Pennsylvania Water Resources Research Center
The Pennsylvania State University

Annual Technical Report
2018

General Information

Products

1. Project 1: Wen, T., Agarwal, A., Xue, L., Chen, A., Herman, A., Li, Z., Brantley, S.L., 2019. Assessing changes in groundwater chemistry in landscapes with more than 100 years of oil and gas development. Environ. Sci. Process. Impacts 21, 384–396. DOI: 10.1039/C8EM00385H
2. Project 1: Wen, T., Woda, J., Marcon, V., Niu, X., Li, Z., Brantley, S.L., 2019. Exploring How to Use Groundwater Chemistry to Identify Migration of Methane near Shale Gas Wells in the Appalachian Basin. Environ. Sci. Technol. DOI: 10.1021/acs.est.9b02290
3. Project 3: Desipio, M.M., Thorpe, R., Saha, D.*, 2018, Photocatalytic Decomposition of Paraquat Under Visible Light by Carbon Nitride and Hydrogen Peroxide, Optik, 172, 1047-1056
4. Project 3: Desipio, M.M., Van Bramer, S.E., Thorpe, R., Saha, D.*, 2019, Photocatalytic and photo-fenton activity of iron oxide-doped carbon nitride in 3D printed and LED driven photon concentrator, Journal of Hazardous Materials, 376, 178-187.
5. Project 3: Saha, D.*, Visconti, M.C., Desipio, M.M., Thorpe, R., 2019, Inactivation of Antibiotic Resistance Gene by Ternary Nanocomposites of Carbon Nitride, Reduced Graphene Oxide and Iron Oxide under Visible Light (Under Review in Chemical Engineering Journal, revisions submitted).
6. Project 3: Desipio, Mathew M., 2019, Influence of a 3D printed, LED driven Photostation on the photocatalytic activity of Iron Oxide-doped Carbon Nitride, “MS Dissertation”, Chemical Engineering Department, School of Engineering, Widener University, Chester, PA, 89 pages.
7. Project 3: Visconti, Michael, C., 2019, Inactivation of Antibiotic Resistance Genes by Photocatalysis Under Visible Light, “MS Dissertation”, Chemical Engineering Department, School of Engineering, Widener University, Chester, PA, 73 pages.
8. Project 4: Tzilkowski SS, AR Buda, EW Boyer, RB Bryant, PJA Kleinman, CD Kennedy, AL Allen, GJ Folmar, and EB May (2018). Urea fluctuations in stream baseflow across land cover gradients and seasons in a coastal plain river system. Journal of the American Water Resources Association, DOI: 10.1111/1752-1688.12716.
9. Project 4: Harvey, JW, J Gomez-Velez, N Schmadel, D Scott, E Boyer, R Alexander, K Eng, H Golden, A Kettner, C Konrad, R Moore, J Pizzuto, G Schwarz, C Soulsby, and J Choi. (2018). How Hydrologic Connectivity Regulates Water Quality in River Corridors. Journal of the American Water Resources Association, 13p., DOI: 10.1111/1752-1688.12691.
10. Project 4: Mina O, H Gall, H Elliott, J Watson, ML Mashtare, T Langkilde, JP Harper, and EW Boyer (2018). Estrogen occurrence and persistence in vernal pools impacted by wastewater irrigation practices. Agriculture, Ecosystems, and Environment, 10p., DOI: 10.1016/j.agee.2018.01.022.
11. Project 4: Schmadel N, J Harvey, R Alexander, G Schwarz, R Moore, K Eng, J Gomez-Velez, E Boyer, and D Scott (2018). Thresholds of lake and reservoir connectivity in river networks control nitrogen removal. Nature Communications, 10p., DOI: 10.1038/s41467-018-05156-x.
12. Project 4: Vadeboncoeur MA, MB Green, H Asbjornsen, JL Campbell, MB Adams, EW Boyer, DA Burns, IJ Fernandez, MJ Mitchell, and JB Shanley (2018). Systematic variation in evapotranspiration trends and drivers across the northeastern United States. Hydrological Processes, 14p., DOI: 10.1002/hyp.13278

