AMERICAN WATER RESOURCES ASSOCIATION - WISCONSIN SECTION

42nd ANNUAL MEETING

Working Together for Wisconsin's Water: Balancing Industry, the Environment and Public Health

March 8 & 9, 2018
Paper Valley Hotel
Appleton, 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 Wisconsin Water Science Center

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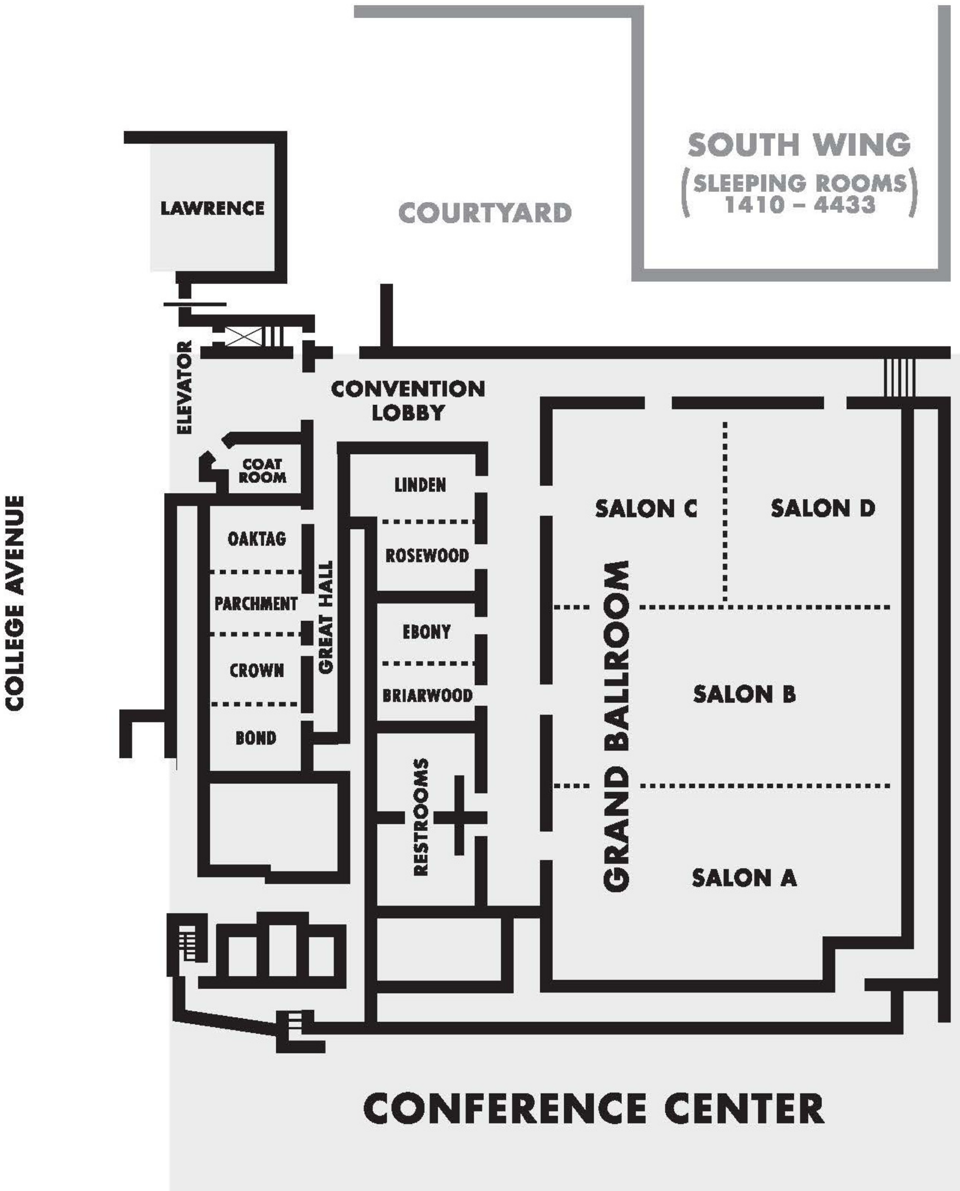

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The Wisconsin Section of the American Water Resources Association provides an interdisciplinary forum for people involved in all aspects of water resources research and management. The success of the section is due in part to the dedication of past 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

Laurel Braatz

Laurel Braatz is an environmental scientist whose career has focused on drinking water resource protection and management. She has worked for the WI Department of Natural Resources for 25 years. Laurel began in NW WI in the Cumberland, and Spooner area in the Remediation and Drinking Water programs and since 1997 has worked in the Drinking Water Program in the Sturgeon Bay. She works with well owners in Door County to resolve drinking water contamination issues associated with local land uses and challenging geology. Ms. Braatz has a Bachelor's and a Master's Degree from UW-Green Bay in Environmental Science. Laurel has been a member of AWRA Wisconsin Section for more than two decades. The meeting and information that members share has provided an energizing reminder on why she works in the water field.

Treasurer

Eric Booth

Eric Booth is an Assistant Research Scientist at UW-Madison in the Departments of Agronomy and Civil & Environmental Engineering. He also collaborates with the North Temperate Lakes Long-Term Ecological Research site, Center for Limnology, UW Arboretum, Great Lakes Bioenergy Research Center, and Wisconsin Energy Institute. He holds a BS in Environmental Engineering from UW-Madison (2004), MS in Hydrologic Science from UC-Davis (2006), and PhD in Limnology from UW-Madison (2011). His research interests cut across many disciplines with water as a centerpiece; these include hydroecology, impacts of climate and land-use change, urban stormwater management, wetland/stream restoration, water quality, groundwater hydrology, fluvial geomorphology, environmental history, agroecology, remote sensing, and numerical modeling.

Vice President

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 looks forward to having an opportunity to contribute to the AWRA Wisconsin Section by serving on their Board of Directors.

President-Elect

Andy Leaf

Andrew Leaf is a hydrologist at the Wisconsin Water Science Center, where he works on hydrologic modeling studies throughout Wisconsin and the greater U.S. He received his bachelor's from Gustavus Adolphus College, and M.S. degrees in Hydrogeology and Water Resources Management from UW-Madison. He worked in the environmental consulting field in Seattle and has been with the USGS since 2012. He has attended the annual AWRA meeting since 2007, and looks forward to continued service on the board.

BIOGRAPHIES OF PLENARY AND EVENING SPEAKERS

Plenary speakers

Jim Jordahl

Jim Jordahl is the Director of Programs and Operations for the Iowa Agriculture Water Alliance. Jim works with many private and public sector partners to facilitate the implementation of conservation practices to improve water quality in Iowa. Jim brings more than 30 years of experience working in farming operations, soil science, engineering, environmental science and project management. At the beginning of Jim's long career, he worked as a soil conservationist and district conservationist in Iowa.

Jim VandenBrook

Jim VandenBrook is the Executive Director of the Wisconsin Land and Water Conservation Association, which represents County Land Conservation Committees and Departments who work every day to help landowners and others interested in protecting, conserving, and enhancing Wisconsin's natural resources. After receiving a BS degree in Soil Science from UW-Madison he worked as a County Conservationist in Vernon and Trempealeau Counties in the mid 80's. Then 26 years with the Wisconsin Department of Agriculture, Trade and Consumer Protection on Soil and Water Conservation programming, groundwater research and protection related to pesticides, and nutrient management programs to protect water resources. Jim completed his 34th American Birkebeiner ski race in February.

Evening speaker

Mike Tiboris

Michael Tiboris is global water fellow at the Chicago Council on Global Affairs and public fellow for the American Council of Learned Societies. His research concerns primary resource stability as a foreign policy objective, and is particularly focused on water resource policy, cooperative resource governance, and global justice. He holds a PhD in ethics and political philosophy from the University of California, San Diego, and has previously held fellowships supported by the Spencer Foundation, and San Diego State University's Institute for Ethics and Public Affairs. His written work is published in a number of academic sources (including Social Theory and Practice, the Georgetown Journal of International Affairs, and The Journal of Applied Philosophy), popular media sources (including The National Interest, Foreign Policy, and Chicago Tribune), and has been recognized by the University of Pennsylvania's Global Go To Think Tank Index as among the best work produced in 2016.

