

Illinois Water Resources Center

**Annual Technical Report
2018**

General Information

Products

1. Effect of sample holding time on bioaccessibility and sediment ecotoxicological assessments

Kara E. Huff Hartz, Federico L. Sinche, Samuel Natile, Courtney Y. Fung, Patrick W. Moran, Peter C. Van Metre, Lisa H. Nowell, Marc Mills, Michael J. Lydy. Environmental Pollution, 2018, volume 242 part B, pp. 2078-2087, doi: 10.1016/j.envpol.2018.06.065.

2. Survey of Bioaccessible Pyrethroid Insecticides and Sediment Toxicity in Urban Streams of the Northeast United States

Kara E. Huff Hartz, Samuel A. Natile, Courtney Y. Fung, Federico L. Sinche, Patrick W. Moran, Peter C. Van Metre, Lisa H. Nowell, Michael J. Lydy. Submitted to Environmental Pollution, in review.

3. Challenges in connecting contaminant exposure with toxic effects in sediment quality assessments: Case study of bioaccessible pyrethroid concentrations and invertebrate bioassays

Kara E. Huff Hartz, Samuel A. Natile, Amanda D. Harwood, Patrick W. Moran, Peter C. Van Metre, Lisa H. Nowell, Michael J. Lydy. Environmental Toxicology and Chemistry, in preparation.

4. Lydy, M.J. and K. Huff Hartz. 2019. Application of a bioaccessibility-based method for pyrethroid insecticides: A case study. UCOWR/NIWR Annual Water Resources Conference. Snowbird, UT, June 11-13.

5. Lydy, M.J. and K. Huff Hartz. 2019. Does the use of a sediment holding time bias laboratory bioassay results? UCOWR/NIWR Annual Water Resources Conference. Snowbird, UT, June 11-13.

6. Featured NIWR Research, Illinois Water Resources Center 2019. <https://iwrc.illinois.edu/featured-research/>

7. Lydy, M.J., C.Y. Fung, D.P. Weston, K.M. Major, and H.C. Poynton H.C. 2018. The contribution of detoxification pathways to pyrethroid resistance in *Hyalella azteca*. National SETAC, Sacramento, CA, November, 4-8.

8. Major, K.M., A. Grove, D.P. Weston, M.J. Lydy, C. Higbee, J. Joyner-Matos, and H.C. Poynton. 2018. Overview and mechanisms of resistance in the freshwater crustacean, *Hyalella azteca*. National SETAC, Sacramento, CA. November, 4-8.

9. Lydy, M.J. University of Illinois, Urbana- Champaign. IL Sustainable Technology Center. Are pyrethroid insecticides a threat to aquatic non-target species? March 2, 2017.

10. Derby, A., K. H. Sever, J. Heim, and M.J. Lydy. 2017. Are provisional species of *Hyalella azteca* capable of producing viable offspring and are the resulting offspring less able to handle environmental challenges? Undergraduate Creative Activities and Research Forum, Carbondale IL, April 3.

11. Sever, H, J.R. Heim, A. Derby, K. Major, H. Poynton and M.J. Lydy. 2017. Assessing dominance of pyrethroid insecticide resistance in *Hyalella azteca* by crossbreeding homozygous resistant (L925I) and non-resistant (wild-type) populations. Creative Activities and Research Forum, Carbondale IL, April 3.

12. Fung, C., J. Heim and M.J. Lydy. 2017. The contribution of detoxification pathways to pyrethroid resistance in *Hyalella azteca*. Ozark Prairie SETAC, Columbia, MO, May 22-23.

13. Sever, H, J.R. Heim, A. Derby, K. Major, H. Poynton and M.J. Lydy. 2017. Assessing dominance of pyrethroid insecticide resistance in *Hyalella azteca* by crossbreeding homozygous resistant (L925I) and non-resistant (wild-type) populations. Ozark Prairie SETAC, Columbia, MO, May 22-23.

14. Feature article in UpClose Illinois Water Resources Center extension office.

15. Sustainable phytoremediation of Cr (VI) contaminated soil and tetrachloroethylene (PCE)/trichloroethylene (TCE) contaminated groundwater from a Superfund site using sunflower (*Helianthus annuus* L.). Md Hadiuzzaman,

Department of Civil and Environmental Engineering, SIU, Carbondale.