Information Transfer Program

PAWRRC supported four projects in FY18. Project 1 entitled “Data-Driven Models to Assess Water Quality in the Region of Marcellus Shale” applied innovative data mining techniques to assess water quality with respect to sources of possible contamination and natural conditions in Pennsylvania. Project 2 entitled “Integrative Modeling to Quantify Systems-Level Benefits of Green and Grey Infrastructure Networks to Urban Water Quality” developed integrative models to predict the performance and quantify the system-level benefits of green and grey infrastructure networks to urban water quality. Project 3 entitled “Photocatalytic Water Purification Under Visible Light: A New Direction for Water Treatment Process” provided a new direction for water treatment processes by introducing a photocatalyst that can be activated under visible light to decompose the organic pollutants into harmless products. Project 4 entitled “Advancing Public Education about Water Resources in Pennsylvania and the Mid- Atlantic Region” facilitated broad dialog about water resources issues. Information transfer products stemming from these projects included 12 research publications, 2 publicly accessible data products, and 25 presentations to the scientific community.

PAWRRC co-sponsored 5 scientific conferences related to water resource and helped to facilitate 3 public seminars. These activities encourage synthesis of data and results; enable networking; stimulate research collaborations, and provide support to early career researchers. Further, PAWRRC led a workshop on water resources and earth sciences in the French Creek watershed of Pennsylvania and New York. At Allegheny College in Meadville, PA, we brought together 4 faculty, 6 extension educators, 9 staff from non-governmental organizations, 15 science teachers from middle and secondary schools, and 9 college and university students. In so doing, we disseminated information about water issues, and taught researchers how to communicate results to stakeholders.

Student Support

8 graduate students and 1 postdoctoral research associate were supported or partially supported as part of the FY18 104B projects at multiple academic institutions across Pennsylvania.

Notable Achievements and Awards

Notable Achievement: PAWRRC led a workshop for educators on water resources and earth sciences in the French Creek watershed of Pennsylvania and New York. French Creek is nationally renowned as one of the most ecologically important streams in eastern North America. At Allegheny College in Meadville, PA, we brought together 4 faculty, 6 extension educators, 9 staff from non-governmental organizations, 15 science teachers from middle and secondary schools, and 9 college and university students. We engaged all educators in bringing aquatic habitats and water resources into their respective educational settings through field studies, visual imagery, digital maps, and data. This effort improved regional science communication about the origin of the interrelationships among the history, water quality, and aquatic ecology of waterways in northwest Pennsylvania. The effort also led to follow-on research and educational collaborations.

Award: Dr. Boyer was recognized with the 2018 Paul A. Witherspoon Award from the American Geophysical Union. The award recognizes significant and innovative contributions by a mid-career scientist in advancing the field of hydrologic sciences — considering the awardee's research impact, innovative interdisciplinary work, application of research to socially important problems, and inspired mentoring of young scientists.

Projects

Advancing Public Education about Water Resources in Pennsylvania and the Mid-Atlantic Region

Project Type: Annual Base Grant **Project ID:** 2018PA237B

Project Impact: Concerns over water resources have been growing in Pennsylvania, in response to severe droughts and floods, a growing population, increasing demands for water, and the need to understand how changes in land use, climate, and energy extraction affect water quantity and quality. The Pennsylvania Water Resources Research Center co-sponsored activities that promote dialog of important water resources issues in Pennsylvania and beyond. By supporting conferences and symposia, we facilitate dialog about water issues of importance in Pennsylvania; encourage synthesis of data and results; enable networking; stimulate research collaborations, and provide support to early career researchers. By offering educational outreach programs, we disseminate information about water issues, and teach graduate students how to communicate water science and research to a broad audience.