CONTENTS

PROGRAM SUMMARY

Working Together for Wisconsin's Water: Balancing Industry, the Environment, and Public Health

42nd Annual Meeting of the American Water Resources Association—Wisconsin Section Appleton, Wisconsin

THURSDAY, MARCH 8, 2018

9:00 – 11:00 a.m.	**Registration** Convention Lobby Area
11:00 – 11:45 a.m.	**Welcome and Lunch** Salon B, Grand Ballroom
11:45 – 1:45 p.m.	**Plenary Session and Lightning Talks** Salon B, Grand Ballroom Jim Jordahl Director of Programs and Operations with the Iowa Agriculture Water Alliance *Farmers, Cities, Ag Retail and More: Diverse Partnerships Working to Improve Water Quality in Iowa* Jim VandenBrook Executive Director of the Wisconsin Land and Water Conservation Association *The Collision of Agriculture, Environment, Public Health, and Science: NR 151 - An Unprecedented Collaboration to Protect Groundwater Quality in Eastern WI* **Lightning Talks**
1:45 – 2:00 p.m.	**Break:** Convention Lobby

2:00 – 3:20 p.m. **Concurrent Sessions 1A, 1B and 1C**

Session 1A **Groundwater**
Room: Lawrence
Moderator: Adam Freihoefer

2:00 **Well Dataset Quantifying Potential Human Influence at USGS Wells in the U.S. Glacial Aquifer System**
Martha Nielsen, U.S. Geological Survey (USGS)

2:20 **Comparing the Results of a Random Survey of Well Water Quality with Archived Homeowner-Submitted Well Water Samples**
Michael Mechenich, University of Wisconsin-Extension & University of Wisconsin-Stevens Point

2:40 **Integrating and Managing Water Quantity Data**
Jeff Helmuth, Wisconsin Department of Natural Resources (WDNR)

3:00 **Cumulative Precipitation Deviation as a Predictor for Groundwater and Lake Levels**
Robert Smail, Wisconsin Department of Natural Resources (WDNR)

Session 1B **Urban Water Quality**
Room: Bond/Crown/Parchment/Oaktag
Moderator: Bill Selbig

2:00 **Influence of Hydrogen Peroxide and Ultrasonic Treatment on Cyanobacteria and Chlorophyta Development - Longterm versus Shortterm Bioremediation Measures**
Hedda Sander, Ostfalia University, Germany

2:20 **Evaluation of a Screened Stormwater Structure for Removal of Sediment and Phosphorus in Urban Runoff**
Nicolas Buer, U.S. Geological Survey (USGS) – Upper Midwest Science Center

2:40 **Improving Predictions of Urban Runoff Volume**
Judy Horwatich, U.S. Geological Survey (USGS) – Upper Midwest Science Center

3:00 **Sediment Toxicity Assessment and Contaminant Source Tracking at Two Wisconsin Areas of Concern (AOCs) and Non-AOC Comparison Tributaries to Lake Michigan**
Hayley Olds, U.S. Geological Survey (USGS) – Upper Midwest Science Center

Session 1C	**Geomorphology** **Room:** Rosewood/Linden **Moderator: Faith Fitzpatrick**
2:00	**Pike River Geomorphic and Water Quality Study** Nicholas Potter,* University of Wisconsin-Parkside
2:20	**Bluff Recession on a Developed Coast in Southeastern Wisconsin: New Perspectives on Coastal Management** Isak Fruchtman,* Department of Civil and Environmental Engineering, University of Wisconsin-Madison
2:40	**Assessment and Design of Braid-Island Rehabilitation in Cherokee Marsh, Wisconsin** Peter Torma, Department of Civil and Environmental Engineering, University of Wisconsin-Madison
3:00	**Status of Lidar Elevation Products in Wisconsin 2018** Jim Giglierano, Wisconsin Department of Administration
3:20 – 3:40 p.m.	**Break: Convention Lobby**
3:40 – 5:00 p.m.	**Concurrent Sessions 2A, 2B and 2C**
Session 2A	**Groundwater Quality I** **Room:** Lawrence **Moderator: Patrick Gorski**
3:40	**Recharge and Well Vulnerability in the Silurian Dolomite Aquifer: Deeper Is Not Necessarily Protective** Maureen Muldoon, University of Wisconsin-Oshkosh, Department of Geology
4:00	**Geochemical Study of Aquifer Conditions on Radium in the Cambrian-Ordovician Aquifer** Madeleine Mathews,* University of Wisconsin-Madison
4:20	**Anthropogenically Driven Changes to Shallow Groundwater in Southeastern Wisconsin and its effects on the Aquifer Metagenome** Madeline Salo,* Geosciences Department, University of Wisconsin-Milwaukee
4:40	**A Field Investigation of a Small Drainage Lake and Contamination Plume in Northern Wisconsin** Andrew Leaf, U.S. Geological Survey (USGS) – Upper Midwest Science Center

* Student presentation

Session 2B	**Central Sands** **Room:** Bond/Crown/Parchment/Oaktag **Moderator: George Kraft**
3:40	**Crop Rotational Strategies to Improve Freshwater Quantity and Quality in the Wisconsin Central Sands** Mallika Nocco, University of Minnesota-Twin Cities
4:00	**Understanding Natural and Anthropogenic Effects on Groundwater Levels in Wisconsin's Central Sands** Colin McGuire,* University of Wisconsin-Madison
4:20	**Evaluating Tree Growth and Quantifying Groundwater Use in Sandy Wisconsin Forests** Dominick Ciruzzi,* University of Wisconsin-Madison
4:40	**The Little Plover River Watershed Enhancement Project: A Collaborative Effort to Restore Baseflow and Ecological Health** Stephen Gaffield, Montgomery Associates: Resource Solutions, LLC

Session 2C	**Surface Water Extremes** **Room:** Rosewood/Linden **Moderator: Nic Buer**
3:40	**Flood Risk and Warnings for the Yahara River Chain of Lakes (RCL)** John Reimer,* University of Wisconsin-Madison
4:00	**Application of Stochastic Storm Transposition and Hydrologic Modeling to Flood Frequency Analysis: A Case Study for Turkey River, Iowa** Guo Yu,* University of Wisconsin-Madison
4:20	**Characterization for Dangerous Currents at Port Washington, Lake Michigan** Yuli Liu, University of Wisconsin - Madison
4:40	**Inundation Frequency and Extent of a Wetland Stream** Kenneth Potter, University of Wisconsin
5:00 – 5:30 p.m.	**Networking**

* Student presentation

5:30 – 7:00 p.m. **Dinner and Evening Speaker**
Salon B, Grand Ballroom

Michael Tiboris
Global Water Fellow at the Chicago Council on Global Affairs
Nutrient Pollution and the Broadening Urban-Rural Divide

7:00 – 10:00 p.m. **Poster Session and Social**
Salon A, Grand Ballroom

1. **Source to Sink Tracing of Phosphorus Contamination Pathways in Surface Water and Groundwater of Western Wisconsin**
Carly Mueller,* University of Wisconsin-Eau Claire

2. **Trophic Fate of PPCPs and Trace Metals in a Low-Order Stream System**
Alyssa Mianecki,* University of Wisconsin-Stevens Point

3. **A Multi-Agent Based Model for Human Decision Behaviors Response to Dangerous Currents in Lake Michigan**
Ling Li,* Beihang University / University of Wisconsin-Madison

4. **Water Quality Conditions and Harmful Algal Blooms in Utah Lake, Provo, UT**
Michell Zeien,* University of Wisconsin-Parkside

5. **Nitrate and Chloride Leaching Below Irrigated Agroecosystems**
Kevin Masarik, University of Wisconsin-Stevens Point & University of Wisconsin-Extension

6. **The Geochemistry of Nitrate Contamination**
Amy Nitka, University of Wisconsin-Stevens Point Water & Environmental Analysis Lab

7. **Linking Hydrology, Spectroscopy, and Floristic Quality of Fens**
Arthur Ryzak,* University of Wisconsin-Madison

8. **Delineation of the Dead Tree Wetland at the University of Wisconsin-Parkside, Kenosha WI**
Sabrina Tusa,* University of Wisconsin-Parkside

9. **Bathymetric Study of Lake Russo, Pleasant Prairie, WI**
Ian Nebendahl,* Geosciences Department, University of Wisconsin-Parkside