16. Md Hadiuzzaman, Jia Liu, Michael Coffey, Chuck Beasley (2018). Remediation of Cr(VI)-contaminated soil from a superfund site using sunflower *Helianthus annuus* L. Society of Environmental Toxicology and Chemistry (SETAC) North America 39th Annual Meeting. Sacramento, CA, USA. Nov. 4-8.
17. Md Hadiuzzaman, Jia Liu (2018). Biosolids as an alternative to conventional chemical fertilizers for sunflower (*Helianthus annuus* L.) in phytoremediation of Cr(VI)-contaminated soil from a superfund site. Materials Technology Center Poster Session, Southern Illinois University Carbondale, IL. Dec. 3.
18. Md Hadiuzzaman, Jia Liu (2019). Remediation of trichloroethylene (TCE) and tetrachloroethylene (PCE) contaminated groundwater from a Superfund site using sunflower *Helianthus annuus* L. Exhibition on Goal 6: Clean Water and Sanitation, UN Sustainable Development Goals Event, Southern Illinois University Carbondale, IL. Feb. 28, 2019.
19. A review on drone-based harmful algae blooms monitoring
Wu, D., Li, R., Zhang, F. et al. *Environmental Monitoring and Assessment* (2019) 191: 211.
<https://doi.org/10.1007/s10661-019-7365-8>
20. Drone-based Water Quality Monitoring for Harmful Algal Blooms. Dr. Ruopu Li. Invited talk for the local community under Southern Illinois Volunteer Lake Monitoring Program on Apr 19, 2019 in Marion, IL.
21. Izadmehr, M. and K. J. Rockne (2018). Pocket Wetlands for Nutrient Removal in Tile-Drained Agriculture. World Environmental and Water Resources Congress 2018: Watershed Management, Irrigation and Drainage, and Water Resources Planning and Management. Sri Kamojjala, Ed., pp 404-414. <https://doi.org/10.1061/9780784481400.038>.
22. Buckley, D., M. Izadmehr, J. Kostel, and K. J. Rockne (2016). Constructed Wetlands to Reduce Nutrients from Runoff in Croplands: The Implications for Urban Stormwater. *Stormwater* 17(7):4.
23. Izadmehr, M. and K. Rockne (2019). Identifying Factors Influencing Tile Drainage Nutrient Removal Efficiency in Constructed Wetlands. American Society of Civil Engineers Environmental and Water Research Institute (ASCE-EWRI) 2019 World Environmental & Water Resources Congress. Pittsburgh, PA. May 19-23, 2019.
24. Izadmehr, M. and K. Rockne (2019). Impact of Drought Conditions on Nutrient Removal, Sediment Organic Matter, and Microbial communities in a Treatment Wetland. Association of Environmental Engineering & Science Professors (AEESP). Tempe, Arizona. May 14-16, 2019.
25. Izadmehr, M. and K. Rockne (2018). Impact of Drought Conditions on Nutrient Removal, Sediment Organic Matter, and Flow Hydraulics in a treatment Wetland. American Geophysical Union Academic & Science (AGU). Washington, D.C. Dec 10-14, 2018.
26. Izadmehr, M. and K. Rockne (2018). Annual Changes in the Sediment Microbiome Structure During Development of a Constructed Wetland. American Society for Microbiology (ASM) Microbe 2018. Atlanta, GA. June 8, 2018.
27. Izadmehr, M. and K. Rockne (2018). Pocket Wetlands for Nutrient Removal in Tile-Drained Agriculture. American Society of Civil Engineers Environmental and Water Research Institute (ASCE-EWRI) 2018 World Environmental & Water Resources Congress. Minneapolis, MN. June 3-7, 2018. Paper awarded first place in the graduate student paper competition.
28. Izadmehr, M. and K. Rockne (2018). Nutrient Removal Efficiency in An Engineered Wetland. Christopher B. and Susan S. Burke Civil Engineering Graduate Poster Competition, UIC. Chicago, IL. April 2018. Poster awarded 3rd place in the competition.
29. Rockne, K. J. and J. Kostel (2017). Treatment Wetlands for Meeting the Illinois Nutrient Reduction Strategy Goals, Illinois Nutrient Research and Education Council, Northern Illinois Public Forum, Princeton, IL, June 27, 2017.

