

**West Virginia Water Research Institute
West Virginia University**

**Annual Technical Report
2018**

Project Title	Environmental STEM Research Program: West Virginia University/Boy Scouts of America Summit Bechtel Reserve
Type of report	Final report
USGS award number	2016WV223B
Reporting Period Start Date	March 1, 2018
Reporting Period End Date	February 28, 2019
Principal Investigators	Paul Ziemkiewicz; James Anderson; Todd Petty; David Smaldone; Richard Thomas; Nicolas Zegre; Megan Kruger

Synopsis

The Environmental STEM (E-STEM) Research Program has had great success since funding was initially acquired in February 2016. Year 1 and 2 of the project yielded great results with sensor installation and initial curriculum development. Year 3 has been focused on making minor adjustments to curriculum and growing the E-STEM research project into a larger program with new collaborators.

During the reporting period, the E-STEM program created a new partnership with Adventure WV at West Virginia University (WVU) to write a proposal to fund a new project called Science Adventure Camp. The proposal outlined a collaborative effort between the E-STEM program at the West Virginia Water Research Institute and the Science Behind the Sport Program at WVU to create a STEM camp for middle school students in Nicolas, Fayette, and Raleigh counties in West Virginia and run a pilot version in May 2018. These counties were chosen due to their proximity to the Summit Bechtel Reserve (SBR). This proposal was funded, and the pilot was developed and ran in May 2018. The pilot brought 28 students from Beckley-Straton Middle School to the SBR for a 4-day STEM camping trip. The students learned all components of the E-STEM program and the Science Behind the Sport program.

Other collaborative efforts included writing a proposal for the U.S. Environmental Protection Agency's Environmental Education Grant Program based on some of the success of the E-STEM program. This proposal was also successfully funded. Research will be conducted to determine if environmental education and citizen science increase environmental stewardship behaviors in participants.

Products

No items were published during the reporting period

Information Transfer Program

Many successes were had to transfer information from this program. During the reporting period, the project manager, Megan Kruger, was asked to speak at the National Science Teachers Associations National Conference in Atlanta, GA. Her presentation highlighted the E-STEM program and how it could be used to increase environmental and climate literacy.

Another collaboration was made between the E-STEM program and the WVU Arts in the Library project. A collaborative exhibit on water research was developed and installed in the WVU Main Campus Library, with Megan Kruger being the interpretive curator. The exhibit was titled WATER: A cross-disciplinary exhibit exploring the significance, power & play of life's critical resource. This exhibit highlighted the E-STEM program.

Student Support

Category	Number of students supported with USGS 104b base grant	Number of students supported with matching funds	Total number of students supported
Undergraduate	2	2	2
Masters			
Ph.D.			
Post-Doc			
Total	2	2	2

Notable Achievements and Awards

After the success of the Science Adventure Camp, another proposal was written to acquire more funds to run a larger version of the camp in Fall 2019. The proposal was funded and the project, now called “Science Adventure School” will bring over 500 6th grade students to Summit Bechtel Reserve over a six-week period for a 4-day, 3-night STEM camp with the E-STEM program contributing half of the curriculum.

The collaboration with the Summit Bechtel Reserve and the West Virginia Water Research Institute has gained great acknowledgment, as Megan Kruger, with others, was invited to speak in front of the WVU Board of Governors and the president of the university to outline the E-STEM program and Science Adventure School.

Project Title	West Virginia State Water Conference
Type of report	Final report
USGS award number	2017WV228B
Reporting Period Start Date	March 1, 2018
Reporting Period End Date	February 28, 2019
Principal Investigators	Paul Ziemkiewicz; Tamara Vandivort; Megan Kruger

Synopsis

The West Virginia Water Research Institute developed and facilitated a two-day West Virginia State Water Conference on September 27 & 28, 2018 to highlight all the water research being conducted in West Virginia. The conference theme was WATER: Exploring the understanding, significance, and power of life's critical resource and was held at the Morgantown Marriot at Waterfront Place in Morgantown, WV. A request for abstracts was sent out via email from our institute. Thirty-six abstracts were received. This consisted of twenty oral and sixteen poster presentations. Furthermore, we invited experts in their fields to present for plenary, panel, and opening sessions.