10. **Comparison of Phosphorus and Nitrogen within an Algae-Dominant and a Macrophyte-Dominant Marsh**
Sarah Fuller,* University of Wisconsin-Madison

11. **Classifying Land-Use Temperatures Using Drone Imagery**
Joseph Naughton,* Marquette University

12. **Review of a Utility-Led Agricultural Based Adaptive Management Pilot Study in Silver Creek–Green Bay, WI**
Erin Houghton, NEW Water: Green Bay Metropolitan Sewerage District

* Student presentation

13. **Measuring and Modeling Stormwater Runoff from Residential Blocks in Milwaukee, WI**
Carolyn Voter,* University of Wisconsin-Madison

14. **Denitrification from Land-Applied Vegetable Processing and Cheese Making Wastewater**
Clay Vanderleest,* Soil Science Department, University of Wisconsin

15. **Streamflow Trends and Timing of Peak Discharge in Wisconsin**
Guenevere Adams,* University of Wisconsin-Whitewater

16. **Petrology of the Cambrian Strata in Northeastern Wisconsin**
Tyler Hischke,* University of Wisconsin-Green Bay

17. **Dissolved Boron, Lithium and a Groundwater $\delta^{11}B$ Isoscape in Paleozoic Bedrock Aquifers of Northeastern Wisconsin**
John Luczaj, University of Wisconsin-Green Bay

18. **Extensive Fecal Contamination of Public Wells as Determined by the Human Gut Bacteria Bacteroides**
Aaron Firnstahl, U. S. Geological Society (USGS) – Upper Midwest Science Center

19. **Infiltration of Sodium Chloride into Deep Dolomite Wells Located near the Upper Fox River and Its Implications**
Jane Pfeiffer,* University of Wisconsin-Milwaukee

20. **A Method to Assess Infiltration Properties of Farm Fields in Support of a Soil Health and Water Quality Study in the Great Lakes Basin**
Kevin Fermanich, University of Wisconsin-Green Bay

21. **A Physically-Based, Lumped Sediment Washoff Model for Urban Watersheds**
Sazzad Sharior,* Marquette University

22. **A Tool to Receive Daily Plant Evapotranspiration (ET) Data for Irrigation Water Management**
John Panuska, Biological Systems Engineering Department, University of Wisconsin-Madison

* Student presentation

FRIDAY, MARCH 9, 2018

7:00 – 8:30 a.m.	**Board Breakfast Meeting** Briarwood Room
8:30 – 9:50 a.m.	**Concurrent Sessions 3A, 3B and 3C**
Session 3A	**Streams** **Room:** Lawrence **Moderator: Amanda Bell**
8:50	**Water Quality Assessment of Beaver Creek Subwatershed and Beaver Dam Lake, WI** Suzan Limberg,* University of Wisconsin-Madison
9:10	**Multi-Instrument Stream Surveys with Continuous Data for Better Groundwater/Surface Water Understanding in Wisconsin** Catherine Christenson,* University of Wisconsin-Madison
9:30	**Evaluating Ecosystem Services in the Yahara Watershed under Land-Use Change, Varying Land Management, and a Changing Climate** Tracy Campbell,* University of Wisconsin-Madison
Session 3B	**Groundwater-Surface Water** **Room:** Bond/Crown/Parchment/Oaktag **Moderator: Megan Haserodt**
8:30	**Linking Groundwater and Climate to Understand Long-Term Lake Level Fluctuations in Wisconsin** Zhixuan Wu,* University of Wisconsin-Madison
8:50	**Groundwater-Surface Water Interaction in Agricultural Watershed that Encompasses Dense Network of High Capacity Wells** Ammara Talib,* University of Wisconsin-Madison
9:10	**Toward Better Simulation of Ecohydrology: Forecasting Pumping Effects to Fens** Randall Hunt, U.S. Geological Survey (USGS) - Upper Midwest Science Center
9:30	**Findings of the 2014-2017 Wisconsin Springs Inventory** Grace Graham, Wisconsin Geological and Natural History Survey (WGNHS)

* Student presentation

Session 3C	**Coastal Modeling** **Room:** Rosewood Linden **Moderator: Mike Penn**
8:30	**A Resilient Wave Forecast System in the Apostle Islands, Lake Superior, WI** Michael Meyer,* University of Wisconsin-Madison
8:50	**Forecasting Extreme Water Level Oscillations Induced by Fast-Moving Storms in Lake Michigan** Alvaro Linare,* University of Wisconsin-Madison
9:10	**An Integrated Nowcast and Forecast Operation System (INFOS) for Dangerous Currents and Extreme Waves at Sheboygan, WI** Chen Jin,* Civil and Environmental Engineering, University of Wisconsin-Madison
9:30	**An Upgraded Forecast System of Wave Climate and Hydrodynamics for Lake Winnebago, WI** Joshua Anderson, University of Wisconsin-Madison
9:50 – 10:20 a.m.	**Break: Convention Lobby**
10:20 – 11:40 a.m.	**Concurrent Sessions 4A, 4B, and 4C**
Session 4A	**Agriculture and Watershed Management** **Room:** Lawrence **Moderator: Anthony Parolari**
10:20	**Nutrient and Sediment Management for Sub-Watersheds in NE Wisconsin Using ArcAPEX** Forrest Kalk,* University of Wisconsin-Green Bay
10:40	**Save the Bay Initiative: Two Congressmen's Effort to Improve Water Quality** Pauline Meyer, Congressman Gallagher's Office
11:00	**Mobile Tools for Watershed Management and Adaptive Management Verification** Brent Brown, CH2M
11:20	**Evaluating Edge-of-Field Water-Quality Monitoring Techniques: Relating Data Quality to Long-Term Monitoring Costs** Mari Danz, US Geological Survey (USGS) – Upper Midwest Water Science Center

* Student presentation

Session 4B	**Groundwater Quality II** **Room** Bond/Crown/Parchment/Oaktag **Moderator: Mike Rupiper**
10:30	**Source Investigations of Nitrate for Private Wells in Eau Claire County, Wisconsin** Audrey Boerner, Eau Claire City-County Health Department
10:50	**Making Sense of Microbial Indicator Data Using Medical Test Performance Metrics: Assessing the Relationship Between Total Coliforms and Pathogens** Joel Stokdyk, US Geological Survey (USGS) – Upper Midwest Water Science Center
11:10	**Prevalence of Cryptosporidium in Groundwater from Community and Non-Community Wells** Susan Spencer, U.S. Department of Agriculture (USDA)
11:30	**Land Use, Weather, Hydrogeologic, and Well Construction Risk Factors Associated with Private Well Contamination in Kewaunee County, Wisconsin** Mark Borchardt, U.S. Department of Agriculture (USDA)
Session 4C	**Groundwater Modeling** **Room:** Rosewood/Linden **Moderator: John Skalbeck**
10:30	**Evaluating Effects of Model Design and Complexity on Simulated Groundwater Ages** Paul Juckem, U.S. Geological Survey (USGS) - Upper Midwest Water Science Center
10:50	**Professional Judgement in Hydrogeology - A "Blink" Test** David Hart, Wisconsin Geological and Natural History Survey (WGNHS)
11:10	**Comparing MODFLOW 6 to MODFLOW-2005 Child Models Extracted from a Parent Analytic Element Model** Megan Haserodt, U.S. Geological Survey(USGS) - Upper Midwest Water Science Center
11:30	**Developing a Geologic Framework for Aquifer Geometry through Modeling of Gravity and Aeromagnetic Data** Esther K. Stewart, Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension
11:50 – 12:10 p.m.	**Student Awards and 2019 Meeting Announcements** Bond/Crown/Parchment/Oaktag
12:30 – 2:00 p.m.	**Student Career Session Lunch** Briarwood Room

Lightning Talks
Thursday, March 8, 2018
11:45-1:45

Forecast Fast-Moving Storm-Induced Water Level Oscillations in Lake Michigan Using a Deep-Learning Approach

Bo Peng, Department of Geography, University of Wisconsin - Madison, bo.peng@wisc.edu*
Álvaro Linares, Department of Civil and Environmental Engineering, University of Wisconsin - Madison
Qunying Huang, Department of Geography, University of Wisconsin - Madison
Chin Wu, Department of Civil and Environmental Engineering, University of Wisconsin - Madison

Water level oscillations induced by fast-moving storms have caused severe casualties and damages in Lake Michigan. To date, forecasting these type of events is still lacking. The rapid propagation speed of the storms leaves a very limited amount of time, within the order of minutes to a few hours, to process a large volume of data and provide a reliable forecast. The velocity and volume of data associated with the analysis of fast-moving storms makes the forecasting of extreme water level oscillations a very challenging task. In this study, we use state-of-the-art deep learning techniques to forecast fast-moving storm-induced water level oscillations from mesoscale atmospheric conditions. Specifically, we developed a deep convolutional neural network to extract key features of the fast-moving storms from mesoscale radar and satellite imagery. Feature selection conducted by this algorithm contributes to analysis of complex datasets and images. Results show that the features extracted from each fast-moving storm provide valuable information to classify the potential hazard of each storm. Overall, the developed algorithm produces prediction results with high accuracy and a low probability of false alarm, and can improve the forecast of water level oscillations induced by fast-moving storms.

