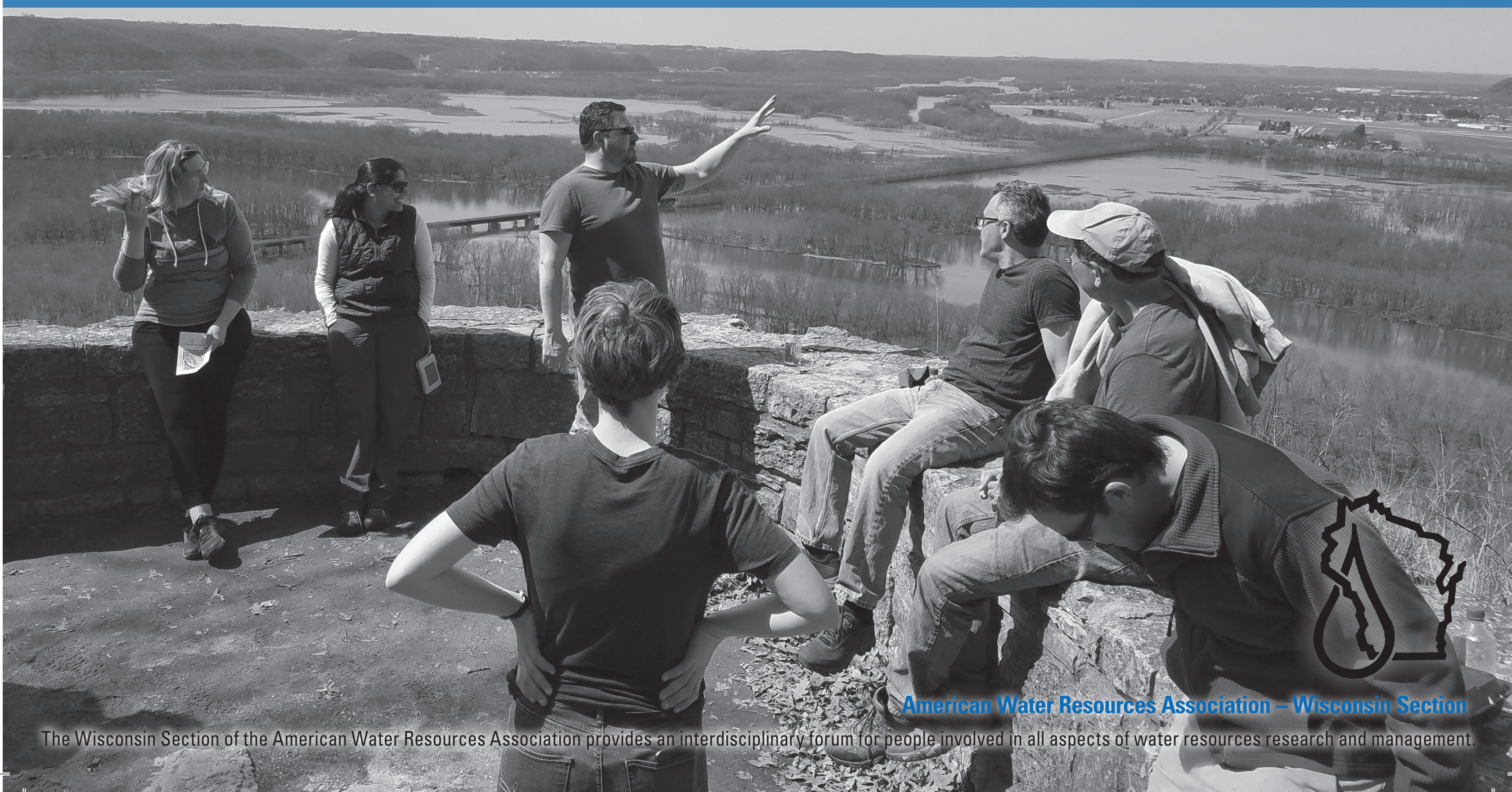
FEBRUARY 28 & MARCH 1, 2019 | LAKE LAWN RESORT | DELAVAN, WISCONSIN

American Water Resources Association – Wisconsin Section

43rd Annual Meeting Program & Abstracts

CLEARING THE WATERS:
EFFECTIVE SCIENCE AND COMMUNICATION



American Water Resources Association – Wisconsin Section

The Wisconsin Section of the American Water Resources Association provides an interdisciplinary forum for people involved in all aspects of water resources research and management.

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AMERICAN WATER RESOURCES ASSOCIATION - WISCONSIN SECTION

43rd ANNUAL MEETING

Clearing the Waters:

Effective Science and Communication

February 28 and March 1, 2019
Lake Lawn Resort
Delavan, Wisconsin

Support From:

University of Wisconsin Water Resources Institute
Wisconsin Department of Natural Resources
Center for Watershed Science and Education, UW-Stevens Point
Wisconsin Geological and Natural History Survey
U.S. Geological Survey Upper Midwest Water Science Center

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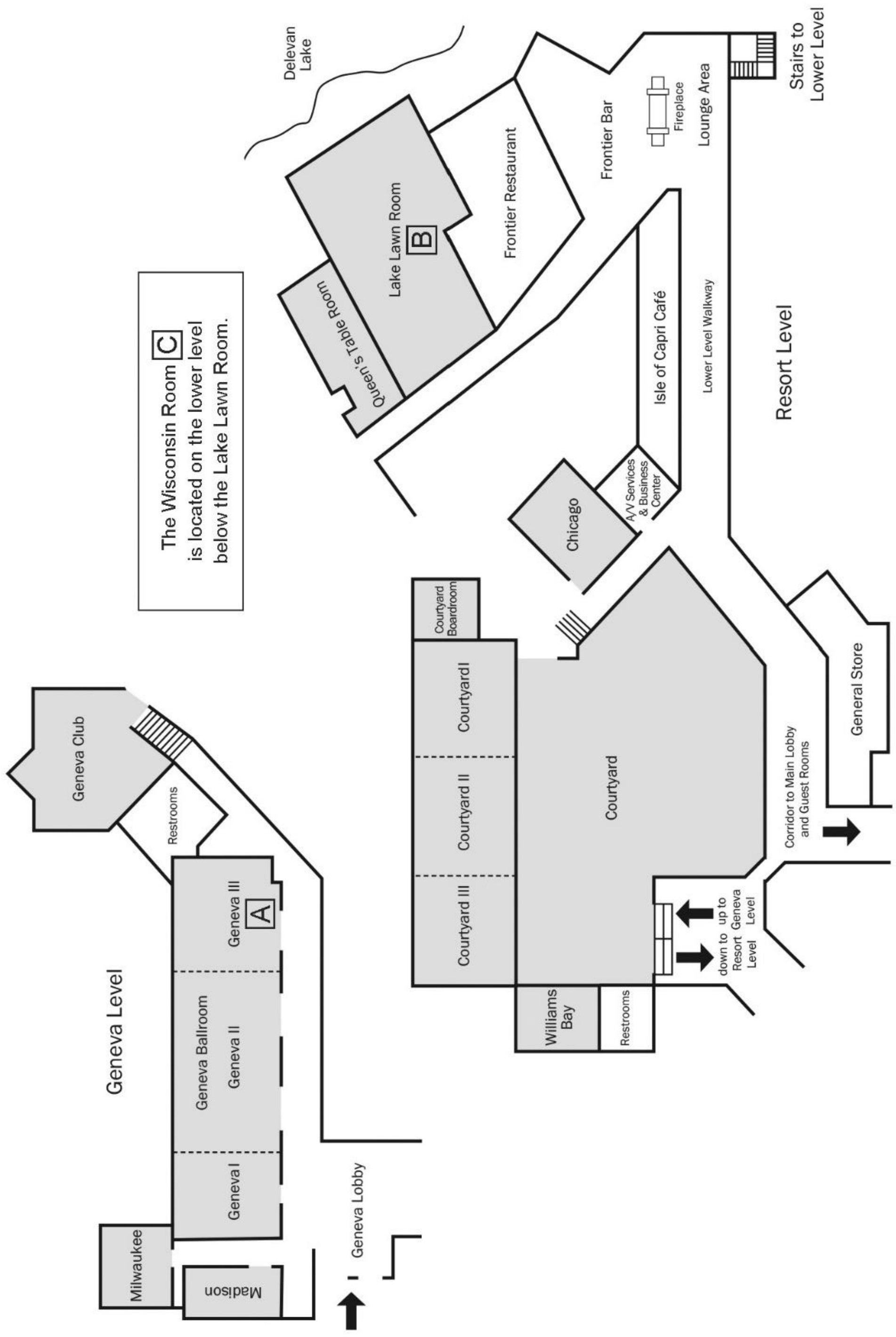

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The Wisconsin Section of the American Water Resources Association provides an interdisciplinary forum for people involved in all aspects of water resources research and management. The success of the section is due in part to the dedication of past and current members of our board of directors. We heartily acknowledge the following individuals for their service, and we invite others to consider volunteering to ensure an ongoing dialogue among those committed to water resources research and management in the state of Wisconsin.

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AWRA BOARD OF DIRECTORS POSITION DUTIES

President (1-year term)

Shall preside at meetings, shall, in consultation with the Board of Directors, appoint all committees, and shall perform all other duties incident to the office. The President shall prepare, in collaboration with the Secretary and Treasurer, an annual report of the Section's activities to be presented to the annual meeting of the Section and to be forwarded by the Secretary to the President of the American Water Resources Association.

President-Elect (1-year term)

Shall perform the duties of the President when the latter is absent and shall succeed to the office of President in the following year. Historically has helped to recruit plenary and keynote speakers, has helped coordinate the nomination and election of officers, and performed other responsibilities related to the annual conference.

Vice President (1-year term)

Shall perform the duties of the President-Elect when the latter is absent. Some of the duties that the vice-president has helped with in the past include recruiting moderators for the general sessions, assisting with the technical program review, and performing other miscellaneous duties as assigned.

Secretary (2-year term, elected in odd years)

Shall keep the minutes of the Section's meetings, shall issue notices of meetings, and shall perform all other duties incident to the office.

Treasurer (2-year term, elected in even years)

Shall be responsible for all funds of the Section and the dues of the American Water Resources Association as agreed to between the Board of Directors and the American Water Resources Association. The Treasurer's accounts shall be audited at the close of each year as directed by the President. The Treasurer shall prepare an annual report and financial statement for presentation at the annual meeting.

Director-at-Large (2 positions, 2-year term, staggered appointments)

Shall serve on the Board of Directors to help manage the affairs of the Section including administration, program development and supervision of financial affairs.

BIOGRAPHIES OF CANDIDATES FOR THE AWRA WISCONSIN SECTION BOARD

Director-at-Large

James Drought

James F. Drought, P.H., District Manager and Principal Hydrogeologist at GZA GeoEnvironmental, Inc., has 30 years of professional consulting experience in the evaluation, protection, and management of surface water, groundwater, and natural resources. Mr. Drought received a Master of Science Degree in Hydrogeology from the University of Wisconsin-Milwaukee, and a Bachelor of Science Degree in Physical Geography and Biology from Carroll College in Waukesha, Wisconsin. Mr. Drought teaches Environmental Engineering as an Associate Faculty Member in the Civil Engineering Department at the Milwaukee School of Engineering (MSOE), and has taught Physical Hydrogeology as an Associate Faculty Member in the Department of Geosciences at the University of Wisconsin – Milwaukee. Mr. Drought is a Professional Hydrologist and a member and of National Ground Water Association, Wisconsin Ground Water Association, and Federation of Environmental Technologists.

Megan Haserodt

Megan Haserodt has been a hydrologist at the USGS Upper Midwest Water Science Center since 2016. Her work focuses on operating stream gages in southwest Wisconsin and groundwater modeling studies. She has a Bachelor's Degree in Chemistry and Geology from Hope College in Holland, MI and a Master's Degree in Hydrogeology from UW-Madison. Prior work experience includes time in the non-profit sector studying salmon habitat in Alaska and in the private sector as an environmental consultant working on mine permitting projects in Minnesota. Megan joined the Wisconsin chapter of AWRA as a graduate student. She appreciates that the AWRA annual meeting provides a chance to interface with other Wisconsin water professionals and learn about the exciting water research happening in this state.

Secretary

Brent Brown

Brent Brown is a registered Professional Engineer for Jacobs Engineering Group (formerly CH2M) in their Milwaukee office. Mr. Brown practices water resources engineering and works on projects involving ecosystem protection and restoration, habitat and fluvial geomorphic assessments, watershed and storm water management, low-impact development stormwater controls, sediment dredging and dewatering and airport deicing fluid control. Mr. Brown has a Bachelor's Degree from the University of Wisconsin Platteville in Civil/Environmental Engineering and a Master's Degree from the University of Illinois at Urbana-Champaign in Environmental Engineering. Mr. Brown has been employed with Jacobs for 18 years.

Vice President

Mitch Olds

Mitch received his Bachelor's Degree in Watershed Management and Hydrogeology from the University of Wisconsin-Stevens Point in 2012. While attending UWSP, Mitch was an active member of the student chapter of AWRA serving as Treasurer (2009-2010) and chapter president (2010-2012). Mitch is employed at the Milwaukee Metropolitan Sewerage District (MMSD) where he is involved in water quality monitoring in southeastern Wisconsin and is the captain of R/V Pelagos on Lake Michigan. Mitch is continuing his education by pursuing a Master's Degree in Freshwater Sciences and Technology at the University of Wisconsin-Milwaukee. He has continued to attend AWRA Wisconsin Section Annual Meetings, serving as a judge for student presentations, and plans to continue to be involved in AWRA throughout his career.

President-Elect

Mike Rupiper

Mike Rupiper is the Director of Environmental Resources Planning at the Capital Area Regional Planning Commission (Dane County), one of the nine regional planning commissions in the state. He has a Bachelor's Degree in Civil and Environmental Engineering (1989) and a Master's Degree in Environmental Studies (1998), both from UW-Madison. Mr. Rupiper is a registered Professional Engineer in Wisconsin and is certified as an Envision Sustainability Professional. He has over 25 years of experience ranging from planning to engineering of stormwater management systems, wastewater collection and treatment systems, and other water resource projects. Mr. Rupiper currently serves on the Community Board of the Clean Lakes Alliance and has been on the AWRA Wisconsin Board for one year. As a continuing board member his goals are to help the organization increase its membership, update its website, and expand its use of social media.

BIOGRAPHIES OF PLENARY AND EVENING SPEAKERS

Plenary speakers

Dominique Brossard

Dominique Brossard is professor and chair in the Department of Life Sciences Communication at the University of Wisconsin-Madison and an affiliate of the UW-Madison Robert & Jean Holtz Center for Science and Technology Studies, the UW-Madison Center for Global Studies and the Morgridge Institute for Research. She earned her M.S. in plant biotechnology from the Ecole Nationale d'Agronomie de Toulouse (France) and her M.P.S and Ph.D. in communication from Cornell University. Brossard's research focuses on the intersection between science, media and policy with the Science, Media and the Public (SCIMEP) research group, which she co-directs. A fellow of the American Association for the Advancement of Science and a former board member of the International Network of Public Communication of Science and Technology, Brossard is an internationally known expert in public opinion dynamics related to controversial scientific issues. She is particularly interested in understanding the role of values in shaping public attitudes and using cross-cultural analysis to understand these processes.

Lee Bergquist

Lee has been a reporter at the Milwaukee Journal Sentinel for 36 years and has covered environmental issues for the past 15. He has written on issues including chronic wasting disease in the deer population, water shortages in the Central Sands, invasive carp and their potential to reach the Great Lakes, and recent political battles over environmental regulations in Wisconsin.

Evening speaker

Dale Robertson

Dale Robertson is a Research Hydrologist with the U.S. Geological Survey, Upper Midwest Water Science Center, in Middleton, WI. He received his M.S. and Ph.D. in Oceanography and Limnology at the University of Wisconsin-Madison, where his research dealt with examining the effects of climate change on the physical dynamics of lakes, and he was a Post-Doctoral Research Fellow at the University of Western Australia, where he helped develop models to simulate the physical dynamics of lakes and reservoirs. Since joining the USGS, his work has dealt with understanding and modeling eutrophication and mixing in lakes, estimating nutrient and sediment concentrations and loads in streams and rivers over large geographic areas, such as the Mississippi and Great Lakes Basins, and developing nutrient criteria for streams and rivers. Dale has been involved with various Federal, State, and local scientists examining the water quality of Delavan Lake for over 25 years.

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PROGRAM SUMMARY

Clearing the Waters: Effective Science and Communication

43rd Annual Meeting of the American Water Resources Association—Wisconsin Section Delavan, Wisconsin

THURSDAY, February 28, 2019

9:00 – 11:00 a.m.	**Registration** Geneva Lobby
11:00 – 11:45 a.m.	**Welcome and Lunch** Geneva Ballroom (Geneva I and II)
11:45 – 1:45 p.m.	**Plenary Session and Lightning Talks** Geneva Ballroom (Geneva I and II) Dominique Brossard Professor and Chair, Department of Life Sciences Communication University of Wisconsin-Madison *Science Communication: Challenges and Opportunities* Lee Bergquist Milwaukee Journal Sentinel *A Reporter's Perspective on Reporting and Writing on Wisconsin Environmental Issues* **Lightning Talks**
1:45 – 2:00 p.m.	**Break:** Geneva Lobby

2:00 – 3:20 p.m.	**Concurrent Sessions 1A, 1B and 1C**
Session 1A	**Wetlands** **Room:** Geneva III **Moderator:** Sue Swanson
2:00	**Hyperspectral Remote Sensing of Calcareous Fens** Arthur Ryzak,* University of Wisconsin - Madison
2:20	**Water Quality Assessment of Waubesa Wetlands Watershed, Dane County, WI** Rachel Johnson,* University of Wisconsin-Madison
2:40	**Wetlands by Design: A Watershed Approach to Communicate Science and Target Conservation** Nick Miller, The Nature Conservancy
3:00	**WDNR NR40: Helping Prevent and Slow the Spread of Invasive Species in Wisconsin Wetlands** Matthew Wallrath, Wisconsin Department of Natural Resources
Session 1B	**Hydrogeology** **Room:** Lake Lawn Room **Moderator:** Jeff Helmuth
2:00	**A General Inset Model Creator for the Central Sands Region** Andrew Leaf, U.S. Geological Survey
2:20	**Effective Implementation of a Large-Scale Bio-Enhanced Reductive Dechlorination Strategy to Address Chronic cVOC Mass Loading to a Glacial Aquifer** John Osborne, GZA GeoEnvironmental, Inc.
2:40	**Trees as Hydrologic Sensors: Evaluating Tree Rings to Reconstruct Historic Groundwater Levels in Central and Northern Wisconsin** Dominick Ciruzzi,* University of Wisconsin-Madison
3:00	**A Workflow for Developing a MODFLOW Inset Model** Megan Haserodt, U.S. Geological Survey