Day one of the conference started with opening remarks by Morgantown's Mayor, Bill Kawecki. This was followed by a plenary session on State Water Policy Updates. Speakers included Laura Cooper, Assistant Director of the Division of Water and Waste Management for the WV Department of Environmental Protection, David Wellman, District 2 Fisheries Biologist for the WV Division of Natural Resources, and John Wirts, Assistant Director of the Watershed Assessment Branch at the WV Department of Environmental Protection. A panel session with four WVU researchers on current water research in WV followed. The day ended with breakout sessions and a poster reception at the WVU Downtown Library.

Day two of the conference opened with a plenary session on aging water infrastructure. Invited speakers included Amy Swann, Executive Director, West Virginia Rural Water Association, Brian Bruce, President, West Virginia American Water, and Magdalene Cunningham, Clean Water Revolving Fund Coordinator, Region 3 Water Division, U.S. Environmental Protection Agency. Breakout sessions and a panel session on West Virginia Pipelines followed. Panel speakers included three WVU researchers, a representative from the Division of Natural Resources, and a representative from Markwest Energy Partners.

The conference had 76 attendees, made up primarily of students, faculty, non-profit groups, businesses, and state employees.

Products

No publications were produced.

Information Transfer Program

Information transfer activities included creating a conference website that housed all important conference materials. This website was also updated with all the presentations from invited and selected speakers. These presentations were available to the public. Also, we collaborated with the West Virginia University Library to cross-promote the WATER Exhibit (an exhibit that highlighted all the water related research happening at West Virginia University) and the West Virginia State Water Conference. The poster presentation was held at the Library to further encourage information transfer.

Student Support

Category	Number of students supported with USGS 104b base grant	Number of students supported with matching funds	Total number of students supported
Undergraduate	2	2	2
Masters			
Ph.D.			
Post-Doc			
Total	2	2	2

Notable Achievements and Awards

No notable achievements were made during the reporting period.

Project Title	Environmental STEM (E-STEM) Research Program: West Virginia University/Boy Scouts of America Summit Bechtel Reserve 2017 National Scout Jamboree
Type of report	Final report
USGS award number	2017WV230B
Reporting Period Start Date	March 1, 2018
Reporting Period End Date	February 28, 2019
Principal Investigators	Paul Ziemkiewicz; Megan Kruger

Synopsis

Phase 2: Environmental STEM (E-STEM) Research Program: West Virginia University/Boy Scouts of America Summit Bechtel Reserve 2017 National Scout Jamboree had great success during year one of the project and continued to support the E-STEM program throughout year two. Year two activities involved implementing the curriculum developed during year one at various field trips, developing new collaboration projects, and preparing to attend the 2019 World Jamboree at Summit Bechtel Reserve.

Collaboration was initiated between the E-STEM program and the West Virginia University's Upward Bound Program. The Upward Bound program serves high school students that are either low-income, first-generation, or academically at-risk. The E-STEM program brought the Upward Bound Summer Program students to the Summit Bechtel Reserve for an all-day E-STEM workshop.

Collaboration was further initiated between the E-STEM program and the West Virginia University Institute of Technology's Girls STEM Academy. This program brings high school females to campus for a week-long STEM camp led by females in the field. This collaboration brought the students enrolled in the Girls STEM Academy to the Summit Bechtel Reserve for a full day E-STEM workshop.

Other E-STEM program activities included teaching the Environmental Science Merit Badge at Merit Badge University, writing various proposals that spring-boarded of the success of the E-STEM program (NSF Advancing Informal STEM Learning, EPA Environmental Education Grant, NASA West Virginia Space Grant Consortium, and writing additional environmental educational activities into an already funded NSF EPSCoR grant at the West Virginia Water Research Institute).

Products

No publications were produced.