30. Rockne, K. J. M. Izadmehr, J. Kostel (2017). Treatment Wetlands: A Key Technology for Meeting the Illinois Nutrient Reduction Strategy Goals, Invited Speaker: Society of American Military Engineers (SAME), US Army Corps of Engineers Chicago District, Chicago, IL, January 18, 2017.

31. Izadmehr, M., K. J. Rockne, J. Kostel and G. Johnson (2017). Sediment Microbiome Dynamics in a Nutrient Treatment Wetland Sediment, the Battelle Contaminated Sediment Conference, New Orleans, LA, January 15, 2017.

32. Izadmehr, M., K. J. Rockne, J. Kostel and Buckley, D. (2016). Constructed Wetlands to Reduce Nutrients from Runoff in Croplands: The Implications for Urban Stormwater, the StormCon Conference, Indianapolis, IN, August 23, 2016.

33. Izadmehr, M. and K. Rockne (2016). Demonstrating and Monitoring Nutrient Removal in a Constructed Wetland. Illinois Water Conference. Urbana, IL. October 27, 2016.

34. Parker, Allison. Social and ecological risk factors for mosquito production in residential neighborhoods. Deposited June 2019. Department of Entomology, University of Illinois at Urbana-Champaign.

35. A Special Issue in the journal Groundwater is in preparation and includes many of the experts that gathered for the IWRC-hosted Groundwater and Geothermal Seminar Series.

Information Transfer Program

1. IWRC hosted a Groundwater and Geothermal Resources Seminar Series. This free event was open to the public and was held in Urbana, IL, on November 2, 2018.

2. "Featured Research" section added to the IWRC website providing an overview of current IWRC funded research (January 2019 – present).

3. IWRC's Facebook renovation (September 2018 – present). During this reporting period:

- a. IWRC has more than 300 followers from 20 countries
- b. The 104G announcement was the most clicked post.
- c. Immediately following each post, activity on the page increased.

4. IWRC hosted a tour of their Center as well as the UIUC ACES Energy Farm for a group of educators from Taiwan as part of an academic enrichment program that specializes in preparing students in Asia for studies in the US.

5. IWRC provided monetary sponsorship to the 2019 Emerging Contaminants in the Environment Conference in the amount of \$1,500 to assist with keynote speakers' and panelists' travel and lodging. The Conference took place in Champaign, IL on May 21-22, 2019.

6. IWRC monetarily sponsored the Illinois Center for Urban Resilience and Environmental Sustainability (CURES) Planning Workshop that took place in Champaign, IL on August 20-21, 2018. IWRC supported a special dinner for the speakers at the workshop.

7. Yu-Feng Lin, IWRC Director visited Southern Illinois University, Carbondale to promote IWRC's mission and to visit IWRC funded PIs.

8. For more information on any of the above, see the IWRC website (iwrc.illinois.edu) which has recently undergone a renovation (November 2018 – present).

Student Support

Category 104B 104G Internship Supplemental Total

funding funding Awards

Undergraduate 13 3 0 0 16

Masters 7 0 0 0 7

Ph.D. 2 4 0 0 6
Post-doctoral 0 0 0 0 0
Total 22 7 0 0 29

1. Anjali Bakliwal, University of Illinois at Urbana-Champaign, undergraduate hourly Designer/Webmaster, 11/5/18 - 5/11/19

- o Designed the flyer that was circulated across campus and promoted on the IWRC website for the Groundwater and Geothermal Resources Seminar Series.
- o Worked to transfer the IWRC website from a “.org” site to an “illinois.edu” site to recognize the university that houses our center.
- o Renovated the look of IWRC’s website and updated the content.