* Student presentation

Session 1C	**Monitoring** **Room:** Wisconsin **Moderator:** Andrew Aslesen
2:00	**Catching Flash Rips in Lake Michigan: A Lifesaving Operational Camera Kit (LOCK) System** Yuli Liu,* University of Wisconsin-Madison
2:20	**Using the Arduino Micro-controller to Build Custom Instrumentation for Groundwater Applications.** David Hart, Wisconsin Geological and Natural History Survey
2:40	**Methods to Monitor Soil Moisture** John Panuska, UW Madison - Biological Systems Engineering
3:00	**UAV-Based Toolkits to Monitor Stream Habitat in Wisconsin: Development and Application** Wei Wang,* Department of Civil and Environmental Engineering, University of Wisconsin - Madison
3:20 – 3:40 p.m.	**Break: Geneva Lobby**
3:40 – 5:00 p.m.	**Concurrent Sessions 2A, 2B and 2C**
Session 2A	**Shorelines** **Room:** Geneva III **Moderator:** John Luczaj
3:40	**Design and Analysis of Submerged Sills Living Shoreline for Kenosha Dunes, WI** Chen Jin,* University of Wisconsin - Madison
4:00	**Roles of Meteorologically Induced Water Level Fluctuations in the Lower Green Bay and Fox River Area of Concern** Shanxiang Wu,* Department of Civil and Environmental Engineering-UW Madison
4:20	**Roles of Wind Waves on Circulation Pattern and Nutrient Transport in Lower Green Bay, WI** Joshua Anderson, UW-Madison

* Student presentation

Session 2B	**Hydrogeology II** **Room:** Lake Lawn Room **Moderator:** Maureen Muldoon
3:40	**Geophysical Modeling of the Precambrian Topography in Columbia County, Wisconsin** Joseph Rasmussen,* University of Wisconsin - Madison
4:00	**Models Supporting Decision Making: The USGS Mississippi Alluvial Plain project** Randall Hunt, US Geological Survey
4:20	**Testing Highly Instrumented Floating Interrogators (HIFI) for Dense Measurements of Stream-Aquifer Interactions** Catherine Christenson,* UW - Madison Geoscience
4:40	**The Importance of Transient Groundwater Exchange on the Water Budget and Water Level Forecasting of a Seepage Lake** Paul Juckem, U.S. Geological Survey, Upper Midwest Water Science Center

Session 2C	**Potpourri** **Room:** Wisconsin **Moderator:** Adam Freihoefer
3:40	**Linking Groundwater and Climate to Understand Long-Term Lake Level Fluctuations in Wisconsin** Catherine Hein, WDNR
4:00	**Isotopes as Tracers of Surface Water Dynamics in Dane County, WI** Sean Scott, Wisconsin State Laboratory of Hygiene
4:20	**Quantifying Nitrate in Irrigation Water in the Wisconsin Central Sands** Tracy Campbell,* University of Wisconsin - Madison
4:40	**Nitrate Loading to Groundwater from a Sandy Agricultural Field** Laura Schachter,* University of Wisconsin - Madison
5:00 – 5:30 p.m.	**Networking**

* Student presentation

5:30 – 7:00 p.m. **Dinner and Evening Speaker**
Room: Geneva Ballroom (Geneva I and II)

Dale Robertson
U.S. Geological Survey Upper Midwest Water Science Center
The Rehabilitation of Delavan Lake and the Long-Term Effects of Changes in the Food Web

7:00 – 10:00 p.m. **Poster Session and Social**
Rooms: Geneva Club, Lake Lawn Room, and Lake Lawn Room Foyer

1. **Optical Properties of Dyes for Estimating Deicer Content in Airport Runoff**
Hayley Olds, U.S. Geological Survey

2. **Coupled Soil Moisture and Gas Dynamics in an Urban Agricultural Soil**
Laine Havens,* Marquette University

3. **Quantification and Prediction of the Impact of Urban Trees of the Reduction of Stormwater Runoff**
William Avery,* University of Wisconsin-Madison

4. **Quantification of Phosphorous Loading through Lacustrine Groundwater Discharge in Mud Lake, Wisconsin**
Chloe Malin,* University of Wisconsin-Eau Claire

5. **Microbially-Mediated Oxidation of Trace Element-Bearing Sulfide Minerals in Sandstones of Trempealeau County, WI**
Lisa Haas,* University of Wisconsin-Madison

6. **Positive Feedback between Hydrology and Soil Properties May Make Fen Wetlands More Susceptible to Groundwater Drawdown**
Eric Booth, University of Wisconsin - Madison

7. **Organic Contaminant Degradation by Manganese Oxides**
Sarah Balgooyen,* University of Wisconsin-Madison

8. **Using Runoff Rates and Stream Hydrochemistry to Understand Stream Phosphorus Concentrations in Southwestern Wisconsin**
Paul McGinley, University of Wisconsin-Stevens Point

9. **Water Quality Impacts Before and After River Restoration on the Pike River**
Courtney Shatkins,* University of Wisconsin-Parkside

10. **Colonial Park Ravine Erosion Analysis**
Meagan Meier,* University of Wisconsin-Parkside

11. **Aerial Imaging River System (AIRS): Measuring Flood Peaks Using Drones**
Spencer Sebo,* Marquette University

* Student presentation

12. **Groundwater influence on Lake Michigan Bluff Stability and Some Control Approaches**
Robert Montgomery, Montgomery Associates: Resource Solutions

13. **The Influence of Road Salt on the Performance and Species Composition of Decomposers**
Shelby McIlheran,* University of Wisconsin-Oshkosh

14. **Coastal Morphology Change in Response to Coastal Structures in Lake Michigan**
Boyuan Lu,* Department of Civil and Environmental Engineering, University of Wisconsin–Madison

15. **Comparing Soil Infiltration Capacity Among and Within Residential Parcels in Milwaukee, WI**
Katlyn Nohr,* University of Wisconsin - Madison

16. **Coverage of Water Issues in Wisconsin's Print Media**
Yanet Fernandez,* UW Fox Valley

17. **Modeling Green Infrastructure Influence on Rainfall Derived Inflow and Infiltration**
Jeffrey Strasser,* Marquette University

18. **Improved Reliability of Stormwater Detention Basin Performance Through Water Quality Data-Informed Real-Time Control**
Sazzad Sharior Sharior,* Marquette University

19. **Method to Transfer Flood Risk for Regional Flood Frequency Analysis**
Elizabeth Regier,* Marquette University

20. **Suck the Muck: Connecting Science to People**
John Reimer, Dane County Land & Water Resources Department

21. **Analyzing Ancient Water-Rock Interaction History in Northeastern Wisconsin Using Fluid Inclusions in Minerals**
Olukayode Akinkuehinmi,* University of Wisconsin - Green Bay

22. **The Health Burden of Private Wells Contaminated by Gastrointestinal Pathogens in the Fractured Dolomite Aquifer of Kewaunee County, Wisconsin**
Tucker Burch, USDA-ARS

23. **Development of an Urban Land Cover Temperature Model Using Drone Imagery**
Joseph Naughton,* Marquette University

24. **Soil Water Dynamics Across Electrical Conductivity Management Zones for Precision Irrigation**
Elizabeth McNamee,* University of Wisconsin-Madison

25. **Geologic and Geochemical Conditions Affecting Radium Mobility in the Wisconsin Cambrian-Ordovician Aquifer System**
Amy Plechacek,* Environmental Chemistry and Technology, Department of Civil and Environmental Engineering, University of Wisconsin-Madison

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* Student presentation

26. **Method Development to Assess Monensin Concentration in Agricultural Runoff Water and Sediment**
Lisa Parlato,* UW-Stevens Point Water and Environmental Analysis Lab

27. **Coupled Modeling of Groundwater Flow and Slope Stability along the Lake Michigan Coastline**
Collin Roland,* University of Wisconsin - Madison

28. **Little Plover River Water Budget Analysis to Evaluate Baseflow Restoration Alternatives**
Stephen Gaffield, Montgomery Associates: Resource Solutions, LLC

29. **An Accounting of Groundwater Withdrawals from Major Aquifers in Wisconsin and the United States, 2015**
Martha Nielsen, U.S. Geological Survey

30. **Effect of Fracture Roughness on Fluid-Facilitated Energy Exchange Processes**
Noah Vriese,* University of Wisconsin-Madison

31. **Assessment of Long-Term and Recent Trends from USGS Groundwater Level Records in Wisconsin from 1947 to 2017**
Duabchi Vang,[*] University of Wisconsin-Eau Claire

32. **Algae Estimator: Mobile Phone Application for Predicting Harmful Algal Blooms in Shallow Freshwater Lakes**
John Skalbeck, University of Wisconsin-Parkside

33. **Leachable Phosphorus in Leaf Litter and Its Impact on Phosphorus Loads in Urban Stormwater**
Yi Wang,* University of Wisconsin-Madison

34. **Translocation of Elimia comalensis (Gastropoda: Pleuroceridae) in a Texas Spring as a Potential Model for Congeneric Species in Wisconsin.**
Kiera Theys,* University of Wisconsin-Whitewater

35. **A Modeling Approach for Source Water Protection: A Case Study in Waupaca, WI**
Stephanie DeVries, Wisconsin Geological and Natural History Survey

36. **Preliminary Water Quality Assessment of the Confined Sandstone Aquifer in and near Kewaunee County, Wisconsin**
Abby Shea,* University of Wisconsin - Green Bay

37. **Wisconsin Water Stewards Program**
Deana Knuteson, UW-Madison

38. **Agricultural Impacts on Water Quality in the Little Baraboo System**
Paul Arellano,* UW-Baraboo

[*] Student presentation

FRIDAY, MARCH 1, 2019

7:00 – 8:30 a.m.	**Board Breakfast Meeting** **Room:** Courtyard 1
8:30 – 10:10 a.m.	**Concurrent Sessions 3A, 3B and 3C**
Session 3A	**Water Quality** **Room:** Geneva III **Moderator:** Steve Gaffield
8:30	**Setting Expectations: What Should Healthy Streams Be Like?** Michael Miller, Wisconsin Department of Natural Resources
8:50	**A Comprehensive Evaluation of Phosphorus Sources and Pathways in the Hydrologic System in Western Wisconsin** Sarah Vitale, University of Wisconsin-Eau Claire
9:10	**Stream Sources of Suspended Sediment and Phosphorus from an Agricultural Tributary to the Great Lakes** James Blount, U.S. Geological Survey
9:30	**Rapid Risk-Based Evaluation of Nitrate Management Scenarios** Michael Fienen, USGS
9:50	**Transition from Pilot to Full-Scale Utility Led Agricultural Based Adaptive Management Watershed Program** Jeff Smudde, NEW Water
Session 3B	**Surface Water and Climate Change** **Room:** Lake Lawn Room **Moderator:** Ken Bradbury
8:30	**The Changing Seasonal Recipe of Flood Frequency in the Midwest** Guo Yu,* University of Wisconsin-Madison
8:50	**Rainfall and Flood Lessons from a Wet Hot Wisconsin Summer** Daniel Wright, University of Wisconsin – Madison
9:10	**Improving Flood Resiliency in the Yahara River Chain of Lakes** John Reimer, Dane County Land & Water Resources Department

* Student presentation

9:30	**A Spatial and Temporal Investigation of Seasonal Stream Discharges in the Upper Midwest** Dale Splinter, University of Wisconsin-Whitewater
9:50	**Increasing Runoff in a Small Watershed in Wisconsin due to Changing Climate, Land Use Change, or Both** Xi Chen,* University of Wisconsin-Madison

Session 3C	**Urban Hydrology** **Room:** Wisconsin **Moderator:** Mike Rupiper
8:30	**Improving Predictions of Urban Runoff Volume** Judy Horwatich, USGS
8:50	**The Effect of Drainage Area on the Water-Quality Performance of Permeable Pavement** Nicolas Buer, USGS
9:10	**Monitoring the Impacts of Trees on Urban Stormwater Volume Reduction** Bill Selbig, USGS
9:30	**New Approaches for Urban Storm Water Collection and Management: Leveraging New Technologies and Community Engagement for Beneficial Reuse** Kara Koch, GZA GeoEnvironmental, Inc.
9:50	**Soil Amendment as a Green-Infrastructure Practice in Residential Areas** Carolyn Voter,* University of Wisconsin-Madison

10:10 – 10:20 a.m.	**Break: Geneva Lobby**
10:20 – 11:40 a.m.	**Concurrent Sessions 4A, 4B, and 4C**

Session 4A	**Science Communication** **Room:** Geneva III **Moderator:** Hayley Olds
10:20	**Wisconsin Water Conflicts: Communication Lessons Learned from Climate Science** Carol McCartney, Wisconsin Geological & Natural History Survey

* Student presentation

10:40	**Can You Hear Me Now? The "And, But, Therefore" System to Tell Your Science Story** Amanda Bell, US Geological Survey Upper Midwest Water Science Center
11:00	**Coastal Bluff Recession Mapping in Southeastern Wisconsin: Data and Insights for Coastal Resilience** Nick Jordan, FreshWater Engineering
11:20	**Water-Resources Challenges for the Next 25 Years** Kenneth Bradbury, Wisconsin Geological and Natural History Survey

Session 4B	**Surface Water Quality** **Room:** Lake Lawn Room **Moderator:** Sarah Fuller
10:20	**Examining Hg Stable Isotopes in the Lower Fox River AOC to Better Understand Bioaccumulation** Tylor Rosera,* Environmental Chemistry and Technology UW-Madison
10:40	**Mercury-Methylating Organisms in Lake Mendota** Benjamin Peterson,* UW-Madison
11:00	**Status and Distribution of the Gastropod Fauna of the Mukwonago River Below Phantom Lake Dam** Rex Hanger, University of Wisconsin-Whitewater
11:20	**Relationship between Chlorophyll and User Perception of Lake Water Quality** Matthew Diebel, Wisconsin Department of Natural Resources

Session 4C	**Water Quality II** **Room:** Wisconsin **Moderator:** Pete Chase
10:20	**Fate and Transport of Recycled Concrete Aggregate Leachate** Morgan Sanger,* University of Wisconsin-Madison
10:40	**Radionuclide Sorption to Aquifer Solids in the Midwestern Cambrian-Ordovician aquifer system** Madeleine Mathews,* University of Wisconsin-Madison

* Student presentation

11:00	**Translating Scientific Research to Policy Action: A Case Study on Reducing Toxic PAHs** Paul Mathewson, Clean Wisconsin
11:20	**SEWRPC's Regional Chloride Impact Study** Dale Buser, Southeastern Wisconsin Regional Planning Commission (SEWRPC)
11:45 – 12:00 p.m.	**Student Awards and 2019 Meeting Announcements** **Room:** Geneva III **Moderator:** Andy Leaf
12:00 – 2:00 p.m.	**Student Career Session Lunch** **Room:** Madison **Facilitator:** Brent Brown

Lightning Talks
Thursday, February 28, 2019
11:45-1:45

Death by PowerPoint: Rethinking How We Communicate to Our Audience

Julia Noordyk, University of Wisconsin Sea Grant Institute, noordykj@uwgb.edu

When was the last time during a PowerPoint presentation you heard, "Well, I know you can't read this, but….?" Unfortunately, probably not that long ago. As scientists, we need to start designing slides for our audience, not ourselves. In this speedy presentation, I will demonstrate why it is important to use best practices for presenting in front of any audience, even your academic peers.

* * *

Rising Water Levels in the Sandstone Aquifer of Eastern Wisconsin: A Conservation Success Story and a Lesson in the Law of Unintended Consequences

John Jansen, Collier Consulting, john@collierconsulting.com

Ten years ago it looked like the sandstone aquifer in Southeastern Wisconsin was dying. The number of wells and the cumulative pumping were increasing. Water levels in wells had dropped over 500 feet and were still declining. TDS levels were creeping up in deeper wells. The aquifer was being mined out and the future looked bleak.
Recent trends have proven this assessment to be wrong. The enforcement of the radium rule caused new wells to be drilled in the shallow aquifer. Water conservation reduced pumping. Pumping from the sandstone aquifer dropped by 50% from 2000 to 2010. Water levels in the center of the cone of depression have risen over 100 feet from 200 to 2015 and continue to rise. Modeling predicts that when Waukesha switches to Lake Michigan water, the aquifer will rise about 90 feet above current levels.

While encouraging, the predicted recovery in the aquifer will not be sufficient to remove Southeastern Wisconsin from being a Groundwater Management Area as per Act 310. Pumping from the sandstone aquifer has begun to increase again, rising 9% from 2000 to 2014. In addition the rising water levels may cause unanticipated changes in water quality. Portions of the aquifer that have been exposed to air for decades are being resaturated, possibly mobilizing oxidized metals from sulfide minerals. Ammonia levels are rising in some sandstone wells in the area of recovery suggesting that organic materials in the resaturating formations may be the source.

If the noise of your water science is worth hearing, please engage the folks who need to hear it early in your design. If your work relates to agriculture and water, please consider being part of the Food, Land and Water Project. The conversation, like conservation, has no end, but needs a beginning. And it needs your science.

* * *

Providing a Nitrate Leaching and Groundwater Quality Calculator for Wisconsin's Nutrient Management Planning SnapPlus

Kenneth Wade, Kenneth Wade Consulting, LLC, kenneth.wade@tds.net

Nitrate contamination of groundwater is severe and widespread in Wisconsin. Approximately 90% of the nitrate contamination is a result of agricultural practices, including application of both commercial fertilizer and waste manure. As a result, 20 to 30% of private wells in highly cultivated areas exceed the drinking water std. Nutrient Management Plans (NMPs) are promoted as a means of insuring Wisconsin's groundwater stds. are met. NMPs are required for CAFOs and some grant programs. Approximately one third of Wisconsin's fields use NMPs. Wisconsin's NMPs and associated SnapPlus software does not currently incorporate a calculation of crop field nitrate leaching and resultant groundwater impacts. For nitrogen, NMPs are largely agronomic tools that set total nitrogen field inputs through economic optimization that balances the anticipated cost of nitrogen inputs versus crop yield and sale price. Groundwater monitoring of cropped fields with NMPs has shown the plans do not insure compliance with groundwater standards. Wisconsin's current NMP SnapPlus software should be modified to include a calculation of nitrate leaching along with an estimate of groundwater recharge to allow for calculation of resultant groundwater nitrate concentration. The software changes should be validated with groundwater monitoring. The NMP groundwater nitrate results will allow operators to adjust nitrogen inputs for minimization of groundwater impacts.

Session 1A:
Wetlands
Thursday, February 28, 2019
2:00 – 3:20 p.m.

Hyperspectral Remote Sensing of Calcareous Fens

Arthur Ryzak,* University of Wisconsin - Madison, ryzak@wisc.edu
Eric Booth, University of Wisconsin - Madison
David Bart, University of Wisconsin - Madison
Philip Townsend, University of Wisconsin - Madison
Steven Loheide, University of Wisconsin - Madison

Calcareous fens are a type of groundwater fed, carbon storing wetland that are threatened with extinction both in Wisconsin and globally. Identification and monitoring of these rare plant communities remains a challenge, as sites are often difficult to access and require specialized expertise to differentiate from similar plant communities such as sedge meadows and wet prairies. In this work, we use partial least squares regression to link lab-based and and airborne hyperspectral imagery to floristic quality, hydrology, soil chemistry, and plant-tissue chemistry data collected at and around six Wisconsin calcareous fens in various states of degradation. Using these relationships, we present a method for estimating conditions at a fen and factors which may be influencing associated health status using airborne spectrometry alone.

* * *

Water Quality Assessment of Waubesa Wetlands Watershed, Dane County, WI

Rachel Johnson,* University of Wisconsin-Madison, rejohnson9@wisc.edu
Mitch Buthod, University of Wisconsin-Madison

Waubesa Wetlands are a 150-hectare state natural area located on the southwestern toe of Lake Waubesa in Dane County, WI. The high-quality wetlands have unique hydrogeology, are extremely diverse, and provide regionally important ecosystem services. Upstream land-use change in the Waubesa Wetlands watershed could affect the ecological integrity of the wetlands.

