

**Pennsylvania Water Resources Research Center
The Pennsylvania State University**

**Annual Technical Report
2019**

Products

Publications:

- 2019PA224B, Kekre KM, A Anvari, K Kahn, Y Yao, and A Ronen (2021). Reactive electrically conducting membranes for phosphorus recovery from livestock wastewater effluents. *Journal of Environmental Management*, 282:111432. DOI: 10.1016/j.jenvman.2020.111432.
- 2019PA224B, Anvari A., KM Kekre, AA Yancheshme, Y Yao, and A Ronen (2019). Membrane distillation of high salinity water by induction heated thermally conducting membranes. *Journal of Membrane Science*, 589. doi: 10.1016/j.memsci.2019.117253.
- 2019PA002I, Rahmani F, K Lawson, W Ouyang, A Appling, S Oliver, and C Shen (2021). Exploring the exceptional performance of a deep learning stream temperature model and the value of streamflow data. *Environmental Research Letters* 16(2): 024025. DOI: 10.1088/1748-9326/abd501
- 2019PA223B, Clune JW, JK Crawford, WT Chappell, and EW Boyer (2020). Differential effects of land use on nutrient concentrations in streams of Pennsylvania. *Environmental Research Communications*, DOI: 10.1088/2515-7620/abc97a.
- 2019PA223B, Clune JW, JK Crawford, and EW Boyer (2020). Nitrogen and Phosphorus Concentration Thresholds Toward Establishing Water Quality Criteria for Pennsylvania, USA. *Water*, 12, DOI:10.3390/w12123550.
- 2019PA223B, Alexander RB, GE Schwarz, and EW Boyer (2019). Advances in quantifying streamflow variability across continental scales: 1. Identifying natural and anthropogenic controlling factors in the USA using a spatially explicit modelling method. *Water Resources Research*, DOI: 10.1029/2019WR025001.
- 2019PA223B, Alexander RB, GE Schwarz, and EW Boyer (2019). Advances in quantifying streamflow variability across continental scales: 2. Improved model regionalization and prediction uncertainties using hierarchical Bayesian methods. *Water Resources Research*, DOI: 10.1029/2019WR025037.
- 2019PA223B, Carroll JM, J Beck, EW Boyer, S Dhanorkar, and S Gupta (2019). Empowering community water data stakeholders. *Interacting with Computers*, 31(5):492-506. DOI: 10.1093/iwcomp/iwz032.

Information Transfer Program

Concerns over water resources have been growing in Pennsylvania, in response to severe droughts and floods, a growing population, increasing demands for water, water pollution, and the need to understand how changes in land use, climate, and energy extraction affect water quantity and quality. By supporting conference and workshop activities about water issues and water resources research, PAWRRC disseminated information, facilitated dialog and communication, and promoted collaboration.

Co-Sponsorship of Scientific Conferences

- *Co-sponsor of 2019 Pennsylvania Groundwater Symposium, held at Penn State University, May 1, 2019.*

- *Co-sponsor of 2019 Susquehanna River Symposium, on Healthy Rivers, Healthy Communities, held at Bucknell University, Lewisburg, PA, October 18-19, 2019.*

Presentations:

- 2019PA225B, Long-term effectiveness of restoration activities in streams of Lancaster County, PA. A Dimova, S Clark, J Sliko, R Smolinski. American Water Resources Association Annual Convention (virtual), November 10, 2020.
- 2019PA225B, Long-Term Effectiveness of Stream Restoration in Lancaster County: Focus on Lititz Run. Monroe County (Pennsylvania) County Conservation District Virtual Workshop on Stream Restoration. Shirley Clark, November 13, 2020.
- 2019PA002I, Rahmani, Farshid, Samantha Oliver, Wenyu Ouyang, Alison Appling, Kathryn Lawson, and Chaopeng Shen. Developing and Testing a Long Short-Term Memory Stream Temperature Model in Daily and Continental Scale. Earth and Space Science Open Archive ESSOAr (2020), in AGU Fall Meeting 2020. AGU Fall Meeting (virtual) 2020.
- 2019PA002I. Shen, Chaopeng, Farshid Rahmani, Wei Zhi, Kuai Fang, Wen-Ping Tsai, Li Li, and Kathryn Lawson. Transcending the uniqueness of places with large-sample multi-physics catchment modeling based on machine learning. AGU Fall Meeting (virtual) 2020.
- 2019PA223B. Boyer EW. Coupled Hydrological, Biogeochemical, and Anthropogenic Processes in Watersheds. Center for Water, Earth Science, and Technology, George Aiken Distinguished Seminar, University of Colorado, February 19, 2020.
- 2019PA223B. Boyer EW, RB Alexander, and JW Harvey. (Invited). Linking hydrological, biogeochemical, and anthropogenic processes across scales. American Geophysical Union, San Francisco, CA, December 10, 2019.