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Water Resources Science - A Tree Falling in the Woods?

Jim VandenBrook, Wisconsin Land and Water Conservation Association, jim@wisconsinlandwater.org

Like a falling tree, does your science make any noise if there is no one there to hear it? What use is water resources science without policy leaders with the vision and will to utilize it?

Witness the purging of scientists in federal and state agencies and legislation that ignores basic scientific principles. The reluctance of scientists to connect with policy makers has led to the denigration of their science and ultimately of themselves. Can science, and scientists become respectable and useful again?

Wisconsin Land+Water sponsored the Food, Land and Water Project to engage farmers, business people, environmentalists, agencies, and academics, to answer this question: “Can Wisconsin find its way toward a sustainable future?” Over the course of two years of respectful conversation, those leaders said “YES”! Examples of the direct application of science, whether to manage phosphorus runoff, pathogens in groundwater, or declining lake and stream levels due to groundwater pumping, reinforced their policy recommendations.

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.

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Doesn’t Wisconsin Already Have Enough Geologic Maps?

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

Aren’t we done mapping the state yet? No, not even close.

Understanding the geologic setting is the starting point for every water resource project. Geologic maps document the distribution and character of earth materials and are essential for planning, infrastructure, economic development, resource assessment, hazard analyses, and many other activities. In the discipline of hydrogeology, geology controls the distribution of hydraulic properties that govern groundwater systems. Geologic maps are the essential foundation of the increasingly sophisticated groundwater flow models we build today.

In Wisconsin, we historically have produced geologic maps and cross sections at the 1:100 000 (1.6 mile/in) scale. Information accurate at this scale is appropriate for regional or county-wide planning but usually inadequate for local-scale decision making. Even at this regional scale Wisconsin lacks bedrock maps for 44 of its 72 counties and Quaternary maps for 30 counties.

Producing new and more-detailed geologic maps requires expertise, time, and money. The expertise is available in Wisconsin. Funding, however, has been lacking, especially when compared with the value of this information and the cost savings to industry, government, and citizens that occur when appropriate geologic maps are available. Environmental professionals need to acknowledge the need for geologic mapping and support increased funding for these fundamental data sets.

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Using Artificial Intelligence, Trained on Groundwater Models, for Rapid Decision Support

Michael Fienen, USGS Upper Midwest Water Science Center, mnfienen@usgs.gov
Daniel Feinstein, USGS
Tom Nolan, USGS
Len Kaufman, USGS

Groundwater models have been proven to be useful for understanding water resources impacts of changes in land use, water extraction, and other future conditions. Groundwater models can have long run times, however, which can hamper their use in decision support, assisting water resource managers and stakeholders in scenario planning. Recent advances in artificial intelligence and machine learning have provided an opportunity to create a statistical emulator of a groundwater model that can be used to gain approximate forecasts in a fraction of the time. Machine learning only sorts out correlation structure, however, so it is incumbent on practitioners to train them on meaningful datasets. If these are gleaned from robust groundwater models, exploring a range of important characteristics the analogues of which can be measured in the field or mapped regionally, the causal relationships are considered. I will highlight examples related to groundwater impacts on streams and susceptibility to contamination.

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Using Hourly Water Demands and Survey Data to Identify Potential Conservation Savings

Austin Polebitski, University of Wisconsin-Platteville, polebitskia@uwplatt.edu

Building on previous data collection, this research uses hourly water demand data from residences in Platteville WI to investigate whether there are opportunities for demand side management through targeted conservation efforts and development of water pattern types. Data from in-residence water fixture surveys (toilets, showerheads) for over 30 homes were analyzed along with their hourly water demand signals to determine whether older less efficient fixtures could be identified. A model was created from the analysis and used to predict residences where inefficient fixtures may be present. A verification survey was conducted using randomly selected homes to assess the models ability to predict the presence of older fixtures.

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Session 1A:
Groundwater
Thursday, March 10, 2018
2:00 – 3:20 p.m.

Well Dataset Quantifying Potential Human Influence at USGS Wells in the U.S. Glacial Aquifer System

Martha Nielsen, U.S. Geological Survey, mnielsen@usgs.gov
Glenn Hodgkins, U.S. Geological Survey
Robert Dudley, U.S. Geological Survey

Many groundwater research questions require that water-level records that may be affected by human influences be treated differently from records having only natural influences on water levels. The USGS recently released a dataset containing information on the degree of potential human influence on water levels in 2228 glacial aquifer wells across the northern US. We evaluated many types of nationally available data and developed an index of potential human influence based on several metrics of land use and water use. Groundwater-level record length and completeness criteria were applied to an initial set of over 4000 candidate glacial-aquifer wells in the USGS National Water Information System with a minimum of 10 groundwater levels collected from 1964 to 2013. Those wells were further screened to thin out highly clustered wells that duplicated water-level information. The resulting dataset of 2228 glacial aquifer wells were assigned to the following categories on the basis of their land and water use metrics : High Influence Potential, Transitional/High Influence Potential, Transitional/Low Influence Potential, and Low Influence Potential. The initial scores were evaluated by state groundwater specialists, and adjustments were made to 15 percent of the wells based on local knowledge not represented in the original scoring datasets. These wells have recently been used in several evaluations of water levels in the glacial aquifer system in the US.

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Comparing the Results of a Random Survey of Well Water Quality with Archived Homeowner-Submitted Well Water Samples

Michael Mechenich, University of Wisconsin-Extension & University of Wisconsin-Stevens Point, mmecheni@uwsp.edu
Kevin Masarik, University of Wisconsin-Extension & University of Wisconsin-Stevens Point
Amy Nitka, University of Wisconsin-Stevens Point
George Kraft, University of Wisconsin-Extension & University of Wisconsin-Stevens Point

Long-term archives of homeowner-submitted well water samples provide a large, valuable dataset, with applications in mapping groundwater quality, inferring pollutant loads from differing land uses, and identifying characteristics of the physical landscape which render groundwater more susceptible to contamination. However, use of such archives raises

potential concerns. Samples collected over several decades may not reflect current groundwater quality. Moreover, homeowners who suspect water quality problems may be more likely to test their well water, resulting in systematic bias in the archive.

A 2017 stratified random synoptic survey of well water quality in Portage County, Wisconsin provided us an opportunity to compare a current snapshot of groundwater quality with archived homeowner-submitted samples, collected since 1972 and saved in the UWEX Private Wells Database. For the 2017 survey, Portage County was divided into a regular grid of 229 four-mile-square cells, and a residential well was randomly selected within each cell for sampling; analytes included nitrate, chloride, alkalinity, hardness, and pH.

In comparing the 2017 survey and the Private Wells Database, we examined the extent to which temporal effects (i.e., how long ago an archived sample was collected) degraded the match between the synoptic and archived data, as well as the extent to which the spatial pattern of groundwater quality within the county differed between the synoptic and archived data.

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Integrating and Managing Water Quantity Data

Jeff Helmuth, Wisconsin Department of Natural Resources, jeffrey.helmuth@wisconsin.gov
Nicki Clayton, Wisconsin Department of Natural Resources
Bob Smail, Wisconsin Department of Natural Resources

In recent years Wisconsin has faced an increasing need for water quantity data to support resource management decisions. Wisconsin statute requires an accurate and accessible water resources inventory. This inventory includes managing statewide spatiotemporal monitoring data for groundwater levels, streamflows, spring flows, lake levels, and groundwater and surface withdrawals. The inventory also assists in identifying monitoring gaps and ultimately supports resource management decisions.