Graduate students from the University of Wisconsin-Madison Nelson Institute's Water Resources Management program conducted monitoring and modeling to support management recommendations under anticipated land-use changes in the watershed. We monitored watershed surface water quality and quantity through collecting monthly grab samples,

capturing storm events, and gathering continuous flow data. Monitoring efforts built upon previous data collection efforts by citizen scientists with the Rock River Coalition. We calculated watershed nutrient loadings for specified parameters and identified trends in nutrient concentrations from 2015 - 2018. Projections about water quality and quantity under various land-use change scenarios and climate change were made using STEPL and HydroCAD models. Key study results and management recommendations for the Waubesa Wetlands watershed will be presented.

* * *

Wetlands by Design: A Watershed Approach to Communicate Science and Target Conservation

Nick Miller, The Nature Conservancy, nmiller@tnc.org
Joanne Kline, Conservation Strategies Group
Tom Bernthal, WI Department of Natural Resources
John Wagner, The Nature Conservancy
Chris Smith, WI Department of Natural Resources
Michele Kille, The Nature Conservancy

Wetlands provide services for people as well as habitat for fish and wildlife, but not all wetlands provide the same services to the same degree. The Nature Conservancy collaborated with the Wisconsin Department of Natural Resources to create an online mapping decision support tool—the Wetlands by Design Explorer (www.WetlandsByDesign.org)—that ranks wetland preservation and restoration opportunities across Wisconsin based on their potential to reduce flood problems, improve water quality, protect shores, maintain streamflow, store carbon, and provide habitat. In addition to ranking sites, the Explorer evaluates watershed “needs” in terms of wetland loss and subsequent declines in services. Through Wetlands by Design, users may: 1) learn about the benefits of wetlands, 2) explore Wisconsin watersheds and their wetland service potential, and 3) find and evaluate sites for protection or restoration based on service potential. Wetlands by Design was developed to communicate wetland science and support the decisions of a broad range of users with different goals, e.g., lake management districts aiming to restore water quality, regulatory programs targeting wetland mitigation funds, land trusts interested in conserving habitat, and municipalities working to abate floods. It is a product of GIS analysis and has been validated in the Milwaukee River Basin using an independent field-based wetland functional assessment methodology.

* * *

WDNR NR40: Helping Prevent and Slow the Spread of Invasive Species in Wisconsin Wetlands

Matthew Wallrath, Wisconsin Department of Natural Resources, Matthew.Wallrath@wisconsin.gov

Since 2009, the Wisconsin Department of Natural Resources (WDNR) has used a new rule to help prevent the introduction and control the spread of invasive plants and animals in Wisconsin: NR40. Education and voluntary compliance is the main goal. By successfully applying these tools, most reports are resolved long before enforcement is necessary.

In this session, I will discuss how the rule is being used by DATCP and WDNR staff to achieve this goal. As the Organisms in Trade specialist at WDNR, I can offer unique perspective on how professional conservation biologists can interact with the trade sector to continue this work.

Topics will include rule definition, examples of the rule in action, occurrence maps that show the rule in action, resources for easy compliance, past, current and future status of NR 40, and how experts can get involved to inform the next round of species assessment leading to regulation.

* * *

Session 1B:
Hydrogeology
Thursday, February 28, 2019
2:00 – 3:20 p.m.

A General Inset Model Creator for the Central Sands Region

Andrew Leaf, US Geological Survey, aleaf@usgs.gov
Megan Haserodt, US Geological Survey
Michael Fienen, US Geological Survey

Accurate analysis of cumulative groundwater withdrawal impacts can be cost-prohibitive. Paradoxically, the areas with the largest cumulative impacts may also be the most difficult to model quickly, due to myriad competing sinks and/or complex boundary conditions that need to be considered. As part of the Central Sands Lake Study established by 2017 Wisconsin Act 10, the USGS, WDNR, and WGNHS have assembled a MODFLOW model and supporting datasets encompassing about 2,500 square miles of the Central Sands Region of Wisconsin and morainal areas to east. An inset model creation tool written in python is designed to rapidly produce fine-scale (~10-20m resolution) inset models that can accurately simulate water-withdrawal effects on individual surface water bodies. The tool allows for arbitrary layering to improve simulation of gradients to surface water, or inclusion of local hydrostratigraphic features. Automated setup of surface water boundary conditions from GIS datasets and the parent model solution facilitates testing of different grid configurations to select perimeter boundaries and layering that are appropriate for the modeling question. Although the study is focused on Plainfield, Pleasant, and Long Lakes, this tool will facilitate detailed inset modeling in a variety of hydrologic settings beyond the Central Sands area.

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Effective Implementation of a Large-Scale Bio-Enhanced Reductive Dechlorination Strategy to Address Chronic cVOC Mass Loading to a Glacial Aquifer

John Osborne, GZA GeoEnvironmental, Inc., john.osborne@gza.com
Bernard Fenelon, GZA GeoEnvironmental, Inc.
Kenneth Oanes, GZA GeoEnvironmental, Inc.

CVOC impacts in groundwater were found to extend more than ½-mile off site and 150-feet deep in a prolific unconfined glacial aquifer consisting of well-sorted sand and gravel to depths greater than 200 feet. A subtle textural gradation was noted of fining upward within the capillary fringe to about 10 feet below the water table. The horizontal groundwater-flow velocity within the upper zone is approximately 500 feet/year but increases with depth. An effective in situ bio-augmented enhanced reductive dechlorination (ERD) pilot test was designed to address chronic cVOC mass loading. A carbon source of

emulsified vegetable oil (EVO) solution with active cultures was injected at 236 locations. Seven months post-injection, cVOC reductions of 30% to 100% occurred up to 175 feet downgradient of the injection zone. An intense site-wide remedy was then implemented using 3 injection profiles with bioaugmented EVO solution injected into 800 multi-sequenced locations for a total injected solution of 435,000 gallons. The injectate included an iron salt-based oxygen scavenger, 0.5% quick-release soluble carbon, 5.5% EVO and 94% dilution water augmented with active dechlorinating bacteriological culture. A meticulous horizon-specific delivery process was implemented to address subtle K-value variations at the water table, which contain the highest levels of impact. Injections occurred over a period of seven weeks in up to 30 simultaneous locations in direct push-borings.

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Trees as Hydrologic Sensors: Evaluating Tree Rings to Reconstruct Historic Groundwater Levels in Central and Northern Wisconsin

Dominick Ciruzzi,* University of Wisconsin-Madison, ciruzzi@wisc.edu
Steven Loheide, University of Wisconsin-Madison

Tree rings record environmental conditions that influence tree growth during a growing season, such as climate, water and nutrient availability, drought, insect infestations, and myriad other drivers of productivity. Where records of an environmental variable are sparse or non-existent, analyzing tree rings may provide insight into the history of that environmental variable if it sufficiently influences tree growth. Here, we investigate the potential for analyzing tree rings to reconstruct groundwater level histories in central and northern Wisconsin. Even in the water-rich Wisconsin landscape, forests with fast-draining sandy soils may experience water stress thus limiting tree growth even in wet years. However, trees avoid water stress by using groundwater in areas where the watertable is shallow and instead grow consistently at high rates from year to year. With our datasets of groundwater levels and tree rings, we analyze and relate groundwater-tree growth interactions over a depth to groundwater gradient in northern and central Wisconsin. Our analysis aims to then transform annual tree growth records (50-100+ years) into groundwater level histories. By reconstructing groundwater level histories, we may be able to fill in groundwater level data gaps in Wisconsin and analyze historic groundwater-related events that may have influenced tree growth, such as drought in north and central Wisconsin, and groundwater pumping which lowered groundwater levels in central Wisconsin.

* * *

A Workflow for Developing a MODFLOW Inset Model

Megan Haserodt, U.S. Geological Survey, mhaserodt@usgs.gov
Randy Hunt, U.S. Geological Survey
Daniel Feinstein, U.S. Geological Survey
John Coleman, Great Lakes Indian Fish & Wildlife Commission

A previous presentation described a regional groundwater-flow model of the St. Louis River Basin in Minnesota developed using an analytic element code, where specified-flux boundary conditions were extracted for a MODFLOW Iron Range inset model. In this presentation, we describe a further-refined model, extracted from the Iron Range model, for the Partridge River Basin at the eastern end of the Iron Range. The objective of the Partridge River Basin model is to characterize surface water/groundwater interactions, including small streams not well represented with the grid used in the Iron Range model, and to explore hydrologic interactions with existing mine features such as large mine pits. The model inherits boundary fluxes and major hydrostratigraphic units from the Iron Range model while the discretization of groundwater recharge, the stream geometry, and minor hydrostratigraphic units were refined for the inset. The Partridge River inset model was re-calibrated using available head and flux targets. This presentation summarizes the workflow decisions and software approaches used and focuses on a forecast scenario assessing the range of impacts to groundwater elevations due to landscape changes from potential mining actions such as mine pit excavation and pit re-flooding. Our summary reports lessons learned from this real-world application using a range of available software tools.

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Session 1C:
Monitoring
Thursday, February 28, 2019
2:00 – 3:20 p.m.

Catching Flash Rips in Lake Michigan: A Lifesaving Operational Camera Kit (LOCK) System

Yuli Liu,* University of Wisconsin-Madison, yliu99@wisc.edu
Chin Wu, University of Wisconsin-Madison

Flash rips are strong and narrow seaward water jets that occur episodically at unpredictable positions. Unexpected swimmers can be suddenly swept into deep water by flash rips, resulting in drownings. In the past, in-situ sensors have been placed to catch flash rips, but little success has been made due to difficulties in identifying flash rip locations. In this talk, a remote Lifesaving Operational Camera Kit (LOCK) system, for the first time, is developed to catch flash rips appearing as sediment plumes extending offshore in large spatial coverage. The LOCK system consists of three components: (i) a panoramic high-resolution camera to automatically identify flash rips and locations using feature recognition techniques; (ii) an operational server to evaluate flash rip risks by compiling the images with wave and wind conditions obtained from nearby monitoring stations; and (iii) a dynamic data network to recursively update flash rip knowledge using new observations through neural networks. The LOCK system is deployed to catch flash rips in Lake Michigan at Port Washington, WI. Results show the LOCK system has the capability of faithfully capturing flash rips. Public can access the warning provided by the LOCK system through internet and beach kiosks. Overall, the LOCK system, a promising tool for capturing flash rips, can be widely applied in many beaches to help promote public awareness of flash rips and foster resilience to flash rip hazards for Great Lakes communities.

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Using the Arduino Micro-Controller to Build Custom Instrumentation for Groundwater Application

David Hart, Wisconsin Geological and Natural History Survey, dave.hart@wgnhs.uwex.edu
Catherine Christenson, UW Madison
Susan Richmond, UW Madison
Dante Fratta, UW Madison

Hydrogeologic data collection often requires specialized equipment and instrumentation that is commonly not available or is prohibitively expensive. A solution to this issue is for the researchers to create their own equipment. This has become easier due to the Maker Movement, a cultural movement where hobbyists create and share “cut and paste”, do-it-yourself

(DIY), open source hardware and software. The result is that hydrogeologists can design and build specialized instrumentation quickly and at low cost for specific applications.

We have built three systems using the Arduino microcontroller platform. They are a groundwater-quality data recorder with GPS, a temperature flux meter with data storage, and a data recorder for an EM-31 conductivity meter. The groundwater quality system records pH, temperature, fluid conductivity, dissolved oxygen, chloride, nitrate, location, and time with the sensors placed in a flow-through cell. The temperature flux meter records seven temperatures with time and depth and was used for groundwater flux measurements. The EM-31 data recorder allows us to store GPS locations and ground conductivity readings at 2-second intervals.

These instruments have allowed us to collect data at a quality, quantity, and cost that is otherwise not possible. Although we recommend consideration of a DIY approach, more complicated instrumentation and more challenging environments are likely to require an engineered and commercial solution.

* * *

Methods to Monitor Soil Moisture

John Panuska, UW Madison - Biological Systems Engineering, jcpanuska@wisc.edu

Soil moisture levels are a critical component of agricultural crop production. This is especially true in areas having sandy soils with low soil-water holding capacity, such as the Central Sands Area in Wisconsin. A significant amount of vegetable and other high value crop production occurs in the Central Sands Area as well as in other sandy soils around Wisconsin. Frequently, these areas require supplemental irrigation to be agriculturally productive. Over-irrigation can result in deep drainage and increase the potential for groundwater contamination, while under-irrigation can adversely impact crop quality and yield. Methods such as irrigation scheduling are commonly used to manage the root zone soil-water balance where inputs include rainfall and irrigation, while outputs are evapotranspiration and deep drainage. Growers strive to maintain soil moisture levels in the optimal range and soil moisture monitoring can help accomplish that goal. Technologies to monitor soil moisture vary in cost and complexity. Several of the more commonly used methods in Wisconsin will be presented and discussed along with additional soil-water management resources available from UW Extension.

* * *

UAV-Based Toolkits to Monitor Stream Habitat in Wisconsin: Development and Application

Wei Wang,* Department of Civil and Environmental Engineering, University of Wisconsin - Madison, wwang487@wisc.edu
Michael Miller, Wisconsin Department of Natural Resources
John Reimer, Dane County Land & Water Resources Department
Chin Wu, Department of Civil and Environmental Engineering, University of Wisconsin–Madison

Quantitative stream habitat data provides valuable information on in-stream, riparian, and watershed conditions. Conventional survey methods, however, are labor and time intensive. In recent years, Unmanned Automated Vehicle (UAV), i.e. drone, photogrammetric technology has been proved to an effective and low-cost alternative for surveillance and survey. Challenges of applying UAV drone technology on in-stream monitoring are acquisition of high quality overlapped image, processing of large image data, and interpretation of image derived stream habitat. In this talk, a state-of-the-art suite of user-friendly and free UAV toolkits are developed. Toolkit A is for flight planning to automate drone survey mission by determining a flying route from analyzing a stream map and specifying pitch, roll and yaw. Toolkit B is for imagery processing, containing interfaces to generate a digital elevation model and an orthophoto using open-source drone image processing software. Toolkit C is for stream habitat evaluation to estimate stream habitat quality based on measures of stream habitat conditions. The UAV toolkits are applied and tested to the black earth creek, WI to facilitate stream habitat data acquisition and habitat indices. Future work will include other instruments such as temperature sensors to assess the thermal characteristics of Wisconsin streams and rivers.

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Session 2A:
Shorelines
Thursday, February 28, 2019
3:40 – 4:40 p.m.

Design and Analysis of Submerged Sills Living Shoreline for Kenosha Dunes, WI

Chen Jin,* University of Wisconsin - Madison, cjin43@wisc.edu
Alvaro Linares, Civil and Environmental Engineering, University of Wisconsin–Madison
Chin H. Wu, Department of Civil and Environmental Engineering, University of Wisconsin–Madison, Madison

Shoreline along the Kenosha Dunes, WI is threatened by, erosion, lake sediment depletion, interrupted shoreline flow processes, and failing revetment systems, all of which are threatening the fisheries and wildlife. At the current rate of shoreline loss, several near shore wetlands could be completely lost within the next decade, leaving local communities more vulnerable to extreme storm events and flooding in the future. In this talk, we will employ an living shoreline concept to the severely eroding dunes. Unlike a concrete seawall or other hard structure that impede the growth of plants and animals, we will devise innovative submerged sills to achieve both resilience goals (reduction of weather-induced hazards and fluctuating lake water levels) and conservation goals (e.g. creating habitats for 26 rare plant species, forage, fish nursey). The configuration and layout of multiple submerged sills on effectiveness of shoreline protection at Kenosha Dunes will be determined and analyzed by employing the high fidelity coupled wave-current interaction model. Furthermore, a particle tracking model will be used to evaluate sediment erosion, deposition, transport processes that can also impact water quality. Overall, the design and analysis of submerged sills at Kenosha Dunes will provide a perspective to examine the efficacy on shoreline protection and restoration, serving for coastal management and future decision-making in Wisconsin.

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Roles of Meteorologically Induced Water Level Fluctuations in the Lower Green Bay and Fox River Area of Concern

Shanxiang Wu,* Department of Civil and Environmental Engineering-UW Madison, swu328@wisc.edu
Álvaro Linares, Department of Civil and Environmental Engineering-UW Madison
Chin H. Wu, Department of Civil and Environmental Engineering-UW Madison

Recent study shows that meteorologically induced water level oscillations (MIWLOs) can play an important role on contaminated sediment transport and in turn remediation decisions of Great Lakes Area of Concern (AOC). For example, the oscillatory nature of MIWLOs can temporarily reverse flow in the Manistique River estuary and transport contaminated sediments upstream to previously cleaned areas. In this talk, we will reveal the frequency and spatial patterns of flow

reversal induced by MIWLOs in the Lower Green Bay and Fox River (LGB&FR) AOC. Interactions of MIWLOs and flooding flows will be examined using a coupled hydrodynamic, sediment transport and water quality model. Role of MIWLOs asymmetry on velocity residuals and net sediment and nutrient transport will be discussed. Overall, the outcomes of this study aid to address the sustainable remediation of LGB&FR AOC.

* * *

Roles of Wind Waves on Circulation Pattern and Nutrient Transport in Lower Green Bay, WI

Joshua Anderson, UW-Madison, janderson1@wisc.edu
Chin Wu, UW-Madison

Knowledge of waves and currents is critical to understanding transport in Lower Green Bay AOC. Due to a relatively large fetch and shallow depths, wind waves in Lower Green Bay can play a dominant role in resuspending bed sediments that degrade water quality. However, little is known about how wind waves affect nearshore circulation and nutrient transport. In this talk, development of a coupled state-of-the-art wave and current model for Lower Green Bay is presented. Field measurements collected in 2018 are used for model calibration/validation. In comparison with the NOAA Lake Michigan model (~250 m), our fine spatial resolution (~2 m) model will reveal detailed circulation patterns in Lower Green Bay. The output of this model will be used as an input to a Virtual Beach model for predicting real-time Harmful Algal Blooms (HAB). We will further apply the model to estimate wave generated sediment resuspension at a Wild Rice restoration site in the Duck Creek Delta.

Session 2B:
Hydrogeology II
Thursday, February 28, 2019
3:40 – 5:00 p.m

Geophysical Modeling of the Precambrian topography in Columbia County, Wisconsin

Joseph Rasmussen,* University of Wisconsin-Madison, jmrasmussen3@wisc.edu
Esther Stewart, Wisconsin Geological and Natural History Survey
John Skalbeck, University of Wisconsin-Parkside
Madeline Gotkowitz, Montana Bureau of Mines and Geology

The Cambrian-Ordovician groundwater system is the primary aquifer in south-central Wisconsin and supplies many high-capacity wells in the eastern portion of the state. The Precambrian surface forms the base of the aquifer and contains many topographic irregularities, the most prominent of which corresponds with the Baraboo Syncline of Columbia and Sauk Counties. The topography of this surface directly impacts aquifer thickness, which in turn affects groundwater quantity. Using coupled modeling of gravity and aeromagnetic anomaly data, we are refining previous interpretations of Precambrian geology and topography beneath Columbia County. Existing basement topographic interpretations are based on sparse outcrops and boreholes with limited spatial distribution. We are conducting forward modeling of gravity and aeromagnetic data using the GM-SYS software package in Geosoft's Oasis Montaj. Interpretations of subsurface layers were created and constrained using geologic mapping, drill logs, well construction reports, magnetic susceptibility, and density data, as well as USGS gravity and aeromagnetic surveys. Preliminary results suggest that a Precambrian-age northeast-trending fault bisects Columbia County. Variation in Precambrian lithology and topography in the area is more varied than previously thought and is, in part, controlled by ancient motion along this structure.