2. Omolola Badmus, Southern Illinois University Edwardsville, master’s research on Impacts of Climate Change on Streamflow and Water Quality in the Cahokia Creek Watershed, Madison County, Illinois – 104B funds used to support her attendance at the ArcSWAT Workshop held at Auburn University, Alabama, February 5-6, 2019.

3. Sam Nutile, Southern Illinois University, Ph.D, December 2016 (2015IL298G) served as lab lead for the bioassays and Tenax extractions during the NESQA lab work. Dr. Nutile also assisted with the development of the NESQA experimental plan, conducted preliminary analyses during the method validation phase, trained researchers in the lab methods, and was responsible for maintaining the NESQA bioassay data. In addition, Dr. Nutile helped plan and conduct the focused toxicity identification evaluations (fTIEs). Dr. Nutile assisted with manuscript preparation for the holding time project and NESQA project (survey article and model development article). Dr. Nutile is currently an assistant professor of biology at Penn State Behrend (Erie, PA).

4. Federico Sinche Chele, Southern Illinois University, Ph.D., May 2018 (2015IL298G) served as lab lead for the Tenax extractions the holding time study. Dr. Sinche helped conduct all Tenax extractions and sample preparation for analysis, assisted in the analysis of the chromatography data, assisted with the bioassays for the NESQA and the holding time projects, and assisted with manuscript preparation for the holding time project. Dr. Sinche is currently an adjunct assistant professor at Universidad Estatal Amazónica, (Lago Agrio, Sucumbios, Ecuador).

5. Courtney Fung, Southern Illinois University, M.S., August 2018 (2015IL298G) served as lab lead for the focused toxicity identification evaluations of the NESQA sediments and for the bioassays during the holding time study. Ms. Fung conducted these analyses, trained other researchers in techniques, and was responsible for maintaining the fTIE and holding bioassay data. During the pyrethroid-resistance in field-collected Hyalella project, Ms. Fung trained researchers in sample preparation procedures for the single-point toxicity tests and identified the field invertebrates. Ms. Fung assisted with manuscript preparation for the holding time project and NESQA project (survey article). Ms. Fung is currently an environmental quality analyst at the Michigan Department of Environmental Quality (Lansing, MI).

6. Corie Fulton, Southern Illinois University, M.S., December 2018 (2015IL298G) assisted with the lab experiments for the NESQA, holding time, and pyrethroid-resistance in field-collected Hyalella project, and assisted with maintenance of the analytical instruments used in all projects. Ms. Fulton is currently a researcher I in the Environmental Toxicology Lab at Southern Illinois University (Carbondale, IL).

7. Andrew Derby, Southern Illinois University, B.S., May 2018 (2015IL298G) was responsible for culturing the *H. azteca* for the NESQA bioassays and assisted with the lab experiments conducted for the NESQA project and holding time studies. For the pyrethroid-resistance in field-collected Hyalella project, Mr. Derby conducted the single-point toxicity bioassays, prepared the analytical samples for analysis and analyzed the chromatography data. Mr. Derby continues his education as a Master’s student in Zoology in the Environmental Toxicology Lab at Southern Illinois University (Carbondale, IL).

8. Haleigh Sever, Southern Illinois University, B.S., May 2018 (2015IL298G) collected the field amphipod and sediment samples for the pyrethroid-resistance field-collected Hyalella project, and helped conduct the bioassays. Ms. Sever assisted with culturing efforts of *H. azteca* for the NESQA bioassays and assisted with the lab experiments during the NESQA and holding time projects. Ms. Sever is currently a fisheries observer at A.I.S. Inc. (stationed out of Juneau, AK).