Over the past year, the DNR's Water Use Section evaluated Wisconsin's water quantity monitoring approach and addressed the following questions: what resources are monitored, what methodologies are being used to collect these data, how are the data being used, and how are the quantity data being shared?

This presentation highlights two key outputs of this effort. The first was a re-evaluation of the Wisconsin's Groundwater Level Monitoring Network with our partners, WGNHS and USGS, which examined priorities and streamlined a decision-making process to ensure the viability and utility of the long-term wells in the network. The second result was a statewide web-based map viewer that serves water quantity monitoring data. These efforts highlight the need for statewide collaboration with partners to ensure consistent data collection and accessibility. The intent is an increased ability to adequately evaluate Wisconsin's aquifers and groundwater/surface water connections.

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Cumulative Precipitation Deviation as a Predictor for Groundwater and Lake Levels

Robert Smail, Wisconsin Department of Natural Resources, robert.smail@wisconsin.gov

Water levels for lakes and aquifers of all sizes in Wisconsin are known to vary considerably through time as a function of climatic variation. This moving baseline complicates our ability to directly assess the impacts of water withdrawals and hydrological modification. While advanced hydrological modeling can be employed to assess impacts, the spatial and temporal scales involved make this computationally and economically unfeasible in many situations. This presentation will demonstrate how a simple manipulation of one variable, monthly precipitation, can be used to predict the expected water level for any location at any point time in the dataset. In this approach, cumulative deviations calculated from Oregon State's PRISM long term gridded precipitation data strongly correlate with water level monitoring data from USGS. These correlations can then be used to interpolate partial water level datasets, such as DNR SWIMS, or to identify divergences from expected water levels. Results from this analysis may also be helpful to water quality assessments, ecological studies or water engineering projects where climatic variation is an important factor.

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Session 1B:
Urban Water Quality
Thursday, March 10, 2018
2:00 – 3:20 p.m.

Influence of Hydrogen Peroxide and Ultrasonic Treatment on Cyanobacteria and Chlorophyta Development - Longterm Versus Shortterm Bioremediation Measures

Hedda Sander, Ostfalia University, Germany, h.sander@ostfalia.de
Fabian Kügow, Ostfalia University
Anastasia Zotova, Ostfalia University

Bioremediation is often the only way to restore eutrophied shallow freshwater lakes exhibiting harmful algal blooms (HAB). Cyanobacteria are the main cause of HAB in freshwater ecosystems, they often represent health risks to the public due to a variety of algal toxins released into the water during the final stage of a bloom. Thus, algal growth is carefully monitored during late summer season, especially in frequented recreational and drinking water areas.

Bioremediation is a longterm option to restore water quality in lakes affected with HAB, however, the public often demands more immediate measures especially in recreational areas. Shortterm options include surface shading, ultrasonic treatment and recently Hydrogen Peroxide treatment options. Own experiments show a reduction of Cyanobacteria and Chlorophyta 24 hrs after H2O2 (60 mmol) treatment, also Daphnia populations are affected.

Ultrasonic device (USD) treatment is effective with frequency 37-45kHz and output power 8W in green algae and cyanobacteria inactivation with treatment duration >24 hours. 29-37kHz USD is coming up next, effective in cyanobacteria elimination after treatment application of 6 days and longer; however, its ability to reduce green algae population is doubtful. Ultrasonication at 40kHz frequency is ineffective against green algae and cyanobacteria.
The present study will present data on different shortterm and longterm treatment options and discuss the benefits of those choices.

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Evaluation of a Screened Stormwater Structure for Removal of Sediment and Phosphorus in Urban Runoff

Nicolas Buer, USGS, nbuer@usgs.gov

Water quality of storm sewer discharge to water bodies is regulated by the National Pollutant Discharge Elimination System (NPDES) Program as part of the Clean Water Act. To remain in compliance, municipalities are required to develop a Stormwater Management Plan (SWMP), implementing practices aimed at preventing pollutant runoff. Catch basins are commonly used by regulated cities to remove sediment and associated contaminants from stormwater through settling. Recently, the city of Madison has modified traditional catch basins by incorporating a fine-mesh (500 micrometer) screen into the design with the goal of removing sediment and organic matter from stormwater that might have previously been allowed to bypass.

The U. S. Geological Survey (USGS), in partnership with the city of Madison, installed a water-quality monitoring station at a screened catch basin in Madison, WI to quantify reductions in total suspended solids (TSS), suspended sediment concentration (SSC), total phosphorus (TP), and dissolved phosphorus (DP) from urban stormwater before entering Lake Monona. A comparison of the cumulative load from 33 samples collected during the summer of 2016 and 2017 show a 23 and 46 percent reduction in TSS and SSC, respectively. Less of a reduction was observed for TP at 16 percent while DP remained unchanged. Reported traditional catch basin sediment removal varies greatly although typical removal rates are around 30% (Pitt, 1985).

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Improving Predictions of Urban Runoff Volume

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

Predictions of urban runoff volumes are important for sizing stormwater control measures and predicting pollutant loadings for TMDLs. The computer program, Source Loading and Management Model for Windows (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 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 models' predicted values. The 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 knowing their watershed characteristics such as slope and connectiveness in initial stages of model development.

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Sediment Toxicity Assessment and Contaminant Source Tracking at Two Wisconsin Areas of Concern (Aocs) and Non-AOC Comparison Tributaries to Lake Michigan

Hayley Olds, U.S. Geological Survey (USGS), htolds@usgs.gov
Barbara Eikenberry, USGS
John Besser, USGS
Rebecca Dorman, USGS

Great Lakes Areas of Concern (AOCs) are some of the most degraded areas within the Great Lakes basin. Each AOC was originally designated by assessing up to 14 possible beneficial use impairments (BUIs), several of which are primarily or partially caused by historical sediment contamination. The Sheboygan River and Milwaukee Estuary are two Wisconsin Lake Michigan AOCs that were listed as AOCs in part because of sediment contaminated by polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and metals. In fall 2016, the USGS collected composite samples of streambed sediment from 19 sites— 11 at the Sheboygan River and Milwaukee Estuary AOCs and 8 at non-AOC comparison sites. Sediment was analyzed for concentrations of PCBs, PAHs, and selected metals, as well as midge and amphipod toxicity. Amphipod toxicity at the sites was found to be primarily related to PAHs and secondarily to metal concentrations in the sediment. Source tracking techniques, such as the comparison of PAH diagnostic ratios and proportional concentrations of PAH congeners in each sediment sample to published PAH sources, were used to estimate the most likely sources of PAHs to sediment at each AOC and non-AOC comparison site. The results from this study will be used to evaluate remediation progress and determine future remedial actions for improving contamination and toxicity to benthic invertebrates at these sites.

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Session 1C:
Geomorphology
Thursday, March 10, 2018
2:00 – 3:20 p.m.

Pike River Geomorphic and Water Quality Study

Nicholas Potter, University of Wisconsin-Parkside, potte016@rangers.uwp.edu*
Rachel Headley, University of Wisconsin-Parkside

The Pike River, draining an urban-rural watershed, flows through the University of Wisconsin-Parkside's campus. In the fall of 2017, Parkside's Geosciences Department began to study the Pike's water quality and discharge. The intent was to understand the impact of two ravines that discharge into the Pike and to provide baseline measurements for both future studies and when the river undergoes remediation and restoration projects. The river's watershed, straddling Racine and Kenosha counties, is 146.36 square kilometers, and discharges into Lake Michigan. The study area (a 0.6 km segment of the river) begins at USGS gaging station 04087257 and ends downstream of a ravine of interest. Within the study area are two ravines of interest (one at the beginning and one at the end) and seven different measurement locations (at which three measurements were taken trisecting the river). Two sets of stream flow measurements were taken around each ravine, one set upstream and one downstream to give an idea of the river's stage and to compare against the USGS gaging station. Equipment used included a YSI ProDDS for pH, dissolved oxygen, turbidity, temperature, and specific conductivity and a Flow Watch for flow measurements. Weekly data collection began on October 15. Initial results show the ravines' turbidity are lower than the river's while all other parameters are almost identical and the turbidity of the river also appears to be directly related to the flow present in the river.