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Models Supporting Decision Making: The USGS Mississippi Alluvial Plain project

Randall Hunt, US Geological Survey, rjhunt@usgs.gov
Emily Pindilli, US Geological Survey
Michael Fienen, US Geological Survey
Wade Kress, US Geological Survey

The US Geological Survey (USGS) is commonly asked to provide science support for societal decision-making, including numerical models. Twentieth Century workflows emphasized paper reports and a handoff of "the answer" to those charged with making decisions. Such workflows are ill suited for today's decisions – especially those involving adaptive management or large uncertainties. Moreover, as stakeholders have grown accustomed to near instant access to

information such as real-time weather forecasts, water-resource support systems have not kept pace. This is the context within which local stakeholders initiated the USGS Mississippi Alluvial Plain (MAP) project in 2016. From its inception, effort was dedicated to formulating a new approach of applying USGS models to decision support. The overarching goal is to provide responsive, consistent, and seamless high-quality science even as the forecasts and approaches of decision-making change. Challenges to this vision include building an approach that encompasses moving forecast targets, ensuring scientific reproducibility, developing a common technology and language across a large, multidisciplinary team, and robust script design extensible for new data types and numerical code updates. However, by the end of the MAP project we believe the workflow and supporting documentation developed will have transferability to many areas outside the MAP.

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Testing Highly Instrumented Floating Interrogators (HIFI) for Dense Measurements of Stream-aquifer Interactions

Catherine Christenson,* UW - Madison Geoscience, cchristenso4@wisc.edu
David Hart, Wisconsin Geological and Natural History Survey
Michael Cardiff, UW - Madison Geoscience

Groundwater discharge to surface water systems is an important regulator of stream temperature, water quality, and habitat in a changing climate. Understanding and quantifying groundwater (GW) discharge is also critical for calibrating GW flow models. GW carries unique geochemical and temperature signatures that prove useful for identifying localized zones of GW discharge in small streams in Wisconsin.

We have collected dense data sets from representative streams across Wisconsin's physiographic regions utilizing low-cost methods and Arduino software with the goal of creating a snapshot of GW discharge to streams at a given time. The data include basic stream chemistry and temperature, stream depth and flow rate, video of the stream, and geophysical properties such as resistivity. Instruments mounted in a canoe in a controlled float collect georeferenced data, which provides detailed information about spatial variability.

Our data was validated using conventional methods for identification and quantification of GW-SW interaction (i.e. seepage meters, mini-piezometers, DTS). The stream float data collection strategy has proven to be a useful, low-cost, and easy-to-execute tool for identifying discrete zones of GW discharge across miles-long stream segments. Integrating stream float data with video of the stream provides an effective visual representation of changing stream parameters through space and time.

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The Importance of Transient Groundwater Exchange on the Water Budget and Water Level Forecasting of a Seepage Lake

Paul Juckem, U.S. Geological Survey, Upper Midwest Water Science Center, pfjuckem@usgs.gov
Dale Robertson, U.S. Geological Survey, Upper Midwest Water Science Center

Understanding the role of dynamic lake/groundwater exchange on lake water budgets is important for forecasting the response of lake levels to climate change and groundwater pumping, and to accurately quantify nutrient loading. This is especially true for seepage lakes in which groundwater is a large part of the water budget.

In this presentation, we explore how simplification of this dynamic exchange can influence long-term forecasts of lake level. A 35-year simulation of monthly lake levels was matched to measured water levels for Anvil Lake, WI, to produce a baseline hindcast of historical levels. Approaches to simplify the dynamic lake/groundwater exchange included: (1) an assumption of no lake/groundwater interaction, (2) use of constant rates from short-term low and high periods of net groundwater exchange, and (3) use of a long-term average exchange rate.

Results illustrate that use of short-term exchange estimates can bias simulated lake level by several meters over a multi-decade period, but only periodic biases occur if the long-term average exchange rate is used. The practical challenge identified from this work is that “normal” or average periods of lake/groundwater exchange may not be apparent a-priori because seasonal and inter-annual lake/groundwater dynamics shift in response to weather and water levels. These findings highlight the importance of long-term (multiple decades) lake-level monitoring to inform modeling efforts and future predictions.

Session 2C:
Potpourri
Thursday, February 28, 2019
3:40 – 5:00 p.m.

Linking Groundwater and Climate to Understand Long-Term Lake Level Fluctuations in Wisconsin

Catherine Hein, WDNR, catherine.hein@wisconsin.gov
Zhixuan Wu, UW-Madison
Noah Lottig, UW-Madison
Robert Smail, WDNR
Eric Booth, UW-Madison
Paul Juckem, USGS

Although the flow regime is an integral part of stream ecology, lake level regimes are not often central to limnology. This is despite research showing that lake level fluctuations are indeed important for understanding a breadth of topics, from invasive species to water quality. Lake levels are rarely monitored across broad spatial and temporal extents resulting in limited knowledge of the hydrologic regimes of most lakes. To fill this knowledge gap, we compiled lake and groundwater level data from ~2000 sites in Wisconsin over the period 1900 – 2015. We found strong spatial and temporal coherence in water levels across two regions in Wisconsin: when water levels were low in the north, they were high in the south. Using a Bayesian modeling framework, we accurately predicted water level fluctuations in seepage lakes with precipitation and evaporation data and estimated net groundwater flux. The statewide average groundwater recharge rate of 1.41 mm/day applied to over 60% of seepage lakes, but groundwater recharge was higher or lower than the average in the remaining seepage lakes. These differences in groundwater recharge may be explained by landscape position, soil permeability, and calcium to magnesium ratios. Our ultimate goal is to characterize the hydrologic regimes of all seepage lakes in Wisconsin. New tools and policies for water level management are needed now more than ever to adapt to more extreme drought and precipitation.

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Isotopes as Tracers of Surface Water Dynamics in Dane County, WI

Sean Scott, Wisconsin State Laboratory of Hygiene, Sean.Scott@slh.wisc.edu
Patrick Gorski, Wisconsin State Laboratory of Hygiene
Joel Overdier, Wisconsin State Laboratory of Hygiene
Christa Dahman, Wisconsin State Laboratory of Hygiene
Martin Shafer, Wisconsin State Laboratory of Hygiene

Surface waters across Wisconsin are subject to chemical changes through time due to variations in surface and groundwater flow. Oxygen and hydrogen stable isotopes are traditionally used to evaluate these changes. However, stable and radioactive isotope ratios of other elements provide an additional means to evaluate surface water dynamics. We present new high-precision Sr, Pb, and U isotope compositions in surface waters within and around Madison, WI. When compared to major and trace element abundances in surface waters, each isotope system may provide a more selective tracer for different source input into surface waters. Strontium isotopes are primarily derived from local marine sedimentary bedrock, and variations in Sr isotopes are correlated with sodium concentration indicating a common additional source. Variations in lead isotopes arise from mixing between local bedrock geology and atmospheric inputs such as anthropogenic aerosols. Uranium-234 is loosely bound in soils and bedrock due to radioactive recoil of ^{238}U; therefore, flooding and surface water runoff increase ^{234}U relative to ^{238}U in surface waters. When combined, these isotope systems can be used to assess/isolate the three major inputs into surface waters, including natural geologic formations, anthropogenic surface contaminants, and atmospheric inputs. Target monitoring will allow for spatial and temporal quantification of the influence of these three components in a given surface water system.

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Quantifying Nitrate in Irrigation Water in the Wisconsin Central Sands

Tracy Campbell,* University of Wisconsin - Madison, tacampbell@wisc.edu
Kevin Masarik, UW-Stevens Point
Chris Kucharik, UW-Madison

The Wisconsin Central Sands (WCS) is experiencing an increasing demand for improved irrigation and nutrient management in cropping systems. Past and current fertilizer applications, combined with the regional climate and sandy soils, have resulted in nitrate levels in groundwater that are often above the EPA threshold of 10 mg/L for safe drinking water. Moving forward, it is critical that we quantify the nitrate delivered to crops through irrigation water to improve nutrient

management plans and water use across the WCS. During spring and summer of 2018 water samples were collected weekly from irrigation systems and from precipitation at four geographic regions in the WCS to quantify nitrate delivered to crops. Preliminary results indicated that nitrate concentrations in irrigation water per field ranged between 6.4 mg/L - 31.5 mg/L. The magnitude of these nitrate concentrations suggests that farmers could utilize N found in irrigation water as a means of reducing crop N application in other forms, and as a result, increase economic return. It is our goal that this research and plan for continued measurements in the long-term will add to the expertise of growers, researchers, and extension agents to develop improved nutrient management plans that improve groundwater quality. These improvements will be crucial as increased weather variability associated with climate change poses greater water and nutrient management challenges to farmers.

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Nitrate Loading to Groundwater from a Sandy Agricultural Field

Laura Schachter,* University of Wisconsin-Madison, lschachter@wisc.edu
Michael Cardiff, UW-Madison
Madeline Gotkowitz, UW-Madison
Jacob Krause, UW-Madison

Across the upper Midwest, nitrogen fertilizers are commonly applied to increase agricultural crop yields. Many of these fields are atop sandy soils with underlying sand or sand-and-gravel aquifers, meaning the fields are extremely well drained. This quick draining allows nutrients to be lost to the aquifer below, especially during large precipitation events. The nitrogen in fertilizers is often leached in the ionic form of nitrate, which is known to be harmful to infants in high concentrations in groundwater (GW).

In this study, we document a method for assessing nitrate loading from an agricultural field via edge-of-field sampling. We present measurements of nitrate in GW and associated nitrate loading computations for an agricultural field (Field 19) located near the village of Spring Green, WI. In order to properly account for a given year's annual nitrate load, a bromide tracer injected at the beginning of each growing season is used to differentiate water recharged during the most recent growing season from older GW. The method relies on collecting vertical profiles of tracer (bromide) and nitrate concentration from multilevel samplers placed within the upper section of the aquifer at the edge of Field 19. Using a simplified conceptual model for GW flow, we are able to calculate annual nitrate loading from Field 19 with associated uncertainty bounds. Continued monitoring will allow assessments of how changes to on-field practices result in changes to net nitrate loading.

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Poster Session
Thursday, February 28, 2019
7:00 – 10:00 p.m.

1. Optical Properties of Dyes for Estimating Deicer Content in Airport Runoff

Hayley Olds, U.S. Geological Survey, htolds@usgs.gov
Steven Corsi, USGS
Peter Lenaker, USGS
Samantha Oliver, USGS

During periods of freezing precipitation, airports must clear snow and ice from aircraft, runways, and other paved surfaces by use of chemical pavement and aircraft deicing and anti-icing materials. Aircraft deicers and anti-icers consist primarily of freezing point depressants, water, and lesser concentrations of various additives. The release of aircraft and pavement deicers to the environment has the potential to cause damaging effects on aquatic ecosystems, creating a need for a continuous monitoring program of outfalls receiving airport runoff. Through a cooperative research project with the General Mitchell International Airport in Milwaukee, WI, the USGS explored cost-effective techniques to predict the presence and magnitude of a suite of deicer components in outfalls receiving airport runoff using optical properties of aircraft deicers. Each type of aircraft and pavement deicer is colored with food-grade organic dyes, which exhibit individually unique optical property signatures. In a case study from 2013 to 2017, samples were collected and analyzed for optical properties (absorbance), freezing point depressants, and other chemical properties that characterize deicer presence. Regression analysis confirmed that optical properties can be used to detect deicer contamination and associated water quality in airport runoff at airport outfalls. This study will be used to optimize an optical sensor suitable for continuous monitoring of aircraft deicer contamination.

* * *

2. Coupled Soil Moisture and Gas Dynamics in an Urban Agricultural Soil

Laine Havens,* Marquette University, laine.havens@marquette.edu
Joseph Sizemore, Marquette University
Anthony Parolari, Marquette University

Climate change and urbanization are creating new challenges for urban stormwater management. Green infrastructure (GI) in urban environments can enhance pollutant removal from stormwater. Stormwater pollutants, such as nitrogen, can be immobilized through uptake by plants and soil micro-organisms or completely removed from the system through microbial processes, such as denitrification. Root and microbial activity in soils are driven by soil moisture and oxygen (O2) availability. When the soil is saturated, soil O2 is depleted and anaerobic microbial processes, including denitrification, are favored and thus contribute to stormwater pollutant removal. GI systems are subject to climatic variability that drives the redox status of the soil, and, therefore, we would expect the pollutant removal efficiency of the soil to change in response to this climate variability. To understand the variability of soil redox status and respiration, we sampled soil moisture, carbon dioxide (CO2), and O2 in an urban soil at a five-minute frequency throughout 2018. O2 was non-linearly and negatively correlated to volumetric water content, and linearly and negatively correlated to CO2. The relationship between O2 and CO2 was controlled by temperature and soil moisture. The data suggests seasonal and daily hydro-climatic drivers produce short and infrequent periods of low O2 availability and high CO2 production which may indicate temporal niches for pollutant removal by anaerobic processes.

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3. Quantification and Prediction of the Impact of Urban Trees of the Reduction of Stormwater Runoff

William Avery,* University of Wisconsin-Madison, waavery@wisc.edu
Steven Loheide, University of Wisconsin-Madison
William Selbig, USGS, Wisconsin Water Center
Dominick Ciruzzi, University of Wisconsin-Madison
Carolyn Voter, University of Wisconsin-Madison
Brian Schlaff, University of Wisconsin-Madison

The use of green infrastructure to reduce stormwater impacts in urban environments has become a common practice in recent decades. However, the role of the urban tree canopy in precipitation interception and stormwater volume reduction has yet to be fully quantified. A holistic investigation on the effect of trees in the urban water cycle is needed. This work represents a preliminary analysis of canopy, soil, and sub-surface hydrology centred around two residential study blocks located in Fond du Lac, Wisconsin. Field research began during the summer of 2018 in which two blocks were outfitted with in-situ soil moisture sensors co-located with groundwater monitoring wells, precipitation gauges, sap-flow sensors embedded within the trunks of the adjacent trees, and accelerometers within the upper canopy to monitor interception. Photography of the tree canopy was performed to quantify leaf area index (LAI) as a measure of tree phenology. Spatially distributed throughfall data were collected beneath two sample trees during a precipitation event during the late summer of 2018. Preliminary results indicate the presence of trees does reduce direct precipitation reaching the landsurface. However, the possibility of the canopy directing precipitation onto impervious surfaces remains in question. Future work will entail quantification of spatial canopy structure through structure from motion photography to determine the effects of canopy characteristics on urban hydrology.

* * *

4. Quantification of Phosphorous Loading through Lacustrine Groundwater Discharge in Mud Lake, Wisconsin

Chloe Malin,* University of Wisconsin-Eau Claire, malincr9520@uwec.edu
Jonah Gagnon-Shoemaker, University of Wisconsin-Eau Claire
Sarah Vitale, University of Wisconsin-Eau Claire
Brian Mahoney, University of Wisconsin-Eau Claire
Anna Baker, USGS Upper Midwest Water Science Center

This study seeks to quantify phosphorous (P) loading through lacustrine groundwater discharge in Mud Lake in Barron County, Wisconsin. Phosphorous-laden runoff has been associated with contamination of surface water and lake eutrophication throughout the upper Midwest of the United States. Although P has been thought to be immobile in groundwater systems, an ongoing investigation in western Wisconsin has shown elevated levels in regional aquifers and suggests that P is actively transporting throughout the groundwater system in large quantities. Mud Lake is one of five interconnected lakes, all of which experience intense seasonal eutrophication events. The geology is characterized as Cambrian sandstone overlaid by sand and gravel glacial deposits. Ten (10) mini-piezometers (5 ft length, 1/2” ID, 4” screen) were installed around the perimeter of the lake. Surface water, groundwater, and soil were sampled every 2 to 3 weeks to measure standard water quality (including pH and redox conditions), nitrate, and dissolved and sorbed metal concentrations. Measurements of vertical hydraulic gradient, hydraulic conductivity, cross-sectional area and water quality are used to estimate nutrient flux into Mud Lake. The results of these calculations yield an average variable phosphorous flux value of 43.6 kg/day during the 2018 field season (June through October), with variable groundwater P concentrations up to 790 ppb.

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5. Microbially-Mediated Oxidation of Trace Element-Bearing Sulfide Minerals in Sandstones of Trempealeau County, WI

Lisa Haas,* University of Wisconsin-Madison, ldhaas@wisc.edu
Eric Roden, University of Wisconsin-Madison

Matt Ginder-Vogel, University of Wisconsin-Madison
Jay Zambito, Beloit College

Metal sulfide mineral dissolution is a concern for groundwater quality in Wisconsin as it can generate acidity and release toxic heavy metals into the environment. Sulfide minerals, for instance pyrite, are naturally occurring in the subsurface and dissolve in the presence of oxidants. Our recent work with microorganisms from other pyrite-bearing subsurface sediments has conclusively shown that chemolithotrophic bacteria can accelerate neutral-pH aerobic oxidation up to 10-fold relative to abiotic controls. Although sulfide oxidation is well documented in acidic environments, it is not well understood at neutral-pH conditions. Sulfide oxidation at neutral-pH environments is relevant as Wisconsin's groundwater is naturally buffered by carbonate minerals in the aquifers.

This is an experimental project to characterize the kinetics of biologically-mediated pyrite oxidation in native geologic samples and groundwater from Trempealeau County, Wisconsin. The two geologic samples include the Wonewoc Formation, a poorly-cemented, quartz-rich sandstone, and the Tunnel City Group, a dolomite-cemented, glauconitic, sub-feldspathic sandstone. Both geologic units have been observed to host pyrite ranging from infrequent centimeter-sized nodules to common millimeter-sized crystals. By studying the rate of microbially-mediated pyrite oxidation at circumneutral conditions, we will better understand the oxidation kinetics of naturally-occurring pyrite in Wisconsin aquifers.

