D.C. Water Resource Research Institute
College of Agriculture, Urban Sustainability and Environmental Sciences

Annual Technical Report
2019

1. Products

During 2019 funding period, the DC Water Resources Research Institute supported seven research projects including administration with the annual base federal grant (104b). Regardless COVID-19 pandemic that restricted face to face research projects and resulted in closing down of research laboratories, a significant research outcomes/products were accomplished including peer reviewed papers, MS thesis and technical reports as indicated as follows:

A. Articles in Refereed Scientific Journals:

1. Wilken RL, A Imanalieva, SE MacAvoy, VP Connaughton. (2020). Anatomical and behavioral assessment of larval zebrafish (Danio rerio) reared in Anacostia River water samples. Archives of Environmental Contamination and Toxicology. https://doi.org/10.1007/s00244-020-00707-0.
2. Sarah S. Aggad, Tolessa Deksissa and Thomas V. Fungwe (2020). Effects of Different Household Treatment Methods on Minimizing Pesticide Residue Levels in Apple and Strawberry Fruits, Australian Journal of Basic and Applied Sciences, 2020 September 14(9): pages 22-28.

B. MS Thesis and PhD dissertation:

1. Acevedo, A. (2021). Concentrations of siloxanes, polycyclic aromatic hydrocarbons, and cations in urban and suburban areas of the Anacostia, MS Thesis. American University.
2. Sarah S. Aggad (2019). Health Effect of Pesticides and Impact of Household Preparation of Fruits and Vegetables in Reducing Dietary Exposure, PhD Dissertation, Howard University.

C. Water Resources Research Institute Reports:

1. Barati, F., Wang, L. (2020). Safety Assessment of Earthen Levees in the Face of Multiple Hazards, 2020 Emerging Researchers National (ERN) Conference in STEM, February 2020, Washington DC (Oral Presentation).
2. Turcios, K., Zendehdel, K., Trobman, H. and Deksissa, T. (2020). Quantifying the Performance of Rooftop Farms in the District's MS4: Green Roofs, 50th Annual Earth Day, University of the District of Columbia. Washington, DC., Poster Presentation.
3. Hunt, B. and Deksissa, T. (2020). Sustainable Urban Stormwater Management Using Green Infrastructure, 50th Annual Earth Day, University of the District of Columbia. Washington, DC. Poster Presentation.
4. Rathnayake, P. and Deksissa, T. (2020). Sustainable water resources management using machine learning, 50th Annual Earth Day, University of the District of Columbia. Washington, DC.
5. Rose, S. and Deksissa, T. (2020). E. coli Contamination of Food and Water, Fact Sheet.
6. Tefera, S. and Deksissa, T. (2020). Arsenic Contamination in Soil and Water, Fact Sheet.
7. Deksissa, T. (2020). Monitoring PFAS in the Environment. PFAS in Water: Policy and Management, NCR-AWRA Symposium, Howard University, March 10, 2020.

8. Deksissa, T. (2021). Advancing Water Quality Monitoring and Modeling, The National Council of Sciences and Environment Drawdown 2021 Annual Conference, January 5-9, 2021
9. Behera, P. (2021). Probabilistic Analytical hydrologic modeling, The National Council of Sciences and Environment Drawdown 2021 Annual Conference, January 5-9, 2021
10. Zhang, N. A. (2021). Advanced modelling and water quality monitoring techniques to improve river basin management: Machine Learning and Artificial Intelligence, The National Council of Sciences and Environment Drawdown 2021 Annual Conference, January 5-9, 2021
11. Massoudieh, A. (2021). Application of deep learning in modeling bioretention processes, The National Council of Sciences and Environment Drawdown 2021 Annual Conference, January 5-9, 2021.
12. Tolessa Deksissa, Sania Rose, Mudiyanselage Rathnayake, and Maryam Sabur (2021). Monitoring Polycyclic Aromatic Hydrocarbons in the Urban watershed and Impact of Green Stormwater Infrastructure, 2021 Annual Water Resources Conference of the Universities Council on Water Resources (UCOWR), Accepted

2. Information Transfer Program

DC Water Resources Research Institutes main accomplishment in the information transfer is in two areas: Organizing water symposium and providing environmental quality testing services to its stakeholders. All information transfer activities of the Institute were supported by 104b.