9. Tristin Miller, Southern Illinois University, B.S., expected May 2021 (2015IL298G) assisted in the maintenance the cultures during the holding time study and the pyrethroid-resistance field-collected *Hyalella* project, and assisted with the bioassays and sample preparation for the field resistant *Hyalella* project. Mr. Miller continues his education as an undergraduate researcher in the Environmental Toxicology Lab at Southern Illinois University (Carbondale, IL).
10. Luis Prado, Southern Illinois University, an undergraduate student, is currently working on 2018IL340B. This project supports his 2019 Summer Research Institute project under the McNair Scholars Program at SIUC.
11. Di Wu, Southern Illinois University, a Ph.D. student, is responsible for setting up, calibrating and validating the remote sensing inversion model (2018IL340B).
12. David Leifer, Southern Illinois University, master's student, pilots the UAS and conduct image post-processing tasks (2018IL340B).
13. Chunjie Xia, Southern Illinois University, graduate assistant, conducts water sample collection and analysis of water quality indicators (2018IL340B).
14. Md Hadiuzzaman, Southern Illinois University, master's student, is responsible for sample collection and analysis, plant cultivation, effluent analysis, and biodiesel extraction (2018IL341B).
15. Chunjie Xia, Southern Illinois University, master's student, is in charge of the biodiesel characterization (2018IL341B).
16. Marissa Campobasso, Southern Illinois University, undergraduate participates in lake water and biosolids collection (2018IL341B).
17. Hyungsuk Kim, University of Illinois at Urbana-Champaign, Ph.D. student, conducts the study under Dr. Guan's supervision (2018IL339B).
18. Stephen C. Tillman, University of Illinois at Urbana-Champaign, master's student, conducts the study under Dr. Matthews' supervision (2017IL331B).
19. Undergraduate student assistant, University of Illinois at Urbana-Champaign, collects and processes the data (2017IL331B).
20. Mahsa Izadmehr, a Ph.D student, Department of Civil and Materials Engineering, University of Illinois at Chicago (2017IL330B).
21. Laura Burns, undergraduate student, School of Integrative Biology (SIB) University of Illinois at Urbana-Champaign (2018IL338B).
22. Geraldine Dagher, undergraduate student, Human Development and Family Studies, University of Illinois at Urbana-Champaign (2018IL338B).
23. Claire Durst, undergraduate student, SIB, University of Illinois at Urbana-Champaign (2018IL338B).
24. Leah Edwards-Blinderman, undergraduate student, SIB, University of Illinois at Urbana-Champaign (2018IL338B).
25. Da Teng Lin, undergraduate student, SIB, University of Illinois at Urbana-Champaign (2018IL338B).
26. William Marshall, undergraduate student, Cellular and Molecular Biology, University of Illinois at Urbana-Champaign (2018IL338B).
27. Kelsey McGill, undergraduate student, SIB, University of Illinois at Urbana-Champaign (2018IL338B).

28. Manuel Perez, undergraduate student, SIB, University of Illinois at Urbana-Champaign (2018IL338B).

29. Maria Velasco Delgado, undergraduate student, Natural Resources and Environmental Science, University of Illinois at Urbana-Champaign (2018IL338B).

Notable Achievements and Awards

1. Dr. Ashlynn Stillwell received the UCOWR Early Career Award for Applied Research for 2019.

2. Dr. Christopher Chini was the First Place recipient of the UCOWR 2019 Ph.D. Dissertation Award in the category of Water Policy and SocioEconomics.

3. Dr. David Waterman's dissertation was nominated for the UCOWR Ph.D. Dissertation Award in Natural Science and Engineering, but was not selected.

4. Dr. Michael Lydy University Level Scholar Excellence Award, 2017.

5. Sam Nutile Morris Doctoral Fellowship, 2016.

6. Andrew Derby REACH Award for undergraduate research, April 2017.

7. Andrew Derby Master's Fellowship Award 2018-2019.

8. Tristin Miller REACH Award for undergraduate research, April 2019.

9. Luis Prado REACH Award for undergraduate research, April 2019.

10. Federico Sinche Dissertation Research Assistantship 2016-2017.

11. Corie Fulton SETAC/EA Engineering Jeff Black Award for top master's student for the society.

12. Courtney Fung Master's Fellowship Award 2016 and 2017-2018.

13. Allison Parker received the William H. Luckman Award for Research in Applied Entomology (\$1,000) for travel expenses to the 2018 ESA, ESC, and ESBC Joint Annual Meeting where she presented the findings of this work, entitled "Socio-ecological perspectives on mosquito ecology in residential neighborhoods," in Vancouver, BC.

14. Allison Parker received the University of Illinois Graduate College Dissertation Completion Fellowship (\$20,000) based on the productivity of this research.