* * *

6. Positive Feedback between Hydrology and Soil Properties May Make Fen Wetlands More Susceptible to Groundwater Drawdown

Eric Booth, University of Wisconsin - Madison, egbooth@wisc.edu
Steven Loheide, University of Wisconsin - Madison
David Bart, University of Wisconsin - Madison

Fens are unique ecosystems of high conservation value. Their identity rests on a strong dependence on consistent discharge of groundwater that saturates the near surface for most of the growing season. Decreases in saturation by reduced groundwater inputs can result in losses of native diversity, decreases in rare-species abundance, & increased invasion by non-native species. As such, fen ecosystems are known to be particularly susceptible to changes in groundwater conditions including reduction in water levels due to nearby groundwater pumping. However, research is lacking on whether the degradation process is influenced by feedbacks between hydrology & soil properties. We present a model of an archetype hillslope fen that couples a hydrological niche model with a variably-saturated groundwater flow model to predict changes in vegetation composition in response to different groundwater drawdown scenarios. The model explores feedbacks between hydrology & soil properties. Model parameters were determined based on data collected from six fens in Wisconsin under various states of degradation. We observed different water retention characteristics between sites that were pristine & degraded that are likely due to decomposition, oxidation, & compaction at the more degraded sites. Results reveal a complex response to drawdown where changes in soil hydraulic properties following dewatering lead to even drier conditions & further shifts away from fen-specialist plant species

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7. Organic Contaminant Degradation by Manganese Oxides

Sarah Balgooyen,* University of Wisconsin-Madison, sjbalgooyen@gmail.com
Christina K. Remucal, University of Wisconsin-Madison
Matthew Ginder-Vogel, University of Wisconsin-Madison

Manganese (Mn(III/IV)) oxides are naturally occurring minerals found in a wide range of natural environments. Mn oxides are also strong oxidants capable of oxidizing a wide range of contaminants, including phenolic compounds like bisphenol A (BPA), triclosan, and nonylphenol. Oxidation of these organic compounds often triggers their degradation while reductively dissolving the Mn oxide mineral. This study uses batch reactors with synthetic manganese oxides and BPA to determine the effect of solution conditions on the degradation mechanism and products. 4-Hydroxycumyl alcohol (HCA), a major BPA oxidation product, is detected in the reactor and used to probe the production of organic products by radical coupling. Solution pH is investigated using batch reactors buffered at varying environmentally relevant pH values. These studies show that both the rate of BPA oxidation and HCA production is affected by solution pH, indicating a shift in mechanism based on solution acidity. The oxidation mechanism and products of BPA and other phenolic contaminants is important to both water treatment and groundwater quality and remediation.

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8. Using Runoff Rates and Stream Hydrochemistry to Understand Stream Phosphorus Concentrations in Southwestern Wisconsin

Paul McGinley, University of Wisconsin-Stevens Point, paul.mcginley@uwsp.edu
Jessica Haucke, University of Wisconsin-Stevens Point
Dennis Busch, University of Wisconsin-Platteville

The phosphorus concentration in a stream is an important predictor of the stream's biological integrity. Higher stream phosphorus concentrations have been associated with increased periphyton growth and reduced invertebrate metrics. Watershed management efforts seeking to lower stream phosphorus concentrations would benefit from a stronger understanding of the controls on these concentrations. This study seeks to understand the role of the watershed on the temporal distribution of stream phosphorus concentrations. We examined variations in stream chemistry within and between storm events in several streams in southwestern Wisconsin. The variations were compared to predictions using a model of mixing runoff from different hydrologic flow paths followed by in-stream routing. The model used edge-of-field runoff rates to simulate the watershed rainfall-runoff response and assigned measured concentrations to the hydrologic flow paths. The measured and modeled stream hydrochemistries show how the watershed influences the temporal variation in stream phosphorus concentrations and explores the role watershed change might have in managing those concentrations.

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9. Water Quality Impacts Before and After River Restoration on the Pike River

Courtney Shatkins,* University of Wisconsin-Parkside, shatk001@rangers.uwp.edu
Jessica Gordon, University of Wisconsin-Parkside
Laura Schulz, University of Wisconsin-Parkside
Rachel Headley, University of Wisconsin-Parkside

The Pike River, which drains an urban-rural watershed in southeast Wisconsin, has been undergoing water quality monitoring for the past two years. Recent monitoring focuses on where the Pike River flows through Petrifying Springs Park in Kenosha County. The intent of this study is to measure the downstream impacts of the current restoration that is being done inside the park. By monitoring the water quality, the temporal and spatial variability of phosphorus and nitrate/nitrite levels can be accounted for. Phosphorous is an important element for plant life, although too much of it will speed up eutrophication. Excess levels of nitrates in water can have a negative effect on aquatic insects and fish making it difficult to survive. Additionally, high amounts of suspended solids can block the amount of light passing through the water, slowing down photosynthesis. By measuring the total suspended sediment, we are able to determine potential problems that may occur downstream due to the new restoration project. The following parameters are also measured: dissolved oxygen, conductivity, pH, and turbidity. A comparison between pre-restoration and post-restoration results shows the immediate impacts of the project, as well as the strong seasonal cycle and abnormal high, flashy flow of fall 2018. We expect there to be an increase in total suspended sediment due to the habitat disruption currently taking place in the park upstream from the sampling sites.

* * *

10. Colonial Park Ravine Erosion Analysis

Meagan Meier, University of Wisconsin-Parkside, meier028@rangers.uwp.edu
Kasey Warmington, University of Wisconsin-Parkside
Rachel Headley, University of Wisconsin-Parkside

The Root River is an urban-rural drainage basin in southeastern Wisconsin, flowing south from western Milwaukee suburbs to its mouth in downtown Racine. This research was conducted working with the Root-Pike Watershed Initiative Network (WIN), an organization that aims to restore, protect, and sustain all watersheds within the Root-Pike Basin. The research focused on the effects of soil texture and invasive vegetation on erosion rates in a ravine formed by a small tributary of the Root River within Colonial Park in Racine County. Fieldwork was conducted every few weeks to collect erosion rates, measured by placing dowels in four separate locations along the ravine, as well as soil samples. At each erosion sampling site the tributary's flow rate and the width of the ravine were measured, as well as soil moisture. Preliminary results show that slight erosion is occurring within the ravine, with major erosion happening near the head of the ravine. The ravine erosion builds up sediment deposits along the banks, leading to build up further downstream into the wetland, potentially damaging habitat. From this work, it is recommended that restoration of the landscape focus native species that act to buffer the landscape and act as erosion control.

* * *

11. Aerial Imaging River System (AIRS): Measuring Flood Peaks Using Drones

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Jamir Jyoti
Henry Medeiros
Walter McDonald

Extreme precipitation events in the U.S., such as Hurricane Harvey in Texas and the 2017 June storms in Southeast Wisconsin, cause billions of dollars in infrastructure damages and hundreds of lives to be lost each year. Engineering solutions to these disasters require accurate and reliable streamflow data that capture the magnitude of flood conditions. However, flow rate measurements during floods are inherently uncertain, and physical measurements of velocity during flood conditions are prohibitive in many cases. Therefore, novel methods to measure stream velocity during extreme floods must be considered. This project addresses this challenge through the development of the Aerial Imaging River System (AIRS), a novel system that utilizes drones, video imaging, and optical flow algorithms to measure velocity in streams during extreme floods. Results indicate that state-of-the-art deep learning-based optical flow estimation methods can be used to estimate the magnitude and orientation of surface velocity. If fully developed, this system can transform the way that extreme floods are measured.

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12. Groundwater influence on Lake Michigan Bluff Stability and Some Control Approaches

Robert Montgomery, Montgomery Associates: Resource Solutions, rob@ma-rs.org

Erosion and slope failures of bluffs along the Lake Michigan shoreline has once again become an issue of concern in Wisconsin. The failure of bluffs composed of glacial materials has been generally been attributed to a recent substantial rise in Lake Michigan water levels, which accelerates the erosion of the toe of the bluff by wave action. However, the distribution of groundwater within the face of the bluff is also a very important variable in determining bluff stability. Recent heavy rainfalls in Wisconsin have produced high rates of groundwater recharge, which has further exacerbated bluff stability problems. Analysis of groundwater hydrology and techniques for groundwater investigation are important in assessment of bluff stability, and also in the design of remedies to reduce stability problems driven by groundwater conditions. This paper presents examples drawn from several projects regarding field investigation of groundwater level and movement within the bluff materials, and within bluff drainage systems. The sensitivity of calculated bluff stability to

the range of groundwater conditions produced by recent increased recharge using the geotechnical analysis program SATBL. Examples are provided regarding techniques to improve slope stability driven by groundwater conditions by limiting groundwater recharge at and landward of the bluff and by intercepting drain systems.

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13. The Influence of Road Salt on the Performance and Species Composition of Decomposers

Shelby McIlheran,* University of Wisconsin Oshkosh, mcilhs19@uwosh.edu
Robert Stelzer, UW Oshkosh
Sabrina Mueller-Spitz, UW Oshkosh

Globally, chloride concentrations are increasing in many freshwater ecosystems. High chloride concentrations can have negative consequences for freshwater biota including decreased growth rate and fertility. Organic matter decomposition is a fundamental component of the global carbon cycle, but the impacts of elevated chloride concentration on decomposers and decomposition are not well known. Our research objective was to determine how elevated chloride concentration affects decomposition processes and decomposer diversity in freshwater systems. We determined how microbes (bacteria and fungi) and invertebrates (Gammarus amphipods) associated with decaying leaves in a local stream were affected by a range of chloride concentrations in two laboratory experiments. In the first experiment we measured how chloride concentration affected amphipod growth, egestion and mortality rates. In the second experiment we determined how chloride concentration impacted microbial respiration and decomposition rates, and species composition (based on 16s rRNA sequencing). We determined that amphipod growth rates and mortality were both impacted by chloride concentration. Preliminary results from the second experiment suggest that microbial respiration was not affected by chloride concentration. At the functional level these results suggest that decomposition by invertebrates may be more sensitive to elevated chloride concentration than decomposition by microbes.

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14. Coastal Morphology Change in Response to Coastal Structures in Lake Michigan

Boyuan Lu,* Department of Civil and Environmental Engineering, University of Wisconsin–Madison, blu38@wisc.edu
Chin Wu, Department of Civil and Environmental Engineering, University of Wisconsin–Madison

Changes of coastal bluffs and beaches are crucial to personal safety, property, and infrastructure in economically vital, high-value, and densely populated Great Lakes coastal areas. Coastal structures are commonly employed to vessel shelter or protect property against erosion. Nevertheless, structures are also known to interrupt longshore sediment transport and disrupt sediment budgets on regional scales. Protection structures also can elevate wave climate locally, creating steeper nearshore slopes adjacent to the structure. As a result, beaches and bluffs experience accelerated erosion. To date, both regional and local impacts of coastal structures on beach and bluff systems have not yet been clearly addressed. This study will investigate processes and feedbacks of coastal bluff evolution adjacent to coastal structures on local to regional scales. We will characterize the erosion patterns at high and low water levels. For this purpose the shoreline and bluff recession is determined and compared in north and south Port Washington. A one-line Model is employed to identify how shoreline and bluff respond to different water levels with presence of water structures. Observation data based on historical aerial images is then applied to calibrate modeling outputs. Overall, the evolution patterns of bluff and shoreline under high and low water levels can provide local residents with the suggestive perspectives in terms of hazard forecasting and coastal structure protection.

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15. Comparing Soil Infiltration Capacity Among and Within Residential Parcels in Milwaukee, WI

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Carolyn Voter, University of Wisconsin-Madison
Steven Loheide, University of Wisconsin-Madison

In hydrologic modeling, soil hydraulic characteristics are typically represented using mean natural parameters based on undisturbed environments. In urban spaces, however, these soils are not necessarily identical to natural conditions due to compaction from construction activities and other disturbances. This project aimed to quantify the infiltration capacity of urban soils and explore whether significant differences in hydraulic conductivity exist based on location in the landscape. Infiltration measurements were collected across six residential city blocks in Milwaukee, WI, representing a variety of soil types. These measurements were analyzed for statistical differences across variables such as city block, location in yard (near a downspout, a driveway, or in the terrace), soil type, and other specific yard conditions such as the presence of connected or disconnected downspouts. Statistical analysis showed that there was no significant difference in hydraulic conductivity across many of the variables, indicating that there is as much variation in hydraulic conductivity within parcels and within blocks as there is across the city. Understanding the hydrologic properties of soil present in urban settings is important for designing green infrastructure and predicting how green infrastructure will change hydrology in a particular area.

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16. Coverage of Water Issues in Wisconsin's Print Media

Yanet Fernandez,* UW Fox Valley, FERNY2646@students.uwc.edu
Jamie Douglas, UW Fox Valley

Newspapers and news coverage has the ability to inform the public and shape discourse on a wide variety of topics. However, print media has faced a number of economic challenges in the last several decades due to declining circulation, the growth of online media, and decreased print media sales revenues. These factors have led to consolidation of local newspapers and shifting of ownership to larger media conglomerates. This research looks at how shifts in newspaper ownership has changed the coverage of water resource issues in Wisconsin. This research evaluates the quantity, placement, and content of water resource related stories in several newspapers in Wisconsin – the Green Bay Press Gazette, the Oshkosh Northwestern, the Milwaukee Journal Sentinel, and the Wisconsin State Journal. Several points in time have been selected to capture coverage before and after media consolidation.

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17. Modeling Green Infrastructure Influence on Rainfall Derived Inflow and Infiltration

Jeffrey Strasser,* Marquette University, jeffrey.strasser@marquette.edu
Anthony Parolari, Marquette University

Urbanization and climate change are creating new challenges for urban stormwater infrastructure. One solution to these challenges is green infrastructure (GI), which are engineered plant and soil systems designed to capture stormwater on-site to enhance infiltration and evapotranspiration. Enhanced infiltration can be problematic as groundwater flows into aged, leaky sewer pipes, i.e., “Rainfall Derived Inflow and Infiltration” (RDII). RDII increases wet weather flows at the wastewater treatment plant and is a major cost for collection system utilities. It is unknown whether GI-enhanced infiltration translates into more RDII and, therefore, more wet weather flows and treatment costs. To quantify GI influence on RDII, we developed a model to estimate RDII under a range of soil and climate conditions using the Hydrus 2D/3D software for coupled unsaturated-saturated subsurface water flow. Using a model of a typical residential property, we compare two scenarios to evaluate the impact of roof drain disconnection on RDII: (1) the roof drain is directly connected to the sanitary sewer lateral and (2) the roof drain is disconnected from the lateral and redirected to a rain garden. Model results demonstrated that focused infiltration in the rain garden can increase or decrease RDII, depending on the soil type, slope, rainfall intensity, groundwater table depth, and the location of the rain garden in relation to the sanitary sewer lateral.

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18. Improved Reliability of Stormwater Detention Basin Performance through Water Quality Data-informed Real-time Control

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Ting Lin, Texas Tech University
Walter McDonald, Marquette University
Anthony Parolari, Marquette University

Stormwater retentions basins are designed to capture stormwater to reduce and delay peak flows and to improve water quality. A novel technology proposed to improve basin performance is real-time, active control of the basin outflow, in so-called "smart" stormwater systems. Ex isting studies demonstrate the performance of active controls that respond in real-time to basin water level, detention time, and rainfall forecast. We hypothesize that the performance of these active controls can be improved by incorporating real-time water quality data into the control algorithm. In this paper, we test this hypothesis using a numerical modeling framework for systems-level reliability analysis of active and passive control. The analysis is performed using the urban hydrology model EPA-SWMM driven by stochastic rainfall time-series generated from the Modified Bartlett-Lewis Rectangular Pulses Model. Water quality-informed real-time active control algorithms are developed, tested, and shown to display an 82.9% improvement over traditional, passive (no control) systems and other storage-based active controls for water and suspended sediment capture. These results show water quality data-informed real-time control can improve sediment capture, resulting in an overall improvement of system-level reliability of the basin. However, not all control systems improved basin operation and the performance depended on the temporal variability of the rainfall-runoff and sediment washoff processes.

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19. Method to Transfer Flood Risk for Regional Flood Frequency Analysis

Elizabeth Regier,* Marquette University, elizabeth.regier@marquette.edu
Joseph Naughton, Marquette University
Walter McDonald, Marquette University

Hurricane Harvey was an unprecedented event that resulted in immense damage to life and property. As a result, it is important to determine how this event, as well as past and future events like it, will impact flood frequency analysis equations, which are based upon historical data. In addition, it is also important to consider if Harvey's flood risk should be limited to where it was observed, or if other areas within its probabilistic path should consider the impact of an event like Harvey within infrastructure design. In this study, we evaluate the impact that Hurricane Harvey had on regional flood frequency analysis and propose a method to transfer that risk to other basins within its probabilistic path. Results indicate that Harvey significantly increased the computations of design floods using Log-Pearson Type III analysis. This subsequently impacted the estimation of instantaneous peak discharges through regional flood frequency analysis by up to 28%. In addition, a synthetic unit hydrograph approach was developed to transfer flood risk from Harvey to other regions within its probabilistic path. Results indicate that transferring precipitation from Harvey to other coastal regions in Texas impacted their design floods by a similar magnitude. These results highlight the influence that recent and future hurricanes can have on engineering design equations and present a potential solution for transferring flood risk to other regions using regional flood frequency analysis.

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20. Suck the Muck: Connecting Science to People

John Reimer, Dane County Land & Water Resources Department, reimer.john@countyofdane.com
Chin Wu, UW-Madison

Science driven research is often unnoticed by the society due to the lack of formulating implementable projects to benefit the community. We will illustrate legacy phosphorus in stream sediments by sound science and effective communication to

the community. Past research has identified that legacy phosphorus of past management may undermine current conservation management strategies due to only targeting today's phosphorus sources, thus delaying the intended water quality benefits for years, decades, or centuries. To account for the contributions of retained and remobilized phosphorus in streams that may hinder accurate estimation of P sources in watersheds and further contribute to contentious TMDL development and implementation, we examine the time lag of legacy sources that might delay the water quality response at the project site, Dorn Creek, WI. The implementation of removal legacy phosphorus in stream sediments due to community support will be presented. We will share effective communication plans by gathering input and support from the public that leads to an allocated $12 million dollar budget. In addition, outreach efforts such as field demos, public presentations, and press events are conducted. A slogan "Suck the Muck", developed for the project, is most recently reported in the Wisconsin State Journal as "Suck"cess achieving the overall goal to connect science to people.

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21. Analyzing Ancient Water-Rock Interaction History in Northeastern Wisconsin Using Fluid Inclusions in Minerals

Olukayode Akinkuehinmi,* University of Wisconsin - Green Bay, akinkuehinmi.k@gmail.com
John Luczaj, University of Wisconsin - Green Bay

Water-rock interaction in northeastern Wisconsin strongly influences the water quality of aquifers. Understanding the source and composition of the contaminants in aquifers allows us to make informed well construction decisions. Ancient geothermal brine from the Michigan basin flowed through sedimentary rocks in northeastern Wisconsin, depositing Mississippi Valley-type minerals throughout the region. The presence of sulfide minerals within the aquifer is linked with water quality issues affecting this region (e.g., arsenic, strontium). Our research provides a window into the ancient groundwater systems present in eastern Wisconsin during the Late Paleozoic Era.

Thin section preparation and fluid-inclusion microthermometry were conducted at UW-Green Bay using rock samples from Oconto, Marinette, Shawano and Outagamie counties to understand the temperature and the salinity of the formation water during deposition. Minerals analyzed included sphalerite, dolomite, quartz, and calcite. Homogenization temperatures for the earlier minerals and ore-stage minerals showed a range of 65 to 100°C, and freezing data show high salinity of the inclusions (~21 to 24 weight %, NaCl equivalent). Late calcite contained mainly all-liquid inclusions, suggesting entrapment below about 40-50°C, and the inclusions had near fresh water salinity. Our results support previous interpretations of hydrothermal brine expulsion from the Michigan basin.