A. Water Symposium

In collaboration with the North Capitol Section Region of American Water Resources Association (NCR-AWRA), the DC WRRI sponsored or co-organized three successfully quarterly or annually water symposium:

- 2020 NCR-AWRA Water Resources Symposium: Water Management in the Era of Artificial Intelligence: Digital Solutions & Smart Technology Applications.
  October 9, 2020, Virtual, University of the District of Columbia, Washington, DC.
- PFAS in Water: Policy and Management, NCR-AWRA Quarterly water workshop, March 10, 2020, Howard University, Washington, DC
- Algal Blooms: Why They Matter and What to Do, NCR-AWRA Quarterly water workshop, November 5, 2019, George Washington University, Washington, DC.

B. Laboratory Testing Services:

With the annual base federal grant (104b) and matching fund, the DC WRRI continued maintaining the national accreditation of UDC's Water/Environmental Quality Testing Laboratory (EQTL). The lab has been recognized by NELAP (National Environmental Laboratory Accreditation Program) since 2015 by conducting required proficiency tests twice a year for all analytes and methods under consideration as well as biannual onsite eternal laboratory audit. As the result of NELAP accreditation, the DCWRRI can now provide compliance tests for the government agencies,

environmental regulators or municipalities. The Institute now provides soil/solid and water quality testing service to the DC residents and beyond. In addition, the accredited lab provided a significant support for young researchers in leveraging extramural funding and building research capacity. Most importantly, the lab trained several graduate and undergraduate students from various majors through laboratory classes as well as working on the research projects. For example, laboratory training in water quality is part of the required course of Professional Science Master's Program in Water Resources Management, Urban Sustainability, Urban agriculture, both graduate and undergraduate Civil Engineering Program, and Undergraduate Chemistry Program. Furthermore, the EQTL services made significant contribution for the increasing student enrolment in the Professional Science Master's Program and Civil and Environmental Engineering.

3. Student Support

Students supported with annual base (104b) and required matching funds:

Number of Students Supported, by Degree and Grant Type: FY2019	
Degree	Base (104B) Grants
Undergraduate	6
Masters	9
Ph.D.	2
Post Doc	0

Thesis or capstone projects completed by the student support include:

- Acevedo, A. (2021). Concentrations of siloxanes, polycyclic aromatic hydrocarbons and cations in urban and suburban areas of the Anacostia, MS Thesis. American University.
- Marni Kravitz (2020). Flood Risk Communication to Improve Community Resilience, PSM Graduate Capstone Project, University of the District of Columbia
- Velasquez, E.M.P. (2020). Effectivity of Emerging Water Production Techniques with Solar Humidification-Dehumidification, Graduate Capstone Project, University of the District of Columbia.
- Rathnayake, M. (2020). Application of Machine Learning Techniques to Predict Flood and Water Quality Parameters in an Urban Watershed, Graduate Capstone Project, University of the District of Columbia.
- Hunt, B. (2020). Enhancing Green Infrastructure Development and Implementation: Innovative
- Financing Policy, Graduate Capstone Project, University of the District of Columbia.

4. Notable Achievements and Awards *

The main notable achievements and awards resulting from work supported with annual base grant (104b) and matching fund includes supporting students training future water resources scientist or engineers and supporting young researchers in successfully leveraging extramural funding. For

example, Dr. Lei Wang has received federal award of $511,707.00 from NSF. In addition, Dr. Amir Shahirinia has received several federal funding including $391,796.00 from the Department of Defense, and $275,420.00 from the National Science Foundation as a PI, and $374,126.00 from NSF as a Co-PI. Overall, more than **1.8-million-dollar** extramural funding was received.

Furthermore, the UDC's Environmental Quality Testing Laboratory has maintained NELAP accreditation in the following areas:

- Microbial analysis in potable and non-potable waters.
- Trace metal element analysis in potable and non-potable waters.
- Mineral element analysis in potable and non-potable waters.
- Mercury analysis in potable and non-potable waters.
- Semi-volatile organic compounds and pesticides in potable and non-potable waters (pending).
- Trace metal element analysis in soil.
- Mineral element analysis in soil.
- Mercury element analysis in soil.

