Georgia Water Resources Institute
School of Civil and Environmental Engineering

Annual Technical Report
2018

General Information

Products

Project reports of all projects funded under the 104b FY2018 program are available at http://gwri.gatech.edu/sites/default/files/files/GWRI_104b_2018_AnnualReport.pdf

Selected Publications:

DiVittorio, C.A., A.P. Georgakakos, 2018. Land Cover Classification and Wetland Inundation Mapping using MODIS. Remote Sensing of Environment, 204(1), pp 1-17.

Dettinger, M., B. Udall, and A.P. Georgakakos, 2015: Western Water and Climate Change. Ecological Applications, 25(8), pp. 2069–2093 (Ecol. Soc. of America Centennial Paper).

Sharif, H.E., J. Wang, and A.P. Georgakakos, 2015: Modeling Regional Crop Yield and Irrigation Demand Using SMAP Type of Soil Moisture Data. Journal of Hydrometeorology, 16, pp. 904–916. Available at http://journals.ametsoc.org/doi/pdf/10.1175/JHM-D-14-0034.1.

Kistenmacher, M., and A.P. Georgakakos, 2015: Assessment of Reservoir System Variable Forecasts, Water Resources Research, 51, pp. 3437–3458 (doi:10.1002/2014WR016564).

Chen, C.-J., and A.P. Georgakakos, 2015: Seasonal Prediction of East African Rainfall. International Journal of Climatology, 35, pp. 2698–2723 (doi:10.1002/joc.4165).

Georgakakos, A.P., P. Fleming, M. Dettinger, C. Peters-Lidard, T.C. Richmond, K. Reckhow, K. White, and D. Yates: Water Resources Chapter, 2014 National Climate Assessment Draft, http://ncadac.globalchange.gov, 2014.

Georgakakos, A.P., H. Yao, and K.P. Georgakakos, “Ensemble streamflow prediction adjustment for upstream water use and regulation”, Journal of Hydrology, doi: 10.1016/j.jhydrol.2014.06.044, 2014.

Kim, D.H., and A.P. Georgakakos, “Hydrologic River Routing using Nonlinear Cascaded Reservoirs,” Water Resources Research, doi: 10.1002/2014WR015662, 2014.

Chen, C-J., and A.P. Georgakakos, “Seasonal Prediction of East African Rainfall,” International Journal of Climatology, doi: 10.1002/joc.4165, 2014. Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability, co-author of Chapter 10, “Impacts of Climate Change and Variability on Water Resources in the Southeast USA,” Island Press, Washington DC, 341p, 2013.

Chen, C-J., and A.P. Georgakakos, “Hydro-Climatic Forecasting Using Sea Surface Temperatures—Methodology and Application for the Southeast U.S.,” Journal of Climate Dynamics, doi:10.1007/s00382-013-1908-4, 2013.

Information Transfer Program

NA

Student Support

The Section 104 base grant supported the following students: 3 Masters, 2 Ph.D, and 3 Post Doc.

Notable Achievements and Awards

The Georgia Water Resources Institute is leading a multi-year, $2.3 million study to assess the historical and current septic system impacts on water quality in Lake Lanier within and outside Gwinnett County, assess the lake water quality restoration expected from progressive removal of septic systems in lakeshore areas within and outside Gwinnett County, and provide environmental lakeshore management recommendations for Gwinnett and other Lake Lanier counties. The project objectives will be met through a combination of interlinked monitoring, modeling, assessment, and outreach activities.

Projects results will be shared with several stakeholders, including Georgia state agencies and other counties/cities facing similar issues. The project will be implemented by a team of engineers, scientists, and outreach experts from Georgia Tech, the University of Georgia, and New York State Water Resources Institute (Cornell University). The project team will be led and coordinated by the Georgia Water Resources Institute (GWRI) at Georgia Tech.