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22. The Health Burden of Private Wells Contaminated by Gastrointestinal Pathogens in the Fractured Dolomite Aquifer of Kewaunee County, Wisconsin

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Joel Stokdyk, USGS
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Aaron Firnstahl, USGS
Mark Borchardt, USDA-ARS

Private wells are an important source of drinking water in Kewaunee County, serving approximately 12,000 residents. Due to the region's fractured dolomite aquifer, these wells are vulnerable to contamination by gastrointestinal pathogens originating from land-applied dairy manure and private septic systems, but the magnitude of the health burden associated with this contamination is unknown. This study combines quantitative microbial risk assessment (QMRA) with a year-long pathogen occurrence study (n = 138 well samples) in order to predict the total cases of acute gastrointestinal illness (AGI) caused by private well contamination in Kewaunee County. It also uses microbial source tracking (MST) to attribute cases to each of the two major fecal sources present in the county: dairy manure and human sewage. Assuming that all private well users drink their water untreated, preliminary results suggest that private well contamination could be responsible for

as many as 460 total cases of AGI per year in the county. Furthermore, 180 of these cases could be attributed to a dairy manure source, while 90 could be attributed to human sewage (190 cases could not be attributed based on MST). Exposure to Cryptosporidium parvum in private well water was predicted to cause 300 cases of AGI per year, the most out of all 9 pathogens included in the QMRA. These results have important implications for the management of fecal waste and groundwater quality in Kewaunee County.

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23. Development of an Urban Land Cover Temperature Model Using Drone Imagery

Joseph Naughton,* Marquette University, joseph.naughton@marquette.edu
Walter McDonald, Marquette University

Temperature represents one of the largest impairments for rivers and streams across the US. In western states like New Mexico it can make up nearly half of the total impairments, and even in Wisconsin, over 17 miles of rivers are impaired for temperature. This situation is projected to get worse as land development and climate change accelerate thermal stress on aquatic environments. Solutions will require accurate and reliable models that represent rainfall-runoff temperature dynamics – particularly the characterization of urban terrain or land surface temperatures. However, existing empirical terrain temperature models are limited by the point-based data they are built upon, and limited studies have considered the high-resolution spatial distribution of temperature across homogeneous land surfaces, which are known to be significant. This can be overcome with drone and thermal camera technologies that collect spatially distributed temperatures accurate to fractions of a degree Celsius. Therefore, this study addresses this knowledge gap by using a drone to collect high-resolution thermal orthoimagery and applying the data to develop an empirical terrain temperature model. Experimental sites include Marquette University and the University of Texas El Paso, two distinct geomorphologic and climatic regions. The outcome is a more accurate and reliable empirical model for terrain temperatures that accounts for high-resolution variability across homogeneous land surface types.

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24. Soil Water Dynamics Across Electrical Conductivity Management Zones for Precision Irrigation

Elizabeth McNamee,* University of Wisconsin-Madison, emcnamee@wisc.edu
Mallika Nocco, University of Minnesota-Twin Cities
Kevin Masarik, University of Wisconsin-Madison
Christopher Kucharik, University of Wisconsin-Madison

Soil apparent electrical conductivity (ECa) mapping to delineate management zones for precision irrigation, and for precision agriculture more broadly, is becoming more popular among Wisconsin Central Sands (WCS) growers. Recent work indicates that topsoil texture and field capacity are significant predictors of ECa measurements in some WCS fields, and soil texture and climate variability are significant drivers of point-based potential recharge (drainage – irrigation) estimates in the WCS. In the precision agriculture literature, few studies have explored the relationship between ECa and modeled deep drainage, and none have compared ECa to measured drainage data. We evaluate ECa relationships with deep drainage and soil moisture using observations from a large network of lysimeters over five years under a field corn-potato-pea/pearl millet-sweet corn cropping rotation and assess the temporal variability of these connections. Results will help inform grower decision making regarding zone-based water management.

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25. Geologic and Geochemical Conditions Affecting Radium Mobility in the Wisconsin Cambrian-Ordovician Aquifer System

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Marie Dematatis, Department of Civil and Environmental Engineering, UW-Madison
Madeleine Mathews, Environmental Chemistry and Technology, UW-Madison

Madeline Gotkowitz, Montana Bureau of Mines and Geology, Butte, MT
Matthew Ginder-Vogel, Environmental Chemistry and Technology, UW-Madison

Radium concentrations in groundwater are primarily governed by the presence of parent isotopes and geochemical conditions within an aquifer system. Geochemical analysis of groundwater from discrete intervals within the aquifer system near Madison, WI, did not reveal a trend across hydrostratigraphic units. However, samples from the confined portion of the aquifer suggest an association between elevated Ra and low dissolved oxygen, while a relationship between total dissolved solids and Ra(II) was observed in samples from the unconfined aquifer.

Our group is investigating the distribution of Ra(II) across WI with a multi-faceted approach, which includes controlled laboratory experiments, data mining methods, and conceptual models. Current laboratory work includes column experiments on well cuttings to determine the primary mineral and phase sources of ^{238}U and ^{232}Th. Data mining methods include examining the distribution of Ra(II) across regional hydrogeologic settings and comparing to potential geologic sources. A third component involves developing conceptual models to fit the variety of geologic and geochemical conditions in radium-impacted areas. One such model illustrates uneven Precambrian basement topography near the surface in some regions and its potential influence on groundwater flow and geochemical conditions. We anticipate that results from these varied approaches will provide a geochemical basis for managing wells and well fields to minimize Ra(II) levels.

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26. Method Development to Assess Monensin Concentration in Agricultural Runoff Water and Sediment

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Paul McGinley, UW-Stevens Point Center for Watershed Science and Education

Monensin is a coccidiostat antibiotic used as a feed additive for disease prevention and increased milk production in dairy cows. The presence of monensin in surface runoff and shallow groundwater near animal feeding operations has been documented in previous research. Being able to track the occurrence of monensin in water may provide a tool to indicate manure contamination as well as to determine the path that the water has taken. Methods of extraction and LC/MS/MS analysis of monensin concentrations from samples of both water and sediment were investigated in this project. Nigericin was used as an internal standard at a fixed concentration for all prepared samples. Solid phase and liquid-liquid extractions were performed with various solvents, and reverse-phase liquid chromatography was conducted with several different mobile phase gradients of acidified water and methanol for analysis by tandem mass spectrometry. Extracted samples were evaporated under nitrogen and reconstituted in solvent for each procedure. After the method was optimized, it was tested on runoff collected at the edge of several dairy grazing plots.

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27. Coupled Modeling of Groundwater Flow and Slope Stability along the Lake Michigan Coastline

Collin Roland,* University of Wisconsin - Madison, cjroland@wisc.edu
Luke Zoet, University of Wisconsin - Madison
Elmo Rawling, Wisconsin Geological & Natural History Survey
Russ Kreuger, University of Wisconsin - Madison
Mike Cardiff, University of Wisconsin - Madison

The supply of sand-sized sediment to Lake Michigan has historically been dominated by the erosion of coastal bluffs, but anthropogenic armoring of significant portions of the coastline has likely decreased the average bluff erosion rate and reduced the amount of sand-sized sediment available to the nearshore. A subset of ‘feeder’ coastal bluffs are hypothesized to contribute an outsized proportion of sediment to the nearshore system due to differences in lithology and hydrogeologic conditions. To assess this hypothesis and better inform coastal planning, an improved understanding of the factors that influence bluff failure is required. We monitored groundwater elevations of bluffs in glacial lithology and generated transient pore pressure models which were coupled with a 3D slope stability model to assess the impacts of lithology, hydrologic forcing, and hydrogeologic properties on bluff stability. High-resolution digital elevation models (DEM's) were constructed to estimate the volume of material eroded from the monitored bluffs and identify areas of bluff failure. Observed bluff failures were compared with model predictions of bluff stability.

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28. Little Plover River Water Budget Analysis to Evaluate Baseflow Restoration Alternatives

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Nick Hayden, Montgomery Associates: Resource Solutions, LLC
Dane Wudel, Montgomery Associates: Resource Solutions, LLC

The Little Plover River Watershed Enhancement Project is a voluntary collaboration that aims to improve baseflow and habitat in this Central Sands trout stream, led by the Village of Plover with partners in agriculture, government and conservation organizations. Information and models developed by decades of previous research are being applied to evaluate a wide range of baseflow restoration options. Steady-state depletion potentials calculated for high capacity wells in the 2017 Little Plover River groundwater flow modeling study are being applied in a spreadsheet water balance model to efficiently screen baseflow improvement potential for numerous pumping reduction scenarios for wells across the watershed and beyond. Transient effects due to the seasonal nature of irrigation well pumping were evaluated using Glover's analytical method and MODFLOW. Both methods indicate that wells within about 1 mile of the river have a substantial seasonal effect on streamflow, and that the seasonal variation in the streamflow diversion is perhaps 20% of the annual average diversion. Thus, while transient effects are worth understanding and addressing, a steady-state water balance approach will continue to be needed for assessing flow restoration options. Alternatives being evaluated include decommissioning wells with high depletion potentials, municipal and agricultural water conservation, wetland restoration, and alternatives to enhance groundwater recharge.

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29. An Accounting of Groundwater Withdrawals from Major Aquifers in Wisconsin and the United States, 2015

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John Lovelace, UGSG, Baton Rouge, LA
Molly Maupin, USGS, Boise, ID
Amy Read, USGS, Tucson, AZ
Chid Murphy, Bureau of Indian Affairs

Groundwater use in Wisconsin and the United States fluctuates over time in response to economic, climatic, demographic, and policy changes. It is difficult to compare withdrawals across large spatial and temporal scales without nationally-consistent datasets to describe the withdrawals. The U.S. Geological Survey (USGS) has defined sixty-seven principal aquifers or aquifer systems in the United States, Puerto Rico, and the U.S. Virgin Islands. In 2000, USGS estimates of groundwater withdrawals for public supply, self-supplied industrial, and irrigation from the principal aquifers and aquifer systems accounted for more than 98 percent of all groundwater withdrawals for all water-use categories in the U.S. In Wisconsin, the glacial and Cambrian-Ordovician aquifers accounted for 93 percent of all groundwater withdrawals in the state. The USGS is currently conducting a second estimate of groundwater withdrawals from principal aquifers for the year 2015. Withdrawals are being estimated for public supply, self-supplied domestic use, self-supplied industrial use, thermoelectric power generation, mining, irrigation, livestock, and aquaculture. While the 2000 estimates were conducted at the state level, the 2015 estimates are being conducted at the county level. Results of this study are expected to be released in 2019 and will complement a national report released in 2018 that documents groundwater and surface-water withdrawals for various uses in each county and state in the US.

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30. Effect of Fracture Roughness on Fluid-facilitated Energy Exchange Processes

Noah Vriese,* University of Wisconsin-Madison, vriese@wisc.edu
Michael Cardiff, University of Wisconsin-Madison

Quantitative studies of flow in fractured rock are important to engineering, hydrogeological, and geotechnical practices due to the ubiquitous nature of fractures in important geothermal, water supply, and petroleum reservoirs. Importantly, fluid flow through fractured systems induces energy and chemical exchange with the host rock. The nature and magnitude of this exchange however, has been shown to be dependent upon several factors including flow path tortuousness and fracture surface roughness [1]. Due to the difficulty of observing flow fields in a natural fracture system, many studies of single-fracture flow have used gross geometric simplifications such as the parallel plate model. These models however, lead to inaccuracies when predicting advection and diffusion in natural systems with complex asperity geometries. More recent studies have used simplified artificial fracture asperities to introduce some of the complexity inherent to natural systems, however few studies have yet focused upon the effect of natural fracture surface roughness on flow and energy exchange processes [1]. Here we present work conducted to quantitatively model the effect of natural fracture roughness on these processes. The first phase of study will involve the replication of natural granite fractures via white light interferometry. Modeling of multiphysical fluid flow and energy transfer through the host fracture will then be conducted using COMSOL Multiphysics®.

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31. Assessment of Long-Term and Recent Trends from USGS Groundwater Level Records in Wisconsin from 1947 to 2017

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Emily Finger, University of Wisconsin-Eau Claire
Sarah Vitale, University of Wisconsin-Eau Claire

This study examines the relationship between regional groundwater level trends, aquifer sensitivity, land use, and climate variability in Wisconsin, USA. Monthly groundwater level data were obtained from the U.S. Geological Survey (USGS) and monthly outputs of WI divisional climate data were obtained from the Midwestern Regional Climate Center (MRCC). Data were analyzed for long-term (1947-2017) and the recent short-term (2002-2017) by MRCC climate zone, with consideration for land use, aquifer type, and well depth. Well records were required to span at least fifteen years for long-term analysis, and ten years for short-term analysis, and contain fewer than 15% omissions. Out of 15 total wells for long-term analysis, six (6) are in sand and gravel, six (6) are in the Cambrian-Ordovician aquifer (sandstone), and three (3) are in the Silurian-Devonian aquifer (carbonates). Groundwater trends show increasing gradients of 0.01 to 0.19 m/yr in southwest Wisconsin (MRCC climate zones 7 and 8). 38 well records met the criteria for short-term analysis (15 sand and gravel, 13 Cambrian-Ordovician, 10 Silurian-Devonian). Short-term analysis shows groundwater trending upward across much of the state with increasing gradients up to 0.28 m/yr.

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32. Algae Estimator: Mobile Phone Application for Predicting Harmful Algal Blooms in Shallow Freshwater Lakes

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Hedda Sander, Ostfalia University of Applied Science

Algae Estimator© is a mobile phone application to predict Harmful Algal Blooms (HABs) in shallow lakes using readily available water quality parameters. Algae Estimator© was developed through a collaboration between Ostfalia University of Applied Science in Wolfenbuttel, Germany and the University of Wisconsin-Parkside in Kenosha, Wisconsin. HABs in shallow lakes often present a public health risk. Thus, monitoring of algal growth during the high growth summer season in recreational areas of high public use can be beneficial to minimize public exposure and can help raise public awareness of HABs. Water quality data and results of total chlorophyll fluorescence (Chl a) and cyanobacteria Chl-a measurements from four shallow freshwater lakes have been used to test the predictive capability of Algae Estimator©. Input parameters for Algae Estimator© include: surface and bottom water temperature, lake depth, light brightness, secci depth and dissolved

oxygen, and phosphorus (PO4) concentration. Algae Estimator© incorporates a simple prediction model of harmful algal growth based on the Verhulst equation and provides tabular and graphic estimates of Total Chl a and Cyanobacteria Chl a concentrations versus time. Summer 2018 data from Lake Stadtgraben was used as Algae Estimator© input to successfully predict a HAB in August 2018. The Algae Estimator© was also utilized to estimate missing PO4 concentrations in Utah Lake using data sets from three dedicated algae monitoring buoys.

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33. Leachable Phosphorus in Leaf Litter and Its Impact on Phosphorus Loads in Urban Stormwater

Yi Wang,* University of Wisconsin-Madison, ywang966@wisc.edu
Anita Thompson, University of Wisconsin-Madison
William Selbig, U.S. Geological Survey

In urban watersheds, a critical biogenic source of nutrients in stormwater runoff is leaf litter from trees. Stormwater extracts phosphorus (P) from leaf litter and transports it directly to the outlet through the storm sewer network. Laboratory experiments were conducted to understand P leaching potential from two dominant tree species (Norway Maple and Green Ash) in three residential watersheds in Madison, Wisconsin. Over a 48 hour period, both species showed a rapid release of Total Dissolved Phosphorus (TDP) in the first 6 hours which gradually plateaued. TDP leached from Norway Maple (1.14 mg/g for intact leaves and 1.10 mg/g for crushed leaves) was greater than from Green Ash (1.03 mg/g for intact leaves and 0.83 mg/g for crushed leaves). Intact leaves initially leached less TDP than crushed leaves for both species but ultimately leached more. Doubling the leaf mass doubled the concentration of TDP in leachate; however, when normalized by leaf mass, concentrations remained the same.

A multivariate linear regression model was used to explore relations among storm event characteristics, leachable leaf P, watershed characteristics, and end-of-pipe P loads in runoff from the three residential watersheds. Preliminary modeling indicates that leaf mass on streets and precipitation intensity correlate linearly with P load in runoff during Fall. Understanding the dynamics in urban residential settings would help regulated cities receive P reduction credit for leaf collection.

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34. Translocation of Elimia comalensis (Gastropoda: Pleuroceridae) in a Texas Spring as a Potential Model for Congeneric Species in Wisconsin

Kiera Theys,* University of Wisconsin-Whitewater, theyskn20@uww.edu
Rex Hanger, University of Wisconsin-Whitewater

Elimia comalensis is an endemic species (Nature Conservancy status G2 = imperiled) of the Family Pleuroceridae, found in only a few springs and streams in central Texas. One such occurrence was the unnamed spring and creek below the outflow of Stillhouse Hollow Reservoir. Despite regular surveys, E. comalensis has been extirpated from this locality since 1992, when flooding forced water over the spillway and through the creek to preserve the dam. Since then, the US Army Corps of Engineers created Chalk Ridge Falls Park that now incorporates the entire creek, allowing for low level protection and oversight of wildlife within the park boundaries. Currently, there are thriving populations of E. comalensis located just a few km away outside the park at Salado Creek. Initial approval has been granted to strategize a proposal to translocate E. comalensis from Salado Creek to Chalk Ridge Falls Park. The proposal and possible subsequent translocation are relevant for the future of Wisconsin in that there exist thriving populations of the congeners, E. livescens and E. acuta in some watersheds, but with patchy distributions statewide, with many once-occupied localities now devoid of the species. The translocation proposal process and activity in Texas can be used as a model for how future gastropod conservation efforts in Wisconsin as well.

35. A Modeling Approach for Source Water Protection: A Case Study in Waupaca, WI

Stephanie DeVries, Wisconsin Geological and Natural History Survey, stephanie.devries@wgnhs.uwex.edu
Michael Cardiff, UW-Madison
Brian Austin, DNR

The municipal water supply system in Waupaca, WI, is divided across two watersheds, with up to 60% of finished water withdrawn from two wells (#5 and #6) that are isolated on a small, city-owned plot of land situated among low-density housing and several large farm operations. Recent reports of rising nitrate concentrations have raised concerns among area residents, as well as local and state agencies, that the long-term security of these important supply wells may be at risk. To address these concerns and answer questions about N-sources and transport in the contributing aquifer, a 3D groundwater flow and contaminant transport model was developed in GW Vistas. Steady-state flow was validated against a network of monitoring wells inside the model domain and used to delineate the 1-, 5-, and 10-year capture zones for each well. Forward-particle tracking was then applied to identify the relative importance of potential N-sources within the watershed including a nearfield cattle waste lagoon and several near-and far-field row cropping operations. Results of this model will be used locally to identify cooperative solutions for land-management that will best protect wells #5 and #6 from additional N-loading. At a larger scale, this work will serve as part of a case-study for a statewide "Nitrogen Decision Support Tool" that is under development in collaboration with the Wisconsin DNR, with the long-term goal of protecting groundwater resources vulnerable to nitrate contamination.

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36. Preliminary Water Quality Assessment of the Confined Sandstone Aquifer in and near Kewaunee County, Wisconsin

Abby Shea,* University of Wisconsin - Green Bay, sheaaw31@uwgb.edu
John Luczaj, University of Wisconsin - Green Bay

The Silurian dolomite aquifer in Northeast Wisconsin has significant anthropogenic contamination. For 30 years, the confined Cambrian-Ordovician sandstone aquifer, which is less susceptible to surface contamination, has been increasingly utilized in parts of southwest Door, northwest Kewaunee, and northeast Brown counties. Little is known about the groundwater chemistry of the confined aquifer in these areas. In portions of the sandstone aquifer farther to the southwest, challenges include high dissolved solids (TDS), Ra, Sr, As, F, SO_4, Cl, B, etc. Our study of 17 wells provides the first water quality analysis of the sandstone aquifer and its suitability to be used as an alternative water supply.