Projects

An experimental evaluation of the contribution of rain barrels to mosquito production

Project Type: Annual Base Grant **Project ID:** 2018IL338B

Project Impact: Objectives: - To better understand how competition between mosquito larvae within artificial containers found in residential areas, including rain barrels, affects juvenile survival and adult life history traits. Findings: - Surveys of container type and juvenile mosquito presence was recorded weekly for ten weeks on 83 residential properties in the cities of Champaign and Urbana, Champaign County, IL. - Large containers (holding ~100L of water) had the greatest abundance of mosquitoes. - *Aedes albopictus*, a Zika, dengue and chikungunya virus vector, was found in all container types. - *Culex restuans* and *Cx. pipiens*, both vectors of West Nile virus (WNV), were mostly found in large containers. - Species composition within the container habitats shifted over the course of the mosquito season. - For *Culex* species, the greatest number of egg rafts were laid in the garbage can. More egg rafts were laid in flower pots compared to saucers. When the garbage can was removed, the total number of egg rafts decreased compared to sites where the garbage can remained for the duration of the study. - For *Aedes* spp., the least number of eggs were laid in the saucers compared to the flower pots and garbage cans. There was no difference in the number of eggs laid before or after removal of the garbage can. At sites where the garbage can was removed, the number of eggs laid in the flower pots increased. Publications: 2 are being drafted for submission to EcoHealth and the Journal of Medical Entomology.

Characterization of harmful algal blooms using small unmanned aircraft systems and watershed analysis in southern Illinois

Project Type: Annual Base Grant **Project ID:** 2018IL340B

Project Impact: Objectives: - To develop an Unmanned Aircraft System (drone)-based Harmful Algae Bloom (HAB) monitoring model. - To understand the watershed characteristics that contribute to HAB outbreaks in Southern Illinois. Findings: - Both drone images and water samples were collected for each water sample location in the Carbondale Reservoir and the SIUC Campus Lake. In the early summer (June 2019), we were not able to identify any algae from the Carbondale Reservoir due to very wet weather. In July, we identified both regular and toxic algae using water sampling from SIUC Campus Lake. We are in the process of analyzing the statistical relationship between the spectral values of images and water quality indicators. Publications: <https://link.springer.com/article/10.1007%2Fs10661-019-7365-8>

Comprehensive multi-measurements of groundwater and surface water interaction survey in Sangamon River

Project Type: Annual Base Grant **Project ID:** 2018IL342B

Project Impact: Objectives: To investigate groundwater and surface water (GWSW) interaction of the streambed in Upper Sangamon River in Central Illinois, multiple measurements of GWSW interaction, including fiber optic distributed temperature sensors (FO-DTS), vertical temperature gradient measurement (VTG), and electrical resistivity tomography (ERT), were carried out in the Sangamon River study site to monitor spatial and temporal temperature variations within the groundwater and surface water interaction zone, deduce the groundwater vertical temperature gradient and flux at the subsurface of riverbed, and predict the potential groundwater movement channel, separately. Findings: The survey results of Sangamon River site showed that the FO-DTS method was able to identify and locate the potential GWSW interaction zone by characterizing the temperature regime of the streambed. The VTG was capable of confirming groundwater vertical flux inside the interaction zone. And the ERT method verified the GWSW interaction in the streambed according to the groundwater flow channel predication.

Evaluating the ability of wetland mitigation banks in the Chicago region to replace native plant species lost to impacts to natural wetlands

Project Type: Annual Base Grant **Project ID:** 2017IL331B

Project Impact: Objectives: - Evaluate the ability of wetland mitigation banks to replace plant species that are lost when permitted impacts via developments occur to natural wetlands and aquatic resources. - Determine how specific changes to mitigation policies affect the replacement of impacted species by banks to generate recommendations for changes to wetland mitigation policy that will improve compensation for lost aquatic resources by wetland mitigation banks. Findings: - Of the native plant species affected by permitted impacts (developments), fewer than half are replaced in wetland mitigation banks. - Suggests that policies requiring greater equivalence between the wetland habitat types produced in banks and those present in impacted natural wetlands prioritize the replacement of the specific wetland resources lost.

