GLM Approach

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Abstract

Residents and businesses of Washington, DC's Bloomingdale and LeDroit Park neighborhoods have historically experienced severe flooding during large storms. In August 2012 the District appointed a Flood Prevention Task Force of experts and residents and has undertaken construction projects to alleviate some flooding problems in principal roadways, but longer term solutions are currently not scheduled to begin until 2022. A deeper understanding of factors that contribute to flooding conditions in the area is necessary to ensure that the District invests its resources most effectively to address this problem. This paper presents a General Linear Modeling (GLM) approach to identify the most influential factors that contribute to flooding in Washington, DC, and proposes a model for predicting historic-level flooding. Also, the uncertainty associated with model's parameter estimates is investigated.