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Bluff Recession on a Developed Coast in Southeastern Wisconsin: New Perspectives on Coastal Management

Isak Fruchtman, Department of Civil and Environmental Engineering, University of Wisconsin - Madison, fruchtman@wisc.edu*
Connor Collies, Geological Engineering Program, University of Wisconsin - Madison
Chin Wu, Department of Civil and Environmental Engineering, University of Wisconsin - Madison

Bluff recession in southeastern Wisconsin has been an increasingly critical concern for homeowners and stakeholders along the coast after consistently low water levels from the late 1990's to 2013. Specifically, Lake Michigan's water levels have

been rising rapidly and have exceeded the historic mean since 2014. Accelerated rates of bluff recession on Wisconsin's southeastern bluffs on Lake Michigan are threatening homeowners and stakeholders. In this talk, a regional analysis is used to evaluate three different degrees of a developed coast: engineered (e.g. revetments and groins), transitional (e.g. deteriorated structures/disturbed beaches), and natural (e.g. undisturbed beaches). Results indicate that transitional coasts exhibit the highest rates of erosion in comparison to the other two degrees of a developed coast – especially under a period of rising water level conditions. The assessment of bluff recession under different degrees of a developed coast, along with a consideration of socio-economic costs to the stakeholders, provides a new perspective on managing coastal bluff areas.

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Assessment and Design of Braid-Island Rehabilitation in Cherokee Marsh, Wisconsin

Peter Torma, Department of Civil and Environmental Engineering, University of Wisconsin–Madison and Department of Hydraulic and Water Resources Engineering, Budapest University of Technology and Economics, Hungary, ptorma@wisc.edu
John R. Reimer, Department of Civil and Environmental Engineering, University of Wisconsin–Madison
Chin Wu, Department of Civil and Environmental Engineering, University of Wisconsin–Madison

Cherokee Marsh, with 3200 acres, is the largest natural wetland in Dane County, Wisconsin. This extensive wetland complex, located at the head of the Yahara chain of lakes, is characterized by marsh, fen, shrub carr, and sedge meadow. Due to anthropogenic alteration of hydrology, excessive sediment and nutrient loadings, and negative impacts of invasive species including carp, reed canary grass, and glossy buckthorn, many ecosystem services have undergone significant degradation in the last decades. In this talk, we adopt a braid-island rehabilitation strategy to revitalize wetland functions and retain functionality and ecological services of the waterbody, such as recreation, navigation and habitat. Specifically, scenarios of water levels and flow conditions that can increase occurrence and duration of inundations over the braid-island and marshland system will be assessed for reducing flood risk to downstream waters and providing diversified habitats. Attenuation of waves and induced sedimentation to enhance conditions for vegetation growth due to braid barrier islands will be examined. Designs and configurations of braid barrier islands for the feasibility of rehabilitation are evaluated by simulating current and wave motions in terms of flow paths, sedimentation, and exposure of waves. At last, potential benefits for water quality improvement by reducing nutrient loading to the lower Yahara Lakes will be addressed.

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Status of Lidar Elevation Products in Wisconsin 2018

Jim Giglierano, Wisconsin Dept of Administration, jim.giglierano@wisconsin.gov

Many water resource program areas in Wisconsin rely on lidar derived digital elevation models to delineate high quality stream networks, water bodies, watershed boundaries, contours and other derived GIS products. These products are critical for modeling surface and groundwater, soil erosion and nutrient management, storm water runoff, and wetland functions. Applications include coastal and floodplain management, disaster planning and response, managing natural resources and site development. With the advent of federal elevation grants and increased Wisconsin Land Information Program funding, much of the remaining area of the state is being acquired and older data sets are in the process of being refreshed. This talk will provide an overview of the status of lidar acquisition in the state, efforts to increase the distribution of data products to users, provide basic lidar training, and future collaborative efforts.

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Session 2A:
Groundwater Quality I
Thursday, March 10, 2018
3:40 – 5:00 p.m.

Recharge and Well Vulnerability in the Silurian Dolomite Aquifer: Deeper Is Not Necessarily Protective

Maureen Muldoon, UW-Oshkosh, Department of Geology, muldoon@uwosh.edu
Kenneth Bradbury, Wisconsin Geological and Natural History Survey
Randall Hunt, US Geological Survey Upper Midwest Water Science Center
Patrick Wanzeck, UW-Oshkosh, Department of Geology

A recent Kewaunee County Groundwater Study has re-focused attention on factors that affect groundwater quality in the dolomite aquifer of northeastern WI. The fractured aquifer, where it is overlain by thin soils, is extremely vulnerable to contamination. A history of contamination has been documented for decades. In an effort to provide safe water to residents of the area, one common suggestion is to replace existing wells with deeper wells that would still be completed within the dolomite aquifer.

Data from previous studies and from the Kewaunee County project show that recharge, and associated contaminants, can penetrate several 100s of feet into the aquifer within a matter of days. Characteristics of the fracture network within the dolomite and the flow characteristics of the aquifer facilitate the deep penetration of recharge.

A special casing requirement has been in place in Door County since the 1970s. A study by the WI Geological & Natural History Survey in the early 1990's found no statistical difference in contamination rates for older wells and wells constructed to meet the newer casing requirements. Indeed, a replacement well included in our recent study (303 feet deep, cased to 200 feet) exhibited contaminated water within 6 months of being constructed and tested positive for pathogens.

These studies lead to the conclusion that changes in well construction are unlikely to mitigate water-quality problems in the shallow dolomite regions of eastern Wisconsin.

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Geochemical Study of Aquifer Conditions on Radium in the Cambrian-Ordovician Aquifer

Madeleine Mathews, University of Wisconsin - Madison, mmathews2@wisc.edu*
Matthew Ginder-Vogel, University of Wisconsin - Madison
Madeline Gotkowitz, Wisconsin Geological and Natural History Survey

This study examines the geologic sources of radium (Ra) in the Midwestern Cambrian-Ordovician aquifer through aqueous and solid-phase analysis. Groundwater geochemical trends were analyzed from samples collected in Madison, Wisconsin from monitoring and municipal wells, as well as data from the Wisconsin Department of Natural Resources (DNR) water quality database. Twenty-two monitoring wells, representative of the hydrostratigraphic range across the two aquifers and confining unit, were sampled over two time periods in 2016-2017, with 13 wells sampled twice. On average, these wells contain 1.3 pCi/L Ra, ranging from non-detect to 5.2 pCi/L. Confined aquifers are associated with minimal dissolved oxygen concentration and a subsequent possible effect on Ra concentrations. In Madison, municipal wells obtaining water from below the confining unit have on average 1.85 pCi/L more Ra than wells pulling water from predominantly above the confining unit. Solid-phase analysis on well cuttings and core from the aquifer system included X-ray spectroscopic techniques such as X-ray fluorescence and X-ray absorption spectroscopy. Increased concentrations of Ra sources were determined in the confining unit, although Ra sources were also found in the unconfined and confined aquifers. Further analysis of the impact of confining units on Ra sorption to aquifer solids would improve current understanding of Ra movement within the Cambrian-Ordovician aquifer.

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Anthropogenically Driven Changes to Shallow Groundwater in Southeastern Wisconsin and its effects on the Aquifer Metagenome

Madeline Salo, Geosciences Department UW- Milwaukee, mjsalo@uwm.edu*
Natalie Gayner, School of Freshwater Sciences UW- Milwaukee
Tim Grundl, Geosciences Department UW- Milwaukee
Ryan Newton, School of Freshwater Sciences UW- Milwaukee

This study investigates if, and to what extent the microbial community present in the shallow groundwater of southeastern Wisconsin is affected by the influx of treated municipal wastewater effluent. The study area consists of three wells located in the shallow sand and gravel aquifer along the upper Fox River in Waukesha, Wisconsin. One well is located roughly 1500 feet from the river and pumps pristine groundwater. Two riverbank inducement wells are located within 200 feet of the river and pump a mixture of groundwater and river water that contains effluent from three upstream wastewater treatment plants. Water from all three wells is being analyzed for geochemical composition (major ions, nutrients, dissolved gases and dissolved organic carbon) and microbial community composition (16s rRNA gene composition, 16s rRNA activity and metagenomic sequencing). Geochemical and microbial genetic data will be combined to identify thermodynamically feasible metabolic pathways capable of being carried out by the microbial consortia. Initial results show slightly higher

levels of metabolic gases, in particular methane and hydrogen, higher levels of ammonia and total dissolved phosphate and lower levels of nitrate in riverbank inducement wells. Initial 16S rRNA gene composition shows subtle differences in the microbial consortia present in the pristine well and the riverbank inducement wells. 16S rRNA gene activity and metagenomic analysis will further refine these differences.