Piper plots show the groundwater is of no dominant type, as cations (Ca, Mg, and Na + K) exist in relatively equal proportions, as do anions (HCO_3, Cl, and SO_4). TDS ranged from 450 to 1720 mg/L. The wells exceeded the EPA lifetime health advisory level for Sr (4 mg/L), and were up to 26.8 mg/L. Most samples exceeded the EPA secondary maximum contaminant level (SMCL) for Fe and SO_4. Five samples exceeded the SMCL for Cl, and three samples exceeded the SMCL for F. All five samples tested for combined radium exceeded the 5 pCi/L standard and ranged from 14.0 to 21.2 pCi/L. Along with a variety of treatment methods used by well owners, the results reveal that the confined sandstone aquifer is a viable source of potable water in the study area

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37. Wisconsin Water Stewards Program

Deana Knuteson, UW-Madison, dknuteson@wisc.edu
Robert Smail, Wisconsin DNR/University of Wisconsin - Madison

In 2016, the Wisconsin Water Stewards Program was initiated with input from a working group composed of municipal leaders, environmentally-oriented NGOs, public agencies, academic researchers, farmers, supply chain partners and agricultural associations to discuss potential groundwater management scenarios that maintain or enhance agricultural, ecosystem and recreational values. The goal was to develop a program that would allow farmers to be recognized when providing water stewardship and documenting improvements and was based on progress toward research-based water

steward and conservation goals. This led to the Water Stewards tier-based program which is now being used by potato and vegetable growers in Central Wisconsin. The assessment has 2-tiers: 1) a base tier that is a practice-based water management program leading to long-term water conservation and increased water use efficiencies; and 2) a top tier that includes a visit with a water use specialist, who helps design a detailed conservation program focused on regional farm and location based option which emphasize restoration, ecological principles, stream protection and new strategies based on risk levels associated with farms. A key outcome for the Water Stewards Program is the linkage of sustainability programs to achieved goals as supply chain partners are looking for local water stewardship solutions. Additional benefits include enhanced education, better messaging and increased public relations.

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38. Agricultural Impacts on Water Quality in the Little Baraboo System

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Austin Polebitski, UW- Platteville
Stephen Swallen, UW-Baraboo
Serge Koenig, Sauk County Land Conservation Department

The primary goal of this research is to study the connection between surface water quality and adjacent agricultural practices. This project provides quantitative data on the health of the Little Baraboo system and attempts to examine policies to better protect Wisconsin's highly impacted waterways. Over the course of the summer of 2018 a sampling campaign was conducted to measure water quality parameters for the Little Baraboo at 6 sites along the course of the river. Sites were sampled weekly for total suspended solids and bi-weekly for P and N along with total suspended solids. This poster presents a summary of the water quality results and a GIS examination of the land use upstream of each sampling site.

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Session 3A:
Water Quality
Friday, March 1, 2019
8:30 – 10:10 a.m.

Setting Expectations: What Should Healthy Streams Be Like?

Michael Miller, Wisconsin Department of Natural Resources, michaela.miller@wisconsin.gov
Jonathan Kult, Wisconsin Department of Natural Resources
Dale Robertson, U.S. Geological Survey

Reference conditions can provide objective criteria to assess stream resources, but inherent variability within and among streams and human disturbance make it challenging to develop accurate benchmarks of natural conditions. We developed Random Forests (RF) models to estimate reach-specific current and reference conditions for various stream physical habitat, water chemistry, and biological field parameters. Initially we used data from least-disturbed reference sites (n = 297), to develop least-disturbed condition estimates. Using data from least-disturbed sites, many with significant human disturbance, limited our ability to derive accurate measures of natural stream conditions. Consequently, residual values from linear regression relationships for both model response and predictor variables, and watershed percent agricultural and urban land, were used to mathematically-remove the influences of these human land use disturbances from the models. This residualization process was applied to stream sampling data from thousands of stream sites across the state that had widely-varying environmental quality. The residual values for predictor and response variables were incorporated into RF models to estimate minimally-disturbed conditions (MDC). Model results were linked to GIS to map current condition and MDC estimates for each of Wisconsin's 110,000 perennial wadeable stream reaches.

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A Comprehensive Evaluation of Phosphorus Sources and Pathways in the Hydrologic System in Western Wisconsin

Sarah Vitale, University of Wisconsin-Eau Claire, vitalesa@uwec.edu
J. Brian Mahoney, University of Wisconsin-Eau Claire
Emily Finger, University of Wisconsin-Eau Claire
Evan Lundeen, University of Wisconsin-Eau Claire
Jacob Erickson, University of Wisconsin-Eau Claire
Laurel McEllistrem, University of Wisconsin-Eau Claire

This investigation uses a multidisciplinary approach to analyze phosphorus (P) transport in the hydrologic system in western WI. Evaluations of surface water and groundwater chemistry, whole rock chemistry, and sequential extraction analysis were

implemented to distinguish the spatial and temporal distribution of P, and to constrain potential sources and mechanisms for mobility in the hydrologic system. P-loading is responsible for lake eutrophication throughout WI, with severe impacts, including a loss of recreational tourism, reduction of commercial fisheries, and a decrease in biodiversity. Historically, P has been dominantly attributed to agricultural inputs delivered by surface runoff; however, this study suggests that P transport in the hydrologic system is more complex.

While surface water P commonly exceeds the WI surface water limit of 15-100 ppb, P in groundwater is far higher (10 to >1000 ppb). Whole rock chemistry and sequential extraction confirm that P occurs naturally in the regional Cambrian-Ordovician strata, and suggests that P is primarily liberated from the source rock in anaerobic environments. Findings indicate that P in the hydrologic system is contributed from both geologic and anthropogenic sources, that cause of mobility is dependent on localized aquifer conditions, and that P in groundwater may contribute to lake eutrophication. The investigation ultimately seeks to quantify relative contributions of geologic vs. anthropogenic P in select aquifers.

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Stream Sources of Suspended Sediment and Phosphorus from an Agricultural Tributary to the Great Lakes

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Faith Fitzpatrick, U.S. Geological Survey
Leah Kammel, U.S. Geological Survey
Sarah Francart, Outagamie County
Allen Gellis, U.S. Geological Survey
Barbara Eikenberry, U.S. Geological Survey

Plum Creek, Wisconsin has a Total Maximum Daily Load (TMDL) requiring a watershed management plan to reduce suspended sediment and phosphorus loads in the Lower Fox River Basin and Green Bay. The Sediment Source Assessment Tool (Sed_SAT) was used to apportion the relative contributions of five potential sources of sediment and sediment bound P including croplands, woodlands, roadside ditches, eroding gullies and ravines, and river bluffs and banks. Sed_SAT is an automated package of statistical procedures that enables the apportionment of sediment sources using trace elements. The proportion of upland vs. stream sources of suspended sediment in Plum Creek varied by season and the amount of runoff. Gully/ravine and bluff/bank erosion accounted for over 50 percent of the sources. Cropland sources were evident mainly in summer months. Woodland accounted for small percentages in December, March, June, and July. Fine-grained soft streambed sediment had mostly bank/bluff and gully/ravine sources. Only streambed sediment from a first order tributary showed sources dominated by cropland and roadside ditches. Part of the overwhelming signature of stream sources of suspended sediment in Plum Creek is due, in part, to its deeply entrenched valley. Additional analyses are being conducted to estimate the proportion of sediment bound phosphorus potentially delivered to the stream from the upland, ravine, and bluff/bank sources.

Rapid Risk-based Evaluation of Nitrate Management Scenarios

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Jeremy White, GNS Science
Matthew Knowling, GNS Science
Daniel Feinstein, USGS
Catherine Moore, GNS Science

Using physics-based numerical simulators such as groundwater flow/transport models for probabilistic management is typically so computationally burdensome that these tools cannot be used during decision-making. The computational challenges associated with these complex models can be addressed through model emulation, which involves deploying simpler, fast-running models that emulate the relationship between complex-model input and outputs. However, many emulation strategies suffer from issues that preclude their application in a decision-support setting. In the land-use/water-quality context, the linear relation between nitrate loading and surface-water/groundwater nitrate concentrations presents an opportunity for employing an emulator that overcomes these challenges. The current study exploits this linear relation through the application of impulse-response matrices in place of complex nutrient-transport numerical models, while propagating uncertainty from model parameters to simulated quantities of interest; this is implemented as a "stochastic impulse-response emulator" (SIRE). SIRE is shown to facilitate non-intrusive, rapid (i.e., near-real time) and risk-based evaluation of nitrate-loading change scenarios, as well as nitrate-loading management subject to surface-water/groundwater concentration constraints in high decision variable and parameter dimensions. SIRE is demonstrated in the Hauraki Plains, New Zealand.

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Transition from Pilot to Full-Scale Utility Led Agricultural Based Adaptive Management Watershed Program

Jeff Smudde, NEW Water, jsmudde@newwater.us

A multi-faceted stakeholder group led by NEW Water, the brand of the Green Bay Metropolitan Sewerage District, is moving from pilot to full-scale watershed Adaptive Management (AM) to achieve phosphorus compliance. WPDES Permit Compliance efforts began in 2018 to improve water quality in the Lower Fox River, Green Bay Wisconsin. The pilot project for AM began in 2014 in Silver Creek, a subwatershed just outside of Green Bay, where a suite of best management practices (BMPs) were implemented to address high levels of nutrient and sediment runoff. AM has proven it could not only be effective at addressing phosphorus pollution, but would also be more cost effective than constructing additional wastewater treatment technology, the alternative for phosphorus compliance. AM efforts in the future will harnesses non-point phosphorus pollution sources while working cooperatively with agricultural landowners and growers in the Ashwaubenon/Dutchman Creek Watersheds in the Lower Fox River Basin. This full-scale project is a ten-fold increase in size over Silver Creek and builds upon collaboration, BMPs, and GIS successes and lessons learned. Water quality monitoring, biological monitoring, and modeling will be three components to document long-term improvements in the watershed. Watershed inventory and prioritization will be key components to charting a course for the next 20 years at NEW Water.

Session 3B:
Surface Water and Climate Change
Friday, March 1, 2019
8:30 – 10:10 a.m.

The Changing Seasonal Recipe of Flood Frequency in the Midwest

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Kathleen Holman, United States Bureau of Reclamation

Floods are the result of a complex recipe, with ingredients that include rainfall, soil moisture, and watershed morphology. Conventional flood frequency analysis (FFA) methods are largely disconnected from these physical processes. Here, we present a process-based framework that couples stochastic storm transposition (SST) with the WRF-Hydro/National Water Model to analyze nonstationary flood frequency. This framework allows us to distinguish sources of uncertainty in the model, inputs, and initial conditions and to elucidate the physical drivers of flood nonstationarity in a watershed. The open-source SST software RainyDay is used to generate a large number of realistic extreme rainfall scenarios by temporal resampling and geospatial transposition of observed storms; the use of WRF-Hydro "fills in" poorly-observed geophysical variables (such as soil moisture) and enables exploration of nonstationary FFA. We first use RainyDay combined with radar precipitation data to generate rainfall scenarios. We then derive the distribution of soil moisture from long-term continuous streamflow simulations. Finally, we highlight the consequences of the individual ingredients of flooding how their combination is contributing to a shift in seasonality from springtime to summertime flooding.

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Rainfall and Flood Lessons from a Wet Hot Wisconsin Summer

Daniel Wright, University of Wisconsin-Madison, danielb.wright@wisc.edu

The summer of 2018 saw heavy rainfall in Madison and beyond, capped off by a "big week" of record-setting rainstorms in late August, first in Dane County and then elsewhere in Southern Wisconsin. These storms and the resulting floods took place against a backdrop of rapid global and regional climate warming which have had major impacts on the frequency and severity of extreme rainfall. In this talk, I briefly review these events from a "rainfall perspective"—how much, where, and when. Key aspects include considerations of rainfall duration and spatial extent, urbanization, and the changing likelihood of such heavy storms in a warming climate. I will show that such storm systems are by no means unprecedented in the region, and argue that the Yahara chain of lakes and urban Dane County are particularly vulnerable. In doing so, I highlight some of the modern data sources and tools that can be brought to bear to better understand extreme rainfall and how it is

changing, including high-resolution weather radar, citizen-operated weather stations, and probabilistic rainfall hazard analysis tools.

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Improving Flood Resiliency in the Yahara River Chain of Lakes

John Reimer, Dane County Land & Water Resources Department, reimer.john@countyofdane.com
Chin Wu, UW-Madison

In August 2018, flooding was experienced in the Yahara River Chain of Lakes (RCL) due to heavy intense rainfall causing over $154 million damages in Dane County. Several spatial and temporal complexities present challenges to appropriately deliver water efficiently leading to flooding in the Yahara RCL system. These complexities include controlled (e.g. dam) and uncontrolled (e.g. river choking) water release, seasonal aquatic plant density, temporary reverse flows, and varying lake water levels due to discharge from different watershed and lake area ratios. In this talk, the 2018 flood year is simulated using the state-of-the-art Integrated Nowcast and Forecast Operation System (INFOS) incorporating complexities of the RCL system. To address the reduction of water levels and the timing needed to recover after flooding, we assess various alternatives of adaptation strategies (e.g. dam operations) or mitigation measures (e.g. remove bridge choking, perform river dredging). The overall goal of our efforts is to develop effective solutions for improving the community's resilience for future flooding.

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A Spatial and Temporal Investigation of Seasonal Stream Discharges in the Upper Midwest

Dale Splinter, University of Wisconsin-Whitewater, splinted@uww.edu
John Frye, University of Wisconsin-Whitewater
Jillian Stephens, University of Wisconsin-Whitewater
Guen Drews, Wisconsin Emergency Management

Changes in the timing, duration, and intensity of precipitation has the ability to alter the hydrologic response of small streams and large rivers. Ramifications include, but are not limited to, changes in high and low flows, increased flash flooding, emergency declarations, economic and emotional hardship, fluctuations in soil moisture and groundwater levels, evapotranspiration rates, and water quality. Understanding how fluctuations in the hydrologic cycle influence streamflow is important in managing water resources. For this reason, a study is being designed to examine how precipitation influences streamflow trends and patterns across Wisconsin and select locations in the upper Midwest. Streamflow from 25 USGS gages in Wisconsin have been examined for trends, change points, and the timing of peak streamflow. Results indicate that peak streamflow is not increasing, but the timing of peak streamflow has varied and transitioned spatially in Wisconsin over the last 50 years. Currently USGS streamflow data is being organized and processed for sites in Iowa, Minnesota, Michigan, Indiana, and Illinois that will be used in conjunction with the streamflow results in Wisconsin. Precipitation records (since 1950) from weather stations in the upper Midwest are currently being examined and aligned to USGS gauging station data. Understanding the changes and duration of precipitation in the upper Midwest will facilitate a better evaluation of hydrologic conditions.

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Increasing Runoff in a Small Watershed in Wisconsin due to Changing Climate, Land Use Change, or Both

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John Reimer, Dane County Land & Water Resources Department, Madison, WI
Chin Wu, Department of Civil and Environmental Engineering, University of Wisconsin-Madison

Increasing runoff can cause undesirable consequences like flooding damages to properties in urban areas. Causes of increasing runoff can be attributed to changing climate, land use change, or both. Nevertheless, assessing the relative importance of both causes is difficult. Best Management Practices (BMPs) and Low Impact Developments (LIDs) are often implemented to mitigate the impacts of increasing runoff. In this study, the roles of changing climate and land use change are assessed using a calibrated hydrologic model, Soil and Water Assessment Tool (SWAT) at a small urbanized watershed, Spring Harbor in Madison, WI. Afterwards, we simulate the long-term runoff trends due to land use change from 1937 to 2017 and climate change from 1940 to 2017. Furthermore scenarios with and without incorporation of BMPs (e.g. drainage ponds and green ways) or LIDs (e.g. rain gardens and green roofs) are conducted. Results of trends of runoff volumes and peak flow rates due to changing climate, land use change, and both are discussed. Our overall goal of this study is to mitigate the increasing runoff by employing effective BMPs and LIDs.

* * *

Session 3C:
Urban Hydrology
Friday, March 1, 2019
8:30 – 10:10 a.m.

Improving Predictions of Urban Runoff Volume

Judy Horwatich, USGS, jahorwat@usgs.gov
Roger Bannerman, WDNR

Predictions of urban runoff volumes are important for sizing stormwater control measures and predicting pollutant loadings for TMDL. The computer program, WinSLAMM, is a WDNR accredited model used to demonstrate compliance with state requirements. WinSLAMM is reasonably accurate for predicting runoff volumes from impervious surfaces, however accuracy tends to decline with increasing perviousness. Recent promotion of stormwater management practices, advancement in the sampling techniques, availability of newly collected data, and enhancement to model routines makes it essential to update WinSLAMM. A recent study by the USGS and WDNR evaluated volumes produced by the updated WinSLAMM runoff coefficient parameter file. The calibration and verification process uses the latest observed values to fine-tune the model's response to predictive outcomes. To calibrate the coefficient curves, runoff coefficients are adjusted to match recently observed volumes from source areas, such as parking lots. Once all coefficient curves are calibrated, a few residential watersheds with existing measured data will be compared to the model's predicted values. Newly calibrated and verified model will evaluate how development characteristics selection can influence model's results. This will provide guidance to users on the importance of quantifying watershed characteristics such as slope, drainage size, and connectiveness in initial stages of model development.

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The Effect of Drainage Area on the Water-Quality Performance of Permeable Pavement

Nicolas Buer, USGS, nbuer@usgs.gov
Bill Selbig, USGS

Since 2014, the U.S Geological Survey has measured the total suspended solids (TSS) and total phosphorus (TP) load reduction capabilities of permeable interlocking concrete pavers (PICP), pervious concrete (PC), and porous asphalt (PA) at a research facility in Madison, WI. Untreated stormwater runoff from an adjacent parking lot was directed towards and distributed equally between the three surfaces. Over the course of the study, the parking lot was modified to represent a

10:1 and 5:1 ratio of contributing to receiving area. Infiltration rates of each surface were measured approximately every month to track surficial clogging as well as the response to periodic maintenance practices.

Cumulative TSS load influent to each surface at a 10:1 ratio was reduced by 69, 79, and 64 percent in the PICP, PC, and PA plots, respectively. Cumulative TP load was reduced by 14, 50, and 23 percent, respectively. Slight variation in pollutant removal efficiency was observed at the 5:1 ratio where TSS was reduced by 59, 77, and 78 percent and TP by 19, 62, and 41 percent, respectively. Infiltration rates decreased over time for all pavement types. This decline resulted in more runoff flowing over and not through each surface. This occurred more rapidly with increasing drainage area leading to a decline in overall treatment. Results from this study will be used to amend the Wisconsin Department of Natural Resources Technical Standard 1008 for installation of permeable pavement in Wisconsin.