Workshop Series for K12 and Informal Educators:

This series of workshops, held virtually online in 2020, were sponsored by PAWRRC in conjunction with the Center for Science and the Schools at Penn State University. They were led by educators from the Paleontological Research Institution (PRI) and its Museum of the Earth. The workshops were aimed at K-12 educators (from schools in Pennsylvania) and informal educators (e.g., from nature centers, parks, and organizations).

- August 6, Tools for teaching about climate and earth sciences
- November 16, Online resources for teaching about water and climate
- November 18, Overview of PRI's Earth@Home teacher resources
- November 23, Earth@Home: Geological Teaching Resources
- November 30, Earth@Home: Climate Teaching Resources
- December 7, Earth@Home: Biological Teaching Resources

Student Support

- USGS 104B (PA) Program:
 - Undergraduate: 1
 - Masters: 4
 - Doctoral: 3
- NIWR-USGS Internship Program:
 - Doctoral: 1

Notable Achievements and Awards

- Through a NIWR student internship award in partnership with USGS-Wisconsin (Project # 2019PA002I), one graduate student (at Penn State) was mentored and trained to use state-of-the-art machine learning techniques, and developed a predictive model of stream temperature, which is an important water quality characteristic.
- The manuscript by Clune et al. 2020 (Project # 2019PA223B), entitled Nitrogen and Phosphorus Concentration Thresholds Toward Establishing Water Quality Criteria for Pennsylvania, was the recipient of the journal's "Editor's Choice" recognition.

Long-term Effectiveness Of Stream Restoration Activities

Project Type: Annual Base Grant

Project ID: 2019PA226B

Project Impact:

This research explores the long-term ability of constructed wetlands to treat domestic sewage. Sampling during FY19 was not possible due to covid19's disruption of research. Rural communities are often served by decentralized, on-site domestic waste treatment systems, many of which have failed due to placement in poorly drained or shallow soils, and development in rural areas is often hindered by these same soil limitations. Emphasis on nitrogen and phosphorus removal effectiveness for conventional and experimental treatment systems within the Chesapeake Bay watershed has received significant state support within the past few years. Such research provides additional timely guidance to private landowners, nonprofits, and state agencies on the long-term functioning of decentralized, domestic waste treatment systems.

Advancing Public Understanding about Water Resources and Climate Change in Pennsylvania

Project Type: Information Transfer

Project ID: 2019PA223B

Project Impact:

Concerns over water resources have been growing in Pennsylvania, in response to floods and droughts, a growing population, increasing demands for water, water pollution, and the need to understand how changes in land use, climate, and energy extraction affect water quantity and quality. In FY19, PAWRRC co-sponsored two scientific conferences, including the Pennsylvania Groundwater Symposium and the Susquehanna River Symposium. Projects also supported presentations at scientific conferences by faculty and students. Further, PAWRRC sponsored a series of six (virtual) workshops for K-12 and informal educators, focused on resources for teaching about water, climate, and environmental science. By supporting conference and workshop activities about water issues and water resources research, PAWRRC disseminated information, facilitated dialog and communication, and promoted collaboration.

Exceptional performance of a stream temperature model and the value of streamflow data

Project Type: Research (NIWR Internship)

Project ID: 2019PA002I

Project Impact:

This research developed a modeling framework to predict stream temperature in surface waters across the United States. This research reduced daily stream temperature prediction error significantly by developing a machine learning model using only the general available information such as climate data and geological attributes. This work also showed simulated streamflow is beneficial for sites without measured streamflow data. This research showed that the presented model could capture the complex relationship between climate data, basin-average attributes, and stream temperature which was extracted by training the model with a few years data. The presented model could outperform state-of-the-art models reported in the literature without any need for detailed representations of the subsurface or the channel network which allowed the model to be assembled easily by using simplified values for basin representation. Measured streamflow information helped improve modeling of stream temperature.