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A field Investigation of a Small Drainage Lake and Contamination Plume in Northern Wisconsin

Andrew Leaf, U.S. Geological Survey, aleaf@usgs.gov
Megan Haserodt, U.S. Geological Survey

Haskell Lake is a shallow, 90-acre drainage lake on the Lac du Flambeau Reservation in northern WI. Historically this lake was an important producer of wild rice for the Lac du Flambeau Tribe. Sediment cores and tribal records indicate the presence of wild rice dating back at least several centuries, but beginning in the late 1970s, the rice began to diminish and by the late 1990s, the lake had little or no rice. The cause of wild rice decline is unknown. The Tribe is also concerned about a petroleum contamination plume in the shallow aquifer upgradient of the Lake. The USGS is working with the Lac du Flambeau Tribe to characterize the lake water balance and contributing groundwater flow system, to inform future wild rice restoration efforts and clean-up of the contamination plume. Field data on lake and groundwater levels, gradients, fluxes and subsurface lithology were collected from 2016-2017 using a variety of high- and low-tech methods. Challenges and successes encountered in the various field techniques, which included pore water sampling, vertical temperature profiling, low-velocity current measurement and several shallow geophysical methods, will be discussed. The field data are informing a MODFLOW model of the hydrologic system that simulates sources of water to the lake and their groundwater contributing areas. Results of the field and modeling efforts will help the Tribe assess some of the potential environmental factors important to wild rice.

Session 2B:
Central Sands
Thursday, March 10, 2018
3:40 – 5:00 p.m

Crop Rotational Strategies to Improve Freshwater Quantity and Quality in the Wisconsin Central Sands

Mallika Nocco, University of Minnesota-Twin Cities, mallikanocco@gmail.com
Robert Smail, Wisconsin Department of Natural Resources
Elizabeth McNamee, University of Wisconsin-Madison
Michael Fienen, United States Geological Survey
Christopher Kucharik, University of Wisconsin-Madison
Tracy Twine, University of Minnesota-Twin Cities

There may be untapped opportunities to conserve water in the Wisconsin Central Sands using interfield crop rotation strategies, precision irrigation, and irrigation scheduling. Rotational strategies involve the placement of low-water and nutrient demand crop rotations in sensitive areas (i.e. adjacent to streams) or staggering different crop rotations to distribute peak water and nutrient demand. Precision irrigation and irrigation scheduling involve controlling the spatiotemporal efficiency of irrigation and fertilization to minimize losses. Though these strategies are promising, long-term studies comparing conventional and conservation rotations are needed to bridge the gap between field studies and application. Our research goal is to assess long-term differences in water and nitrate losses between conventional and conservation crop rotations by implementing new plant functional types (e.g. potato, sweet corn) into a dynamic, process-based agroecosystem model (AgroIBIS-Hydrus) using field data collected from a family farm in Plover, WI. We will also use PEST statistical inverse modeling software to quantify uncertainty and analyze the sensitivity of modeled recharge and nitrate losses. Our work will demonstrate profitable on-farm conservation strategies to growers in the Wisconsin Central Sands that can be temporally incorporated into existing crop rotations during extended droughts or spatially incorporated on fields in close proximity to freshwater ecosystems.

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Understanding Natural and Anthropogenic Effects on Groundwater Levels in Wisconsin's Central Sands

Colin McGuire, University of Wisconsin - Madison, cfmcguire@wisc.edu *
Paul Block, University of Wisconsin - Madison

Groundwater fluctuations in the Central Sands are well known to be modulated via hydrologic variables – principally precipitation – and likely through anthropogenic impacts – principally groundwater extraction – as well. To evaluate the drivers of natural variability, we explore the spatiotemporal relationship of precipitation and groundwater by analyzing precipitation falling within close proximity and at distance to United States Geological Survey (USGS) monitoring wells at various lead times. Additionally, we explore how increasing groundwater sourced irrigation may be affecting groundwater levels, particularly during dry years. This anthropogenic effect is examined through the relationship of active high-capacity wells proximal to USGS monitoring wells. The understanding of how groundwater levels respond to the amount and spatial distribution of precipitation and proximity to high-capacity wells may be of interest to stakeholders within the region, particularly agriculture and lakefront real-estate. Further, season-ahead precipitation and groundwater level prediction models are evaluated based on these relationships.

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Evaluating Tree Growth and Quantifying Groundwater Use in Sandy Wisconsin forests

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

As drought variability increases in forests around the globe, it is critical to evaluate and understand ecosystem attributes that reduce negative drought consequences. Trees in dry regions can sustain tree growth and transpiration by accessing a shallow water table, yet the extent to which groundwater influences forest growth and how forests impact groundwater resources in wetter areas is essentially unknown. We investigated the extent to which groundwater influences tree growth and how the forest impacts groundwater resources in sandy forests in Wisconsin. We hypothesize that even in wet regions soil droughts occur relatively frequently in forests with sandy soils resulting in water stress and reduced tree growth as recorded by tree ring chronologies. We suspect these reductions in productivity are ameliorated if the forest can access a shallow water table during dry conditions. Tree growth response from tree cores was examined across sites covering a 1-9 m depth to groundwater gradient. Further, diurnal water table fluctuations were analyzed to quantify the amount of groundwater consumed by trees for evapotranspiration. In general, trees in areas of shallow groundwater consumed more groundwater and showed lower temporal variability in tree growth than in deeper groundwater areas. Our research aims to

provide a basis for understanding the role of groundwater in conferring drought resistance in temperate forests to help guide sustainable water and forest management decisions.

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The Little Plover River Watershed Enhancement Project: A Collaborative Effort to Restore Baseflow and Ecological Health

Stephen Gaffield, Montgomery Associates: Resource Solutions, LLC, steve@ma-rs.org
Nick Hayden, Montgomery Associates: Resource Solutions, LLC
Robert Montgomery, Montgomery Associates: Resource Solutions, LLC

This collaboration of local and state government, agricultural producers and environmental groups aims to restore baseflow and improve ecological health of the Little Plover River in Wisconsin's Central Sands. Flow depletion due to groundwater pumping has been studied for decades and has generated considerable attention. The State of Wisconsin has established public rights flows intended to protect the health of the river's trout fishery.

We are using available information and models plus additional monitoring to identify and implement realistic, voluntary actions to work toward restoring the public rights flows. A watershed restoration strategy is being developed that prioritizes multiple projects to increase baseflow including: optimizing Village of Plover water supply pumping to increase summer low flows; municipal water conservation; transitioning irrigated agricultural lands near the river to conservation areas or non-irrigated agriculture; riparian wetland restoration; agricultural water management; and infiltration of stormwater runoff. Flow restoration could be complemented by habitat improvements, such as riparian vegetation management to stabilize streambanks and restore a narrower and deeper river channel cross section, which could reduce stream temperature and increase cover for fish. A network of stream gages and monitoring wells already present in the watershed will provide valuable feedback on the success of restoration measures and guide future efforts.

Session 2C:
Surface Water Extremes
Thursday, March 10, 2018
3:40 – 5:00 p.m.

Flood Risk and Warnings for the Yahara River Chain of Lakes (RCL)

John Reimer, UW-Madison, jrreimer@wisc.edu*
Chin Wu, UW-Madison

Historic flood events in the Yahara River Chain of Lakes have resulted in millions of dollars of damages. Commonly, flood risk assessments focus on rivers or lakes. No attention has been paid to a connected system called a River Chain of Lakes (RCL) where spatial and temporal complexities presents challenges to appropriately quantify flood risk. In a RCL, features such as controlled (e.g. dam) and uncontrolled (e.g. river choking) water release, seasonal aquatic plant density, temporary revers flows, and varying spatial patterns of rainstorms on watersheds can affect the spatial and temporal delivery of water to a RCL. In this talk, a suite of models including hydrologic, hydrodynamic, and flood loss are integrated to estimate building loss for the 2008 event and other probabilistic events. Potential management strategies to mitigate flooding are examined. Furthermore, water level outlooks that provide hourly floods on a RCL for the future seven days are integrated to a flood warning system to notify the community, managers, and emergency responders of potential flooding.