Projects

2017GA374B

Project Type: Annual Base Grant **Project ID:** Developing real-time sensor networks for monitoring stream water quality to improve water resource management: Year 1

Project Impact: This project set out to understand patterns and drivers of conductivity across a gradient of urbanization in Athens-Clarke County (ACC), GA with an overarching goal of testing the efficacy of a real-time remote sensor network as a diagnostic monitoring tool. We predicted that by continuously monitoring conductivity we could distinguish between episodic stressors and chronic stressors, such as sewer leaks. We hypothesized that stormwater runoff, sewer leaks, and sediment inputs each would have distinct signals in conductivity (Fig. 1). To test this, we collected continuous conductivity, stage height, temperature, and periodic water chemistry data in ten streams across a gradient of urbanization using a combination of manufactured sensors and custom-built real-time monitoring systems.

A Hybrid Approach of Analyzing Urban Flood Risk: A Case Study in the City of Atlanta, GA

Project Type: Annual Base Grant **Project ID:** 2018GA386B

Project Impact: Atlanta/Metro Atlanta is a densely populated city that has experienced flooding in the past. The Chattahoochee River runs through the city of Atlanta, making it vulnerable to flooding. As the Atlanta area continues to urbanize, many people and properties are at risk of damage due to floods. This research project seeks to examine flood risks in Atlanta by generating maps, called flood inundation maps that will aid in emergency response and help reduce devastation in the event of a flood. Flood inundation maps for Atlanta have been generated in the past, however, the existing maps do not include demographic information or information on economic damages, nor do they show multiple return periods on one map. This project focused on the Proctor Creek watershed, an urban watershed located within Atlanta. Using ArcGIS, HEC-Geo RAS and HAZUS software, we generated hybrid flood inundation maps combining the flood inundation extent with both population and infrastructure density. Flood map with population density shows that the areas immediately bordering watershed have varying population densities. In many locations, higher flood risk was observed in the areas with higher population density. Flood map with infrastructure (showing residential buildings) in the floodplain reveals the extent to which the 100-yr flood year flood will impact the infrastructure in the study area. To this end, we were able to assess both the physical and economic impacts of potential floods. Our results can help the city officials to prepare more efficient emergency response plans for floods.

Developing real-time sensor networks for monitoring stream water quality to improve water resource management: Year 2

Project Type: Annual Base Grant **Project ID:** 2018GA387B

Project Impact: This project set out to understand patterns and drivers of conductivity across a spatial gradient of urbanization in Athens-Clarke County (ACC), GA with an overarching goal of testing a real-time remote sensor network as a diagnostic monitoring tool. We predicted that by continuously monitoring conductivity we would be able to distinguish between episodic, runoff-based stressors and chronic stressors, such as sewer leaks. We hypothesized that stormwater runoff, sewer leaks, and sediment inputs each would have distinct signals in conductivity (Fig. 1). To test this, we collected continuous conductivity, stage height, temperature, and periodic water chemistry data in ten streams across a gradient of urbanization using a combination of manufactured sensors and custom-built real-time monitoring systems. Based on the previously known relationships between conductivity and common urban stressors, we hypothesized that 1) urban sites would exhibit a positive relationship between conductivity and stage height at the onset of storms (also known as the “first flush effect), 2) sites impacted by sewer leaks would display changes in conductivity that are decoupled from concomitant changes in stage height in regular, nonrandom patterns, and 3) random and irregular fluctuations in EC independent of stage height could be indicative of sediment inputs. We then designed and tested real-time water quality monitoring stations to determine the feasibility and efficacy of custom-built “do-it-yourself (DIY)” systems to be used for municipal water resource management. We did this by testing a number of sensor designs and infrastructure and evaluated the efficacy of conductivity to detect a number of disturbance events in ACC.