* * *

Monitoring the Impacts of Trees on Urban Stormwater Volume Reduction

Bill Selbig, USGS, wrselbig@usgs.gov
Steve Loheide, UW-Madison
Bill Shuster, EPA Office of Research and Development
Robbie Coville, US Forest Service
Ralph Haefner, USGS
Bryant Scharenbroch, UW-Stevens Point

In 2018, the U.S. Geological Survey, U.S. Forest Service, U.S. Environmental Protection Agency, and the University of Wisconsin began a study in Fond du Lac, WI to measure the impact trees have on stormwater runoff reduction. The first phase of the study will characterize a baseline water budget by measuring climate inputs and losses, surface runoff, sub-surface flows, and arboricultural water use in a control and treatment catchment. During the winter of 2019-2020, the city plans to remove approximately 60% of ash trees lining the street in the treatment catchment to limit infestation of Emerald ash borer. Since the control will remain the same, any changes from the baseline hydrologic response between the control and treatment catchments can be attributed to the sudden absence of trees.

This study will be used to improve predictive functions of the U.S. Forest Service model i-Tree. The i-Tree Hydro program computes surface runoff volume and baseflow groundwater contribution to surface water flow based on weather, soil conditions, impervious cover, and tree parameters. Using actual data to confirm or direct modification of established i-Tree methodologies will enhance existing methods and provide for more accurate results regarding reporting of tree- and runoff-related benefits provided by vegetation. This model validation will help scientists, resource managers, and communities better understand the role vegetation management can have in stormwater management.

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New Approaches for Urban Storm Water Collection and Management: Leveraging New Technologies and Community Engagement for Beneficial Reuse

Kara Koch, GZA GeoEnvironmental, Inc., kara.koch@gza.com
Tory Kress, Redevelopment Authority of the City of Milwaukee

This presentation will provide examples of vacant, underused, and impaired urban properties in Milwaukee that have been transformed into stormwater parks that accept and retain stormwater from the site and adjacent properties. These new neighborhood resources, developed with active community and stakeholder support, provide forage and refuge for pollinators with native prairie plantings, neighborhood engagement with new infrastructure, and aesthetically appealing assets in the Central City.

The presentation will highlight examples of stormwater diversion from the street, the first of its kind in Milwaukee, that collect stormwater from the street and diverts it onto the site for benefical reuse, and also stormwater diversion from infrastructure into large bioswales. The stormwater parks utilize Opti's Real Time Control (RTC) remote monitoring systems that continually tracks water levels and controls the discharge/infiltration of the bioswale. These infiltration techniques improve the quality of water in the Milwaukee's rivers and Lake Michigan and reduce local flood events and basement backups in the combined sewer service area. The project examples showcase how abandoned properties can be re-used as stormwater detentions by using what is existing while creating aboveground a green community gathering space and new parks in an historically underserved communities. Several of the new developments received Green Luminaries Awards from MMSD.

Soil Amendment as a Green-Infrastructure Practice in Residential Areas

Carolyn Voter,* University of Wisconsin-Madison, cvoter@wisc.edu
Steven P. Loheide II, University of Wisconsin-Madison

In Milwaukee, WI as well as in some other cities leading the nation in green infrastructure adoption, soil amendment is an important component of green infrastructure plans. While there are several definitions of "soil amendment", one common approach is to mix an amendment such as compost into existing topsoil. While effective, this practice is labor intensive and therefore expensive for homeowners to adopt over large areas like an entire residential lawn. However, we hypothesize that this type of soil amendment is most effective when targeted at interfaces between impervious and pervious surfaces, e.g., at downspout outlets, next to driveways, or in the street terrace. We designed a modeling experiment to compare the effectiveness of treating areas that generate the highest amounts of runoff vs. equivalent areas located at easily-identifiable impervious-pervious interfaces, such as the outlets of downspouts and the street terrace. We evaluate the effectiveness of a rule-based approach to soil amendment relative to a focused approach on areas that generate the most runoff according to explicit modeling and we compare both approaches to the end-member case of complete amendment of the yard.

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Session 4A:
Science Communication
Friday, March 1, 2019
10:20 – 11:40 a.m.

Wisconsin Water Conflicts: Communication Lessons Learned from Climate Science

Carol McCartney, Wisconsin Geological & Natural History Survey, carol.mccartney@uwex.edu

Outside of conferences, we communicate science in an increasingly polarized environment. Volatile reactions to climate change communication are common in the public square and are increasingly common in discussions about water in Wisconsin. What strategies work for climate scientists that we can apply to public discussions of water issues?

Prof. Katharine Hayhoe, Director of the Climate Science Center, Texas Tech, has some suggestions for civil and positive conversations around climate change (CIRES Distinguished Lecture Series, Sept 6, 2018, https://cires.colorado.edu/events/distinguished-lecture-series-dr-katharine-hayhoe). I adapt her approach to Wisconsin water issues.

1) Bond – know your audience and identify your common values. There are fishermen and private water supply wells on both sides of Wisconsin's water conflicts. Get personal. Find your shared values.
2) Connect – talk about how the values you share (love of fishing or providing a safe home for your family) connect to the water issue. Loss of trout habitat or groundwater contamination can affect you and your audience.
3) Explain – this is where the facts come in. Talk about what you know and what scientists agree on. Don't emphasize what you don't know. This is not where we discuss scientific uncertainty.
4) Inspire – talk about solutions. Give a sense of the range of options for working together. Even if the solutions are engineering, not science, you can bring a list of ideas for the discussion.

* * *

Can You Hear Me Now? The "And, But, Therefore" System to Tell Your Science Story

Amanda Bell, US Geological Survey Upper Midwest Water Science Center, ahbell@usgs.gov

A researcher makes a groundbreaking discovery that could change the way we look at water resources. To share her research she publishes journal articles, presents at conferences, and tries to inform the public by sharing all the complex details and findings of her study. However, by not having a clear, concise, and understandable message her research is overlooked by the general public and even fellow scientists that get confused by jargon, overwhelmed by the intricacies, and bored by the mountain of data being presented. Therefore, the researcher seeks out ways to more effectively communicate her findings and reach a broader audience to disseminate the information.

The “And, But, Therefore” (ABT) system, a construct developed by Randy Olson in Houston, We Have a Narrative (2015, Univ. of Chicago Press), is a simple way to structure your writing so that the reader remains engaged throughout the entire paper. By rearranging the details of your work into the ABT you, as the writer, will begin to write papers that follow an intuitive narrative structure. However using the ABT isn’t as easy as throwing in extra conjunctions into your writing; it takes practice in identifying the different types of statements and rearranging your writing so that it flows more smoothly . Consequently, by practicing and working with the ABT structure on every paper, abstract, article, and even presentation you write, it will become second nature and your research will reach a larger audience.

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Coastal Bluff Recession Mapping in Southeastern Wisconsin: Data and Insights for Coastal Resilience

Nick Jordan, FreshWater Engineering, njordan@freshwatereng.com
Adam Bechle, Wisconsin Coastal Management Program
Jeff Stone, ASFPM
Chin Wu, UW-Madison
Boyuan (Luke) Lu, UW-Madison
Prakriti Khanal, UW-Madison

Coastal bluff recession is a constant hazard along southeastern Wisconsin’s shoreline, posing risks to property and infrastructure. Bluff recession is the natural outcome of interacting subaerial and subaqueous processes and conditions, including, groundwater flow, geologic inheritance, water level fluctuation, and wave impact. In addition, anthropogenic modification of coastal areas can have significant impacts on erosion and deposition over a variety of timescales due to changes in littoral sediment supply and nearshore conditions. Though much is known about the processes associated with bluff recession, no publicly available information exists on recent (i.e., since the 1990s) and historical (i.e. since the 1930s) bluff recession and coastal evolution on Wisconsin’s coast. This study, a part of a NOAA Coastal Resilience Grant, is mapping bluff recession on the Kenosha, Racine, Milwaukee, and Ozaukee County coasts for recent and historical periods, and is making the results available on the Wisconsin Shoreline Inventory and Oblique Photo Viewer (http://floodatlas.org/asfpm/oblique_viewer/). Ultimately, the available data and analysis of the results will assist coastal communities and stakeholders to identify hazards and develop capacity for resilience to hazards.

* * *

Water-Resources Challenges for the Next 25 Years

Kenneth Bradbury, Wisconsin Geological and Natural History Survey, ken.bradbury@wgnhs.uwex.edu

The National Academy of Sciences (NAS) recently released a consensus report with the goal of determining the most critical water resources challenges facing society in the next 25 years. The report, commissioned by the USGS, was developed by an 11-person committee of water scientists and NAS staff. This committee reviewed recent water-resources literature and engaged with a variety of water scientists and stakeholders. Following spirited discussion and debate, the committee developed the following list of critical water-resource issues or needs facing society:

- Understanding the role of water in the Earth system.
- Quantifying the water cycle.
- Developing integrated modeling.
- Quantifying change in the socio-hydrological system.
- Securing reliable and sustainable water supplies.
- Understanding and predicting water-related hazards.

The committee also discussed the opportunities and challenges posed by new technologies related to environmental sensors, remote sensing, and storage and manipulation of massive real-time data sets.

While the fundamental water resource issues of the future may not be significantly different than in the present or recent past, new technologies, models, and ways of thinking are providing exciting opportunities for new science and new discoveries, and contributions to society in all water-resources fields.

The report is available at https://www.nap.edu/catalog/25134/future-water-priorities-for-the-nation-directions-for-the-us.

* * *

Session 4B:
Surface Water Quality
Friday, March 1, 2019
10:20 – 11:40 a.m.

Examining Hg Stable Isotopes in the Lower Fox River AOC to Better Understand Bioaccumulation

Tylor Rosera,* Environmental Chemistry and Technology UW Madison, trosera@wisc.edu
James Hurley, UW Madison
Sarah Janssen, USGS
Ryan Lepak, UW Madison

Many beneficial use impairments are listed for the Lower Green Bay and Fox River Area of Concern, including those related to sediment and water quality. Our study focuses on the availability of legacy mercury (Hg) in contaminated sediments for bioaccumulation. One factor confounding our understanding of cycling and potential bioaccumulation of legacy Hg is consideration of additional recent Hg sources (atmospheric deposition, watershed inputs). Traditional Hg measurements are inadequate to resolve source apportionment questions, however by tracking subtle changes in the ratios of naturally-occurring Hg isotope ratios, we can begin to assess relative contributions of contrasting sources in a complex Hg pool. Further, by applying this technique to methyl-Hg (MeHg), we can better estimate which sources of Hg are bioaccumulated in the food web. Our initial results from four surface sediments suggest that MeHg isotopic signatures differ from total Hg (HgT) in contaminated sediments (Avg. δ^{202}HgT -0.56 ± 0.05 ‰, Avg. δ^{202}MeHg 0.01 ± 0.16 ‰). Our research thus focuses on better understanding biotic and abiotic processes that govern these Hg isotopic ratios in sediments, biota and in the water column with a goal to more effectively predict bioaccumulation from source-specific pools of Hg. This information is important for resource managers tasked with the responsibility of identifying and remediating Hg source hotspots that potentially influence bioaccumulation.

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Mercury-Methylating Organisms in Lake Mendota

Benjamin Peterson,* UW-Madison, bpeterson26@wisc.edu
Katherine McMahon, UW-Madison
Elizabeth McDaniel, UW-Madison
Anna Schmidt, UW-Madison

Mercury is a potent neurotoxin that poses a public health threat all around the globe, including in the Great Lakes region. Mercury can accumulate in aquatic food webs as methylmercury (MeHg), which is produced from inorganic mercury by

anaerobic microorganisms. These organisms are metabolically diverse, which could potentially link different biogeochemical cycles and water quality conditions to the production of MeHg. In this way, water quality can have just as much of an impact on mercury levels in the foodweb as the overall levels of Hg in the system. However, the identity, distribution, and metabolism of relevant MeHg-producing microorganisms in freshwater systems, particularly in the water column, is not well understood. In this study, we've used the newly-discovered hgcAB genes, shown to be responsible for MeHg production, to identify potential MeHg-producing organisms in the water column of Lake Mendota in Madison WI with genome-resolved shotgun metagenomics. Through this, we have discovered new organisms that are potentially capable of MeHg production. These results have important implications for understanding how general water quality conditions in a lake can influence the production of MeHg and subsequent movement of mercury into the foodweb.

* * *

Status and Distribution of the Gastropod Fauna of the Mukwonago River Below Phantom Lake Dam

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While the high extinction risks of freshwater fish, crayfish and mussels are well known, the extinction rates of the far less studied gastropods are much higher, with some Families having over 70% of their member species listed by NatureServe as G2 or higher. A key goal of the National Strategy for the Conservation of Native Freshwater Mollusks is to increase the knowledge on the status and trends of existing mollusk populations and communities. As part of that effort since 2008, faculty and students at UW-Whitewater have monitored the gastropod fauna of the Mukwonago River below the Phantom Lake dam, including within State Natural Area #417. The status of the diversity, relative abundance, size distribution and secondary production related to changes in stream environmental factors will be summarized, especially for members of the Family Pleuroceridae (*Elimia livescens and Pleurocera acuta*).

Relationship between Chlorophyll and User Perception of Lake Water Quality

Matthew Diebel, Wisconsin Department of Natural Resources, matthew.diebel@wisconsin.gov

Lake recreational chlorophyll criteria should be designed to protect primary contact recreation. The Wisconsin Citizen Lake Monitoring Network has collected over ten thousand chlorophyll samples and corresponding user perception ratings of water quality. I conducted a statistical analysis of the relationship between user perception and chlorophyll concentration to help identify appropriate criteria. The data used in the analysis were all chlorophyll samples collected from the top 2 m of the water column in Wisconsin lakes and reservoirs during the summer assessment period since 2002. The statistical models are mixed effects logistic regressions where the response variable is exceedance of each perception level and the predictors are chlorophyll and several lake class variables. The models also include random effects to account for variance among lakes and observers in the relationship between chlorophyll and user perception. The models show that user perception of lake water quality is strongly influenced by chlorophyll concentration, the relationship exhibits a threshold form that is well suited for identifying breakpoints, and that there are significant differences among several lake classes in the relationship between chlorophyll and user perception. While the primary goal of volunteer monitoring is to characterize individual lakes, this analysis demonstrates the power of aggregating data across the network.

Session 4C:
Water Quality II
Friday, March 1, 2019
10:20 – 11:40 a.m.

Fate and Transport of Recycled Concrete Aggregate Leachate

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Matthew Ginder-Vogel, University of Wisconsin-Madison

Recycled concrete aggregate (RCA) is a well-established, readily available substitute for virgin aggregate base course in pavement construction applications. Crushing concrete for use as RCA, however, exposes fresh surfaces to atmospheric conditions, most notably carbon dioxide and rainwater infiltration. The fresh surfaces contain cement phases, including calcium aluminum silicates, calcium hydroxide, and calcium silicate hydrate, which react with rainwater to form high alkalinity and high pH leachate. Once drained from the base course layer, leachate travels through the subbase to the surrounding in-situ soil profile, where it has the potential impact groundwater. RCA leachate generation from stockpiles and road base is unavoidable, and therefore it is the purpose of this work to understand the fate and transport of the leachate, and whether pre-treatment or remediation is necessary to limit the environmental impact of RCA leachate. The purpose of this work is to integrate the solid phase composition of the RCA samples, laboratory batch reactor experiments, and geochemical modelling to develop an understanding of RCA leachate chemistry. The models and experimental results will inform the development of industry guidelines for pre-treatment or remediation criteria for the safe and responsible use of RCA as pavement base course.

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Radionuclide Sorption to Aquifer Solids in the Midwestern Cambrian-ordovician Aquifer System

Madeleine Mathews,* University of Wisconsin-Madison, mmathews2@wisc.edu
Madeline Gotkowitz, Montana Bureau of Mines and Geology
Matthew Ginder-Vogel, University of Wisconsin-Madison

Radium (Ra) is a carcinogenic contaminant present in aquifer systems. Frequent occurrence of elevated Ra in groundwater is observed in the Midwestern Cambrian-Ordovician aquifer system, a drinking water source for many water utilities. Parent isotopes of uranium (U) and thorium (Th) undergo radioactive decay, emitting radium isotopes into the aquifer system. Uranium and thorium are present in aquifer solids and at low aqueous concentrations across the aquifer system. If Ra groundwater mobility is impacted by the relationship between parent nuclide decay and aquifer solids, then elevated Ra will be observed associated with aquifer solids containing more U, Th, and transition metal (hydr)oxide minerals and/or

shaley facies. We have designed bench scale experiments aimed to measure the aqueous association between Ra, U, and Th isotopes and aquifer solids. Selective leaching extractions conducted on well cuttings from the Midwestern Cambrian-Ordovician aquifer system quantify solid-phase association of these radionuclides. Aqueous analysis of radionuclide isotopes will be accomplished by multi-collector inductively coupled plasma mass spectrometry (MC-ICPMS). Prior to this analysis, we will perform column extractions to separate interfering ions, after which each column fraction will be analyzed by MC-ICPMS. This information will advance current understanding of radionuclide association with aquifer solids in the Midwestern Cambrian-Ordovician aquifer system.

* * *

Translating Scientific Research to Policy Action: A Case Study on Reducing Toxic PAHs

Paul Mathewson, Clean Wisconsin, pmathewson@cleanwisconsin.org
Ezra Meyer, Clean Wisconsin

Polycyclic aromatic hydrocarbons (PAHs) are a class of toxic persistent organic pollutants that have been increasing in the United States. Several PAH compounds are carcinogenic, and exposure to PAHs is associated with other health problems. PAH contamination in waterbodies is toxic to aquatic life causing impaired growth and development, tumors, and mortality. PAH contamination is a direct cause of Beneficial Use Impairments in federally-designated Areas of Concern in Wisconsin coastal communities. Recent research by the United States Geological Survey and academic and governmental researchers has identified tar-based pavement sealants as a primary source of PAHs in urban waterbodies. Most recently, tar-based sealants were found to contribute 75% of the PAHs found in Milwaukee-area waterbody sediment. Sealants are applied to parking lots, driveways, and other paved surfaces for aesthetics and to protect the underlying surface. As sealants deteriorate from weathering and abrasion, PAH-contaminated dust and flakes are tracked or blown into homes and are washed into nearby waterbodies with stormwater runoff. We discuss how the environmental community has communicated this scientific research to policymakers, resulting in restrictions and bans on the use of these products. To date in Wisconsin, 13 municipalities and one county have taken action on this issue to protect human health and aquatic resources.

* * *

SEWRPC's Regional Chloride Impact Study

Dale Buser, Southeastern Wisconsin Regional Planning Commission (SEWRPC), dbuser@sewrpc.org

One of the most pervasive chemicals humans release into waterbodies is common salt (sodium chloride). Chloride concentrations in some streams exceed both chronic and acute toxicity values, undoubtedly disrupting ecological health.

The Southeastern Wisconsin Regional Planning Commission initiated a multi-year study examining chloride sources, temporal/spatial distribution, mass balance, land use implications, and management options. SEWRPC operates a 37-station, real-time, continuous monitoring network on 31 individual rivers/streams distributed over 2,689 square miles. Water samples are also analyzed from many area lakes. Additional data helps establish a relationship between conductance and chloride concentration. The monitoring network helps evaluate water quality in areas of considerably differing land use.

This presentation reviews initial data generated by the monitoring network. Monitoring system design considerations, initial decisions/successes/disappointments, monitoring objectives, project goals, and future project deliverables will also be discussed. Restored stream beds, banks, connectivity, and overall form does little to improve ecological integrity if water flowing in the streams does not support desirable aquatic life. The availability of chloride data and a tool to predict chloride concentrations will help restoration practitioners fold water quality considerations into waterbody/watershed restoration plans on a landscape scale.

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