Information Transfer Program

Information Transfer was achieved through interaction with all the students, teachers, and administrators mentioned above. Furthermore, remaining monies were used to leverage support from the West Virginia University Davis College of Agriculture, Natural Resources and Design to support the E-STEM program attending the 2019 World Jamboree. This support will pay for Megan Kruger and two undergraduate students to attend the 10 day event, as well as provided scholarships for the undergraduate students attending. Much time this year was dedicated to editing and printing the E-STEM Activity book (originally produced in year one), E-STEM patches, and E-STEM T-shirts in anticipation of attending the World Jamboree. This event will bring 50,000 Scouts from 152 countries to the Summit Bechtel Reserve in West Virginia.

Student Support

Category	Number of students supported with USGS 104b base grant	Number of students supported with matching funds	Total number of students supported
Undergraduate	2	2	2
Masters			
Ph.D.			
Post-Doc			
Total	2	2	2

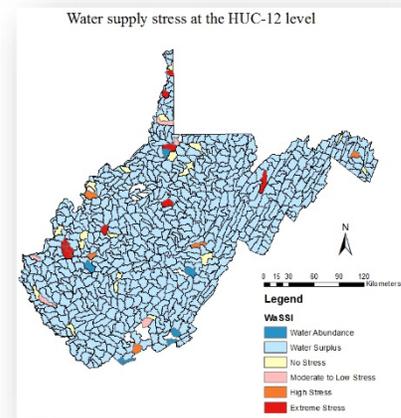
Notable Achievements and Awards

Notable Achievements include expanding the E-STEM program to more audiences through grant writing collaborations and being selected as one of the few West Virginia University programs to attend the 2019 World Jamboree in July 2019. The E-STEM program will attend the event from July 22, 2019 – August 2, 2019, interacting with male and female scouts from 152 countries.

Project Title	High Resolution Assessment of Economic Sector Water Use, Water Supply, and Water Economy – A Novel Approach for Managing West Virginia’s Water Resources
Type of report	Annual report
USGS award number	2018WV232B
Reporting Period Start Date	June 18, 2018
Reporting Period End Date	June 17, 2019
Principal Investigators	Nicolas Zegre

Synopsis

Water withdrawal and water consumption by total water use and water use sector were spatially disaggregated from the native county-scale to a gridded, 30-m scale. These data, in addition to the USGS 1-km groundwater recharge data, were spatially re-aggregated to the HUC8 and HUC12 scales and used to determine watershed-level supply stress using WaSSI. No watersheds were stressed at the HUC8-level, but several were stressed at the HUC12-level (Figure right). Seven catchments were classified as “Extreme Stress” and “High Stress”. Water use associated with thermoelectricity power generation was the greatest driver of water supply stress at the watershed-scale throughout West Virginia.



Products

Journal Articles –Zegre, N., M. Kearns, J. Earle, R. Fernandez. *In preparation*. Water use and water stress at the headwater. To be submitted to the *Journal of the American Water Resources Association* fall 2019.

Thesis – Earle, Justin. “Water use, water supply, and water stress in West Virginia”. Master of Science in Forestry, Division of Forestry & Natural Resources, West Virginia University. Expected defense March 2020.

Information Transfer Program

Pending transfer of watershed-level water use, water supply, and water stress maps and dataset to the West Virginia Department of Environmental Protection Water Use Section, Division of Water and Waste Management.

Student Support

Category	Number of students supported with USGS 104b base grant	Number of students supported with matching funds	Total number of students supported
Undergraduate			
Masters	1	1	2
Ph.D.			
Post-Doc			
Total	1	1	2

Notable Achievements and Awards

NA

Project Title	Evaluating the State of Dam Infrastructure Under a Changing Climate
Type of report	Annual report
USGS award number	2018WV233B
Reporting Period Start Date	June 18, 2018
Reporting Period End Date	June 17, 2019
Principal Investigators	Leslie Hopkinson; John Quaranta

Synopsis

This work is intended to evaluate dam design criteria under a changing climate and assess dam safety impacts due to changes in reservoir pool elevations. The following tasks were completed in the project period:

- A site-specific probable maximum precipitation (PMP) estimation was developed for Howard Creek Dam in Greenbrier County, WV. The analysis resulted in a 6-hr PMP value of 29.4 in, an 11% increase as compared to the standard value (i.e., Hydrometeorological Report No. 51). A 6-hr PMP value of 32.3 was predicted for year 2100. Probable maximum flood analysis is in progress.
- We quantified how changes in the 100-year flowrate may affect emergency spillway activation. Peakflow data were used to analyze changes in the 100-year flowrate. Reservoir routing was used at a high hazard dam under potential future flow. The spillway of the dam was predicted to be reached by approximately a 12% increase in 100-year flow. The results suggest that emergency spillway designs need to consider potential changes in 100-year flow.
- The 24-hr precipitation under a changing climate was evaluated at three locations in West Virginia (Lewisburg, Sutton Lake, and Beckley). It was found that the 100-yr precipitation depth increased by up to three inches when decreasing the period of record to the last 10 years. Additionally, greater precipitation depths were observed in greater frequency when looking at the most recent data. This observation of more frequent high-intensity rainfall should be considered in statewide dam design and rehabilitation.

Products

1. Sutton, A. R. 2019. Evaluating design criteria for high hazard dams in a changing climate. M.S. thesis. West Virginia University. Morgantown, WV.
2. Priest, M., L. Hopkinson. 2018. Design storms under a changing climate in West Virginia. 10th Annual Summer Undergraduate Research Symposium. Erickson Alumni Center, Morgantown, WV.
3. Sutton, A., L. Hopkinson. 2019. Evaluating design criteria for high hazard dams in a changing climate. Annual West Virginia Academy of Science Meeting, March 30, West Liberty University, West Liberty, WV.

Information Transfer Plan

We completed two technical presentation and are in contact with appropriate state agencies (i.e., West Virginia Department of Environmental Protection, Dam Safety Office). We plan to schedule a meeting in fall to share the results. We continue to complete technical presentations and publications.

Student Support

Category	Number of students supported with USGS 104b base grant	Number of students supported with matching funds	Total number of students supported
Undergraduate		1	1
Masters		1	1
Ph.D.	1		1
Post-Doc			
Total	1	2	3

Notable Achievements and Awards

One student, Aaron Sutton, earned a M.S. degree.

Project Title	Drinking Water Treatment Methods to Reduce THM
Type of report	Final report
USGS award number	2018WV238B
Reporting Period Start Date	June 18, 2018
Reporting Period End Date	June 17, 2019
Principal Investigators	Lian-Shin Lin; Nashid Mirza; Paul Ziemkiewicz; Melissa O'Neal

Synopsis

The common by-products of disinfection process are the halogenated compounds named Trihalomethanes (THMs). Given the adverse effect of the THMs, water plant operators are required to monitor the THMs level in the finished water through the distribution network. This study aims to aid the operators reduce trihalomethane occurrences and levels in small treatment plants by investigating causal linkages between the precursor levels and factors that contribute to THMs formation. In this study, monthly samples were taken from three water treatment authorities and five points within distribution network starting from September 2018 till May 2019 in Southwestern Pennsylvania. The results showed that the concentration of TOC in the source water highly controlled the formation of THMs in the finished water. Linear regression of THMs and total organic carbon (TOC) for individual treatment plants gave better model fit than using the combined dataset for all three plants. This indicates varying effects of different treatment operation at individual plants. The highest TOC occurred during September and October which also caused THM violation in all the sampled distribution points. In general, bromide concentration was low (mostly undetected), and the chlorinated THMs dominated in the finished water. A multiple linear regression model was developed to predict THMs in the finished water using chloride, TOC and temperature. Lastly, the secondary data obtained from Charleroi Water Authority was utilized to show the effectiveness of pre-sedimentation tank for controlling THMs.

Products

Presentation

Mirza, N., O'Neal M., Ziemkiewicz P., and Lin, L. "Impacts of Bromide Concentration on Brominated THMs Formation in Southwestern Pennsylvania", West Virginia State Water Conference, Morgantown, WV, USA, September 27-28, 2018.