Groundwater phytoremediation and biofuels production for Crab Orchard National Wildlife Refuge

Project Type: Annual Base Grant **Project ID:** 2018IL341B

Project Impact: Objectives: - To produce biofuels from the contaminated soil and groundwater at the Crab Orchard National Wildlife Refuge to recover groundwater resources. - To test concentrations of contaminants in soil and groundwater samples from the Refuge. - To cultivate sunflowers using either conventional fertilizer or biosolids, with either deionized water irrigation or Crab Orchard Lake water irrigation. - To obtain biodiesel from the sunflower seeds, and to characterize the biodiesel product. - To monitor the change in contaminant concentrations in effluents with time. Findings: - Low concentration of Cr (VI) can be remediated using *H. annuus* L. which was identified as a hyperaccumulator. - Grade A biosolids are applicable as a soil amendment for providing nutrients to the plants, and biosolids were found to be better than low nitrogen fertilizer in terms of plant growth. - PCE/TCE were fully removed from the contaminated soil matrix, which might be possibly due to plant uptake, degradation, plant volatilization or soil volatilization. - Increased microbial biomass after phytoremediation indicates that the activity of rhizosphere microorganisms was improved which could help the remediation process. - The very low concentration of Cr (VI) in the obtained biodiesel makes it a potential source of renewable fuel.

Identifying nitrogen removal limitations in constructed wetlands treating agricultural tile drainage

Project Type: Annual Base Grant **Project ID:** 2017IL330B

Project Impact: Objectives: - To explain the lack of denitrification in treatment wetlands. - To develop strategies to reduce nutrient loading to help the state of Illinois achieve its nutrient reduction targets of 20% by 2020, and 45% by 2040 to combat the Gulf of Mexico hypoxia problem. Findings: - Denitrification-mediated nitrogen (N) removal has occurred at a limited rate in constructed wetland 1 (CW1) located in Bureau County, Illinois. - Sediment organic matter (OM) concentrations increased greatly within CW1 from nearest the inlet and decreasing to the wetland outlet during 2016 and 2017, while nitrate decreased from the inlet to the outlet at the same locations. - The outlet half of the wetland consistently had higher concentrations and more labile OM with a higher abundance of known denitrifying bacteria that resulted in higher removal efficiency as captured tile drainage moved through the wetland towards the outlet. Publications: <https://ascelibrary.org/doi/10.1061/9780784481400.038>

Modeling Effects of Thermo-geology on Boreholes and on the Shallow Geothermal Gradient using Distributed Temperature Sensing in Rantoul, Illinois

Project Type: Annual Base Grant **Project ID:** 2018IL342B

Project Impact: Using fiber-optic distributed temperature sensing (FO-DTS) to study a geothermal exchange system requires great precision. The ease of use and capability to determine the temperature of different media (water, air, soil, etc.) at higher temporal and spatial resolutions compared with other technologies allows for its use in a range of applications and environments. In this study, FO-DTS was conducted in two adjacent boreholes: 1) a cased groundwater monitoring 40-m deep and 2) a grouted, uncased borehole extending 100 m below ground. The fiber optic cable was installed vertically in both boreholes, attached to the PVC pipe in the cased borehole and sealed against the sidewall with bentonite grout in the other. Thermal profiles were measured over a 2-year period from 2015–2017. Following the data collection, heat transfer in the subsurface around both boreholes under both saturated

and unsaturated conditions were numerically evaluated. According to previous studies in Central Illinois, the transient water table in the surficial zone fluctuates within the upper 10 to ~15 m. The temperatures measured in this zone are susceptible to seasonal fluctuations in climate conditions at the ground surface. Below this zone, temperatures are mainly controlled by the local geothermal gradient. In this research, we will show how heterogeneities in the thermo-geology and well construction materials impact the natural geothermal gradient in the shallow subsurface.