Monitoring Polycyclic Aromatic Hydrocarbons In The Downstream Tributaries Of Anacostia River And Rock Creek Watershed In DC

Project Type: Annual Base Grant
Project ID: 2019DC044B

Project Impact:

Anacostia River is one of the most polluted rivers in the nation in Polycyclic Aromatic Hydrocarbons (PAHs) mainly due to urban runoff and combine sewer overflows (CSOs). To address these critical water quality issues in the District of Columbia (DC), the availability of monitoring data is imperative. Monitoring data is key not only in identifying major sources, but to select appropriate mitigation strategies as well. The objective of this research project was to monitor sixteen priority PAH compounds in the downstream tributaries of the Anacostia River in DC. Duplicate samples of stream sediments were collected at the downstream of five main tributaries such as Lower Beaverdam Creek, Kenilworth Marsh, Hickey Run, Watts Branch, Fort Dupont Creek, and Pope Branch. Samples were analyzed using selective ion mode and full scan mode in Gas Chromatography–Mass Spectrometry. The result shows the need for more sample collections and analysis. Significant impacts of this study include training of three graduate students, and implementation of new EPA methods at UDC for organic contaminant analysis and expansion of UDC's environmental quality testing laboratory services.

Concentrations Of Siloxanes, Polycyclic Aromatic Hydrocarbons And Cations In Urban And Suburban Areas Of The Anacostia

Project Type: Annual Base Grant
Project ID: 2019DC045B

Project Impact:

The objective of the project is to review how land use is correlated with water chemistry (inorganic) and organic contaminants such as endocrine disrupters and other polycyclic hydrocarbons (PAHs). Specifically, monitoring of five contaminants – fluoranthene, naphthalene, pyrene, decamethylcyclopentasilolxane (D5) and 4,6,8-Tetramethylcyclotetrasiloxane - at five sites along the Anacostia watershed was considered. The project was the cornerstone of Ashley Acevedo's MS thesis work. The project also supported four undergraduates for the spring 2020 semester and one undergraduate over the summer (when research was allowed on campus again). Portions of the work were presented as a poster during the American Geophysical Union annual meeting in December 2020 (Coastal Pollution session). Ashley Acevedo was first author and the poster title was "PAHs and siloxanes in urban and suburban areas of the Anacostia River, Washington DC.". Portions of the research were presented at the University of Virginia undergraduate departmental seminar on October 28, 2020 titled "Light at the End of the Tunnel: Challenge and Success in the Anacostia River (DC) Restoration.

Resilience-Based Water Infrastructure Rehabilitation Planning In The District Of Columbia

Project Type: Annual Base Grant
Project ID: 2019DC046B

Project Impact:

The impacts of this study comprise: (1) dissemination of research findings in the form of journal conference paper (both of them in progress) which is targeted at the scientific research community as well as practitioners; (2) define a decision making tool that helps water utility operators in seismic regions to find the best set of resilience enhancing rehabilitation strategies; (3) developing a computer code which connects EPANET software with MATLAB programming interface to implement iterative hydraulic simulations of seismically damaged WSSs. EPANET is a hydraulic software which is widely used by researchers to determine the hydraulic parameters of WSSs. However, EPANET and majority of other commercially available software for hydraulic analysis of WSSs are configured for intact networks and cannot be used reliably for the hydraulic analysis of damaged WSSs. Therefore, a programming code is developed in this study which can be used to estimate realistic hydraulic performance of damaged systems.