Thesis

Mirza, N. "Minimizing Trihalomethane Formation through Source Water Monitoring and Disinfection Management Practices." (In progress)

Information Transfer Plan

Throughout the study samples were collected from the three water authorities in southwestern Pennsylvania. Amongst those, one to one information was obtained from the Borough of Charleroi Water Authority which helped greatly in this research. To convey the findings and recommendations stated in the report, a fact sheet has been prepared. The electronic copy of the fact sheet (see attached) will be shared with all the water authorities involved in the study and posted to the WVVRI website.

Student Support

Category	Number of students supported with USGS 104b base grant	Number of students supported with matching funds	Total number of students supported
Undergraduate	2	2	2
Masters	1	1	1
Ph.D.			
Post-Doc			
Total	3	3	3

Notable Achievements and Awards

None under this reporting period.

Project Title	Modeling Flood Risk in WV
Type of report	Final report
USGS award number	2018WV239B
Reporting Period Start Date	June 18, 2018
Reporting Period End Date	June 17, 2019
Principal Investigators	Michael Strager; Nicolas Zegre

Synopsis

Flooding potential in West Virginia and the Appalachian region is predicted to increase due to more frequent and intense storm events. Many government officials, developers, planners, and home owners are interested in improved flood potential modeling to help determine where it is safe to build or live. If this information is not available or inadequate (for example, if flood maps are outdated) then consequences of floods can put communities at risk. Our goal is to better identify areas of high flooding risk in order to better manage watersheds and reduce property damage. We provide flood risk modeling for two watersheds in WV (the Greenbrier and Elk River) that will also help the greater Appalachian region understand the importance of landscape characteristics for future flood planning. Using a combination of site specific high resolution datasets, we mapped the locations in the Greenbrier and Elk River watersheds that are more susceptible to flooding. In addition, we applied a ranking and prioritization approach to identify the most critical areas in the watershed that can aid in restoration and protection to decrease future flood impacts. Our work combines site specific criteria variables at a high spatial and temporal resolution with regional prioritization. Working concurrently at these two scales is helpful to flood management and can provide a framework to be applied across Appalachia. This work contributes to the understanding of the morphology, ecology and land use of watersheds that can be used to reduce runoff and downstream flood risk.

Products

Strager, M. P., J. M. Strager, N. Zegre. 2018. Flood potential and prediction modeling in WV using terrain variables. Water, IN PREP.

Strager, M. P., J. M. Strager, N. Zegre. Modeling flood risk potential in WV. WV State Water Conference, Morgantown, WV, September 27-28, 2018.

Strager, M. P., N. Zegre. Terrain derivatives to aid in flood forecasting. AWRA Spring Specialty Conference GIS and Water Resources X: Spatial Analysis of Watersheds: Ecological, Hydrological, and Societal Responses, Orlando, Florida, April 22 – 25, 2018

Strager, M. P. Improved landscape characterization for modeling receiving stream conditions. Spring Conference of the Institute of Water Security and Science: Advances in Water Resource Science and Management in West Virginia and the Northeastern U.S. Morgantown, WV, February 20-21, 2018.

Strager, M. P., N. Zegre. A two-scaled approach for flood susceptibility prediction in Appalachia. Universities Council on Water Resources Conference, Pittsburgh, PA, June 26-28, 2018.

Information Transfer Program

The results of this study were provided to West Virginia Division of Natural Resources and West Virginia Department of Environmental Protection as polygon derived extents to aid in better flood plain mapping and analysis. In addition, we analyzed the Microsoft building structures within the inundation zones of

our analysis. We also are in the process of disseminating our mapped results to the USDA Natural Resource Conservation Service in West Virginia.

Student Support

Category	Number of students supported with USGS 104b base grant	Number of students supported with matching funds	Total number of students supported
Undergraduate	2	2	4
Masters	1	1	2
Ph.D.			
Post-Doc			
Total	3	3	6

Notable Achievements and Awards

From this effort, we were able to secure a fifth year of funding from our U.S. National Science Foundation -Experimental Program to Stimulate Competitive Research (\$64,331). In addition, funding was recently secured from the WV Department of Environmental Protection (\$50,000) to analyze water budget and tower concepts as well as \$20,000 from the WV Division of Natural Resources to create a statewide high-resolution land cover classification for WV.