Effects of Storm Surge on Coastal Storm Water Systems in Georgia

Project Type: Annual Base Grant **Project ID:** 2018GA389B

Project Impact: The Georgia coastline has been constantly vulnerable to hurricane strikes due to extremely low-lying topography. During the 2016 and 2017 Atlantic Hurricane season, the Georgia coastline experienced two significant surge events caused by Hurricane Matthew and Irma significantly affecting the coastal storm water systems, especially in the Savannah area, despite not making nearby landfalls. Historically in 1898, a major hurricane made landfall near Savannah, causing storm tides ranging from 16 to 18 feet and extensive damage. Given the growth in infrastructure, settlements and population along the coastline over the past century, it is important to study the effect of storm surge on modern coastal storm water systems to prepare for similar events in the future. The general objective of this study is to identify and model storm water systems along the Georgia Coast that are particularly susceptible to storm surge. Harmon Canal located in South Savannah was selected as the site of interest. A HEC-RAS modeling was conducted based on the channel geometry and channel hydrograph of a 100-year flooding event surveyed by United States Army Corps of Engineers (USACE). The model consisted of a steady-state flow analysis and an unsteady flow analysis. For the steady-state flow analysis, the input of peak storm surge was 5, 7, and 12 feet. For the unsteady flow analysis, a synthetic storm surge hydrograph generated from empirical equations was used. The result of the study shows that if a hurricane with a similar scale of Hurricane Matthew makes a landfall near Savannah, there will be increased risk of flooding around Harmon Canal. Also, there may be other less-studied canals with flooding risks in case of a storm surge event. Finally, a new survey for those canal systems is recommended, as current data for those water systems is outdated and difficult to obtain. In the future, HEC-HMS software and ADCIRC model could be incorporated into the study to achieve a more accurate modeling result. The study area may also expand to other water systems or broader regions once a systematic approach of modeling is established. Better communication with coastal municipalities is also necessary for education purpose on the effects and hazards associated with storm surge and storm water system interaction.

Enhanced human mtDNA assays for fecal source tracking applications

Project Type: Annual Base Grant **Project ID:** 2018GA388B

Project Impact: Human mitochondrial DNA (mtDNA) approaches have advantages over bacterial markers used in source tracking applications for fecal contamination. The primary advantage of using this marker is that its presence in the environment is unambiguously associated with human waste, since human mtDNA can only be associated with human cells. However, mtDNA markers are typically found in lower abundance than fecal-indicator bacterial (FIB) markers in wastewaters. We have developed an optimized sample processing and human mtDNA assay on a droplet digital PCR (ddPCR) platform which has potential to improve the use of this source-unambiguous marker to track fecal contamination in the environment by boosting its signal. In the proposed study, we will compare the optimized human mitochondrial DNA assay to standard methods using FIB in impaired waters in Atlanta, GA to assess the sensitivity and specificity of the novel method and to evaluate its usefulness as an improved source-tracking marker. The proposed study has potential to add significantly to the field of fecal source tracking and environmental monitoring.

Quantifying the relative contributions of the physical mechanisms responsible for the Atlanta 2009 flood

Project Type: Annual Base Grant **Project ID:** 2017GA373B

Project Impact: The 2009 Atlanta flood was a historic event that resulted in catastrophic damage throughout the metropolitan area. The flood was the product of several hydrometeorological processes, including moist antecedent conditions, ample atmospheric moisture, and mesoscale training. Additionally, previous studies hypothesized that the urban environment of Atlanta altered the location and/or overall quantities of precipitation and runoff that ultimately produced the flood. This hypothesis was quantitatively evaluated by conducting a modeling case study that utilized the Weather Research and Forecasting Model. Two model runs were performed: 1) an urban run designed to accurately depict the flood event and 2) a nonurban simulation where the urban footprint of Atlanta was replaced with natural vegetation. Comparing the output from the two simulations revealed that interactions with the urban environment enhanced the precipitation and runoff associated with the flood. Specifically, the nonurban model underestimated the cumulative precipitation by approximately 100mmin the area downwind of Atlanta where urban rainfall enhancement was hypothesized. This notable difference was due to the increased surface convergence observed in the urban simulation, which was likely attributable to the enhanced surface roughness and thermal properties of the urban environment. The findings expand upon previous research focused on urban rainfall effects since they demonstrate that urban interactions can influence mesoscale hydrometeorological characteristics during events with prominent synoptic-scale forcing. Finally, from an urban planning perspective, the results highlight a potential two-pronged vulnerability of urban environments to extreme rainfall, as they may enhance both the initial precipitation and subsequent runoff.