Redefine Droughts in the U.S. Corn Belt: Stomatal conductance constraints attributable to atmospheric demand and/or soil water supply

Project Type: Annual Base Grant **Project ID:** 2018IL339B

Project Impact: Hypothesis: The dominant contribution to variability in crop stomatal regulation (decrease in G_s) during droughts in the US Midwest agroecosystems is mostly due to dry air (high VPD) rather than dry soil (low SWC). Implications: This study improves our understanding of the mechanisms of crop response to drought for the US Midwest agroecosystems. The outcomes of this study can improve the modeling capability of crop stress under drought conditions. The study also provides information to crop breeders on what specific traits should be enhanced to obtain drought-tolerant genotypes. Data: Meteorology data and exchange rate of CO_2 and H_2O at the atmosphere and plant canopy landscape interface from Eddy-covariance network sites (<http://ameriflux.lbl.gov/>). Methods: Relationships among VPD, SWC, and G_s are evaluated hourly, daily, and weekly time intervals and fitted a multiple linear regression model and a non-linear model. To attribute the variability in G_s to VPD and SWC, numerically calculated partial derivatives and ANOVA-derived partial contributions are obtained. PATH analysis is conducted to understand the underlying processes. Preliminary Results: VPD and SWC are highly correlated at longer timescale, so to decouple their contributions, the data are analyzed at a daily timescale. Based on the current results, we find that dry air (high VPD) is found to have a higher impact on stomatal conductance (G_s) variability compared to dry soil (low SWC), which supports our hypothesis. Further study is ongoing to understand the specific underlying processes.

TRT and DTRT in Energy Farm borehole site

Project Type: Annual Base Grant **Project ID:** 2018IL342B

Project Impact: Objectives: To evaluate the thermal properties of geologic materials in the subsurface, which is critical for designing shallow borehole heat exchange (BHE) and optimizing ground source heat pumps systems to reduce their installation costs. Findings: In the 97.5 m deep borehole at Energy Farm of University of Illinois at Urbana-Champaign, a thermal response test (TRT) and a distributed thermal response test (DTRT) were carried out to analyze the homogeneous thermal properties and heterogeneous thermal properties, separately. DTRT is a hybrid method coupling a conventional TRT and fiber-optic distributed temperature sensing (FO-DTS) which allows for an analysis of thermal properties along the subsurface layer by layer. According to the 3-D multiphysical model simulation, the DTRT will improve the spatial resolution of thermal properties predication as compared to TRT, which assumes the subsurface as a homogeneous solid. In on-going work, both ground thermal regimes will be analyzed during DTRT to compare how the thermal properties vary with different testing phases and scenarios to evaluate the working efficacy balance of the ground source heat pump.

Using bioavailability to assess pyrethroid insecticide toxicity in urban sediment

Project Type: National Competitive Grant **Project ID:** 2015IL298G

Project Impact: 1. Pyrethroid insecticides were detected in 76% of the total, and 67% of the bioaccessible sites ($n=49$). 2. Total average sum of pyrethroids was 259 ng/g organic carbon and 43.9 ng/g of bioaccessible pyrethroids. 3. Bifenthrin was the most commonly detected pyrethroid. 4. Only 28% and 15% of sediments caused a decrease in *H. Azteca* biomass and survival. 5. Using a temperature-based focused toxicity identification evaluation, confirmed that pyrethroids were a causal factor in the toxicity of 10 of the 12 sediments tested. 6. Prevalence of bioaccessible and total pyrethroids detected in urban streambed sediments indicating that more cost-effective Tenax extraction methods can be used to survey pyrethroids. 7. While a significant relationship existed between Tenax concentrations and toxicity, this relationship was complicated by several factors, including the paucity of toxicological parameters, uncertainties in standard bioassays, and additional contaminants present in sediment, which all point to the need for

additional bioavailability-based studies. 8. Pyrethroid-resistant *H. azteca* were not found, however, other amphipods present in the pyrethroid-contaminated urban stream were more tolerant to permethrin exposure than non-resistant *H. azteca*. 9. Bioaccessible and bioaccumulated polychlorinated biphenyl (PCB) concentrations did not change significantly during the holding time, however, the bioaccessible pyrethroid concentrations were more varied, suggesting that holding time of the sediments prior to bioassay can potentially bias the bioassay tests. 10. <https://www.sciencedirect.com/science/article/pii/S0269749118318414>