Development Of Streamflow Prediction Model And Software Package For Anacostia River At Non-gauged Locations Based On Bayesian Approach

Project Type: Annual Base Grant
Project ID: 2019DC047B

Project Impact:

Streamflow data of a river is important as it provides insight into the water quality of the river. Major parameters that are measured in the rivers include pH levels, conductance, temperature and nitrate vs nitrite. In Washington D.C, the Potomac River is the major body of water that goes through the southern and northwestern portions of the city. There are two smaller bodies of water which interacts with the Potomac: the Anacostia River and Rock Creek. The Anacostia River goes through the eastern part of Washington D.C and empties into the Potomac at Buzzard Point as Rock Creek is a tributary of the Potomac River and goes through central D.C. Each body of water has a stream gauge that measures critical parameters; including the ones mentioned earlier. As each of these gauges provide real time data of the water streams, the Anacostia River has far less amount of river data that the other rivers which only covers one year. On the other hand, Potomac River and Rock Creek have data dating back further than a decade; including more parameters measured.

Application Of Deep Reinforcement Learning In Optimizing The Operation Of Biofilters In Carbon And Nitrogen Removal From Stormwater

Project Type: Annual Base Grant
Project ID: 2019DC048B

Project Impact:

Chesapeake Bay is the largest estuary in the United States, but the land used modifications within the watershed have contributed significantly to the sedimentation, turbidity, eutrophication, and hypoxia, and consequently reducing submerged aquatic vegetation and affecting many other aspects of the aquatic ecosystem in the bay. To address these critical water quality issues, the District of Columba is committed to implement wholistic approach including low impact development (LID) to achieve a 60% reduction in sediment load, nitrogen and phosphorus by the year 2025. Bioretention cell is one of the LID widely implemented in the District as way to sustainable urban stormwater management to reduce the volume and the peak flow rate of stormwater hydrographs and also to retain the contaminants through process. The goal of this project was to evaluate the efficacy of biofiltration systems in removing organic carbon and nitrogen from stormwater. The pilot biofiltration system was to test carbon and nitrogen removal from stormwater at the Catholic University of America. We are currently using the pilot system under steady-flow condition and performing continuous monitoring to evaluate its effectiveness under a variety of conditions. We hope the system that we have constructed to be used to produce some preliminary data that will be used for a larger grant. This project supported one PhD students and one MS student.

Risk Assessment Of Levees In The Face Of Flood Hazards In The District Of Columbia

Project Type: Annual Base Grant
Project ID: 2019DC049B

Project Impact:

In recent years, the nation has experienced a rapid increase in the number and magnitude of major natural hazards, which causes flooding of many metropolitan areas and imposes a tremendous risk to lives, society, and built environment. Levees are critical engineering infrastructure serving as a key flood prevention system of many flood-prone communities around the nation. The collapse of these structures can be catastrophic and cause significant loss of life and damage to properties and infrastructures, especially to the coastal and riverside cities. It is crucially important for evaluating the safety of the levees for risk informed decisions to mitigate flood hazards. This research aims to develop a probablistic risk assessment framework for levees in the face of flood hazards for Metropolitan DC. The framework includes a numerical model for seepage and stability analysis of levees using the finite element method and a probabilistic assessment procedure for evaluating the failure probability of levees in the face of flood hazards. The developed risk assessment framework can enable a more informed decision making for the stakeholders considering the reliability of the levee infrastructure against flood hazards and associated failure probability. The research provides oppotunties to promote the awareness of risk and resilience of critical water resource infrastructure among high school and community college students of DC metropolitan area and offers an excellent opportunity to train a graduate student of civil engineering at the University of the District of Columbia.

Runoff Control Performance Evaluation And Development Of Design Guideline For Green Roof Systems For District Of Columbia- Phase II

Project Type: Annual Base Grant
Project ID: 2019DC050B

Project Impact:

The objectives of the research project was to design and built two mobile green roof systems to demonstrate the effective stormwater runoff control from impervious roof surface and pervious green roof surfaces. The project planed, designed and built two benches with each having 50 square feet of roofs which will be placed at 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 funding of the project enabled to construct the green roofs. Due to COVID Pandemic situation, the green roof were not able to be installed in the appropriate place for monitoring runoff.
These 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 seed grant 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. The project funded one undergraduate and one graduate student. The research helped the students from various departments and schools to understand the efficacy of green roofs in runoff control. The research project helped in obtaining a NSF grant entitled “Targeted Infusion Project: Integrating “Risk and Resilience” into Undergraduate Engineering Education for Workforce Towards a Hazard-Resilient Built Environment.