Data-Driven Models to Assess Water Quality in the Region of Marcellus Shale

Project Type: Annual Base Grant **Project ID:** 2018PA234B

Project Impact: This research applies innovative data mining techniques to assess water quality with respect to sources of possible contamination and natural conditions in Pennsylvania. A large data set of water chemistry for over 20,000 groundwater samples has been compiled, checked for quality, and published in online data repositories. Based on this funded work and previous work in the group, two machine learning algorithms were developed to investigate water chemistry. The techniques were applied to the large data set compiled as part of this funded work: (1) an ensemble model combined with feature bagging was used to detect groundwater samples that could be impacted by new influxes of methane based solely on geochemical analytes other than methane (

Integrative Modeling to Quantify Benefits of Green and Grey Infrastructure Networks to Urban Water Quality

Project Type: Annual Base Grant **Project ID:** 2018PA235B

Project Impact: This research developed a first neighborhood-scale stormwater fate model including both overland and sewer system flows for the City of Pittsburgh encompassing 600+ subcatchments around the University of Pittsburgh campus and Phipps Conservatory and Botanical Gardens. This project produced four major outcomes: (i) a stormwater fate model and associated sensitivity analysis for sewershed M29 in the city of Pittsburgh, a highly variable 2400-acre watershed including the University of Pittsburgh's urban campus, (ii) an initial analysis of green infrastructure monitoring data from the Phipps Conservatory's Center for Sustainable Landscapes, providing insight into how green infrastructure (and sensor) performance changes with season and time, (iii) a journal publication on stormwater model sensitivity and uncertainty analysis with important implications for model calibration; and (iv) a successfully funded 5-year NSF proposal to study green infrastructure design and performance in the City of Pittsburgh with a parallel effort in Chicago. For the model development, we used the US EPA's Stormwater Management Model to conduct an extensive, systematic Monte-Carlo-based sensitivity analysis, identifying critical parameters that determine stormwater fate in this system. Spearman correlation coefficients showed diverse relationships with parameter values, indicating that model sensitivity to parameters can be influenced by urban conditions, further confirmed by parameter rank tests. In parallel, our initial analysis of a long-term (~10 year) sensor data set from several green infrastructure installations at Phipp's Center for Sustainable Landscapes illustrated correlations among sensor data types and seasonal variations, suggesting that an optimal set of sensor types and locations could be identified to provide the most impactful GI monitoring. This work forms the foundation for a five-year green infrastructure modeling and monitoring study recently funded by the NSF, which preliminary results from this project helped to secure.

Photocatalytic Water Purification Under Visible Light: A New Direction for Water Treatment Process

Project Type: Annual Base Grant **Project ID:** 2018PA236B

Project Impact: This Research developed pure and modified structures of graphitic carbon nitride and designed an energy efficient photoreactor to degrade varieties of organic pollutants in presence of visible light in an inexpensive manner. More specifically, this research developed pure graphitic carbon nitride (g-C_3N_4), and composites of iron oxides/carbon nitride and iron oxides/reduced graphene oxide/carbon nitride. Different types of organic pollutants, including Dye (methylene blue), herbicides (dicamba, paraquat, and diquat), infecting agent (plasmid DNA) have been degraded successfully in present of those composite photocatalysts under visible light. In order to enhance the recovery and reusability of the photocatalyst composite, the particles of the composite have been confined in an electrospun nanofiber with fiber diameter 80-150 nm. Furthermore, in order to enhance the overall photocatalysis of the organic pollutant, hydrogen peroxide has been employed in trace amounts along with the photocatalyst. In an effort to further increase the efficiency of the process, a photostation has been designed and 3D printed with parabolic reflective surfaces so that the maximum amount of incident light can be transferred to the photoreactor. Additionally, as light sources, chips-on-board (COB) light emitting diodes (LEDs) have been employed as the sources of visible light. These LEDs can provide very high light intensity with minimal current usages that significantly reduce the cost of operation. The overall results suggest that this photocatalyst along with an energy efficient photostation can be potentially used for wastewater treatment purposes to inactivate varieties of waterborne pollutants.