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Application of Stochastic Storm Transposition and Hydrologic Modeling to Flood Frequency Analysis: A Case Study for Turkey River, Iowa

Guo Yu, University of Wisconsin-Madison, gyu29@wisc.edu*
Daniel Wright, University of Wisconsin-Madison

Floods are the product of complex interactions of factors including rainfall, watershed morphology, and antecedent conditions. Long-standing flood frequency analyses that use statistical models of river discharge offer few insights into these interactions. For example, the role of soil moisture in flood frequency is poorly understood, despite its obvious importance. In this research, we develop a framework that couples Stochastic Storm Transposition (SST) with a simple hydrologic model to analyze flood frequency and to distinguish sources of uncertainty in the model, inputs, and in initial conditions. The open-source SST software RainyDay is used to extend the rainfall record by temporal resampling and geospatial transposition of observed storms to generate a large number of realistic extreme rainfall “scenarios.” We first use RainyDay combined with radar precipitation data to generate rainfall scenarios for exceedance probabilities ranging from 1 to 0.002. We then derive the distribution of soil moisture and snowpack from long-term continuous simulations of

daily streamflow. Finally, we couple rainfall scenarios with antecedent conditions to simulate flood frequency ensembles that consider input and model parameters uncertainty. We contrast the results against stream gage-based statistical analyses. The framework is relative simple to apply in other settings, provided that sufficient data are available for hydrologic model calibration.

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Characterization for Dangerous Currents at Port Washington, Lake Michigan

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

Dangerous currents in Lake Michigan are one of the significant water safety concerns to the communities of Port Washington, WI. To date it remains unclear the locations and factors associated with dangerous currents in this area. In this talk, a comprehensive approach that integrates remote sensing, field measurements and nested-grid numerical modeling to characterize dangerous currents at Port Washington is presented. First, potential locations of dangerous currents are identified using remote aerial photos and LiDAR raster images. Next, environmental factors, including nearshore wave climates and wind conditions, are connected with dangerous currents that were measured at those identified locations. Lastly, the spatial and temporal evolution of dangerous currents under those associated environmental factors are revealed using a nested-grid hydrodynamic wave-current interaction model. Results show that dangerous currents can occur alternatively on both north and south side near the harbor at Port Washington under changing wind conditions. Overall, static, statistical and dynamic characterization for dangerous currents at Port Washington in Lake Michigan are provided to improve the understanding and enhance the resilience of coastal communities in response to dangerous current hazard/disaster.

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Inundation Frequency and Extent of a Wetland Stream

Kenneth Potter, University of Wisconsin, kwpotter@wisc.edu

It has been observed that baseflow dominated streams flowing through wetlands are commonly at or near bankfull, and overflow their banks much more frequently than other streams. However, there is very little published quantitative support for this observation. This study focuses on a reach of Black Earth Creek, a baseflow-dominated stream in Wisconsin. We used one-dimensional hydraulic modeling to estimate bankfull discharge at 50 evenly spaced stream cross sections, 37 of which were in the wetland. We used two-dimensional modeling to quantify the inundation extent as a function of discharge. In both cases we modeled with and without the sediment deposits that were observed on the streambed. We then used historical streamflow data from two USGS gaging stations to quantify the frequency of wetland inundation. For the case where the sediment was assumed to be present, the frequency of overbank conditions at the 37 cross sections ranged from 3 to 85 days per year, and averaged 43 days per year. For the same case, 10% of the wetland was inundated for an average of 35 days per year. For the case without sediment, the frequency of overbank conditions ranged from 2.6 to 48 days per year and averaged 14 days per year. For this case, 10% of the wetland was inundated for an average of 25 days per year. These unusually high rates of floodplain inundation are likely due to very low sediment concentrations in overbank flows and the absence of lateral stream migration.

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Poster Session
Thursday, March 8,, 2018
7:00 – 10:00 p.m.

1. Source to Sink Tracing of Phosphorus Contamination Pathways in Surface Water and Groundwater of Western Wisconsin.

Carly Mueller, University of Wisconsin - Eau Claire, muelleca4376@uwec.edu*
Melissa Hackenmueller, University of Wisconsin - Eau Claire
Adam Wiest, University of Wisconsin - Eau Claire
J. Brian Mahoney, University of Wisconsin - Eau Claire
Sarah Vitale, University of Wisconsin - Eau Claire
Laurel Mc Ellistrem, University of Wisconsin - Eau Claire

This investigation will create the first comprehensive source to sink assessment of phosphorus (P) transport pathways throughout western Wisconsin. Excess loading in surface water causes eutrophication events that result in significant degradation of surface water quality. Understanding the source and mobility of P is becoming increasingly urgent as 60% of the 225 bodies of water on the WDNR 2016 Impaired Water list exceed the total P criteria. The study area encompasses the northeastern upper Mississippi River watershed. This area has seen a dramatic increase in both silica sand mining (300% since 2011) and CAFOs (600% since 2000) making it vital to determine the potential impact that these growing industries have on surface water and groundwater quality.

A multidisciplinary approach integrating stratigraphy, geochemistry, sequential extraction, surface water and groundwater chemistry, and hydrologic flow characterization will be used to assess the spatial and temporal distribution of P, constraining the natural and anthropomorphic sources. Ongoing water chemistry at UW- Eau Claire has documented differences in concentrations of P in geology, surface water, and groundwater. Whole rock geochemistry indicates that bedrock P2O5 values range from .25-2.5%. Surface water concentrations commonly exceed 100 ppb, while adjacent groundwater concentrations are far higher (10 to >1000 ppb). These high concentrations suggest that P is mobile and concentrating in groundwater reservoirs.

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2. Trophic Fate of PPCPs and Trace Metals in a Low-Order Stream System

Alyssa Mianecki, UW - Stevens Point, amian812@uwsp.edu*

Wastewater treatment plants continually release treated human waste into the natural environment. Typically, the wastewater is only treated to remove bacteria and excess nutrients. Compounds such as pharmaceuticals and personal care products as well as heavy metals are able to bypass the treatment process. Pharmaceuticals and personal care products (PPCPs) are used to improve the quality of life for humans, through means of medication, cosmetics, or food enhancement. Trace metals such as gadolinium and lithium are used medically and the metal boron is commonly found in detergent. Both metals and PPCPs can be detected in the aquatic environment. Due to the constant inflow from wastewater effluent, there is opportunity for accumulation of metals and PPCPs in stream organisms that are directly impacted by wastewater treatment plants due to the constant background concentrations in the water. Using novel methods for extraction, PPCP quantities can be analyzed using an LC/MS/MS system. Heavy metals are extracted via a digestion and analyzed on an ICP-OES system.

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3. A Multi-Agent Based Model for Human Decision Behaviors Response to Dangerous Currents in Lake Michigan

Ling Li, Beihang University / University of Wisconsin–Madison, lli444@wisc.edu*
Yuli Liu, University of Wisconsin–Madison
Chin Wu, University of Wisconsin–Madison

The high occurrence of dangerous currents in Wisconsin is of importance to beach safety concern. In the past 15 years, there were 366 incidents in Lake Michigan shoreline and 43 incidents in Lake Superior, which not only resulted in drownings, but also led to wide-ranging public panic. As a result, dangerous currents have aroused an increasingly attention from both local community and stakeholder. While efforts on effective measures and safety education have been implemented, such as beach flags, warning system, and signs, beach goers have yet take appropriate best practices. This study attempts to investigate how the social-economic factors affect the human behaviors under dangerous currents hazards, and to explore the corresponding emergency alert strategies for controlling public panic and mitigating mortality. Specifically, a multi-agent based simulation model is developed. Unlike other traditional simulation models from the macroscopic perspective, the bottom-up analysis technique is employed to describe systems from the microscopic perspective, focusing on the individual activities of each agent and the gathering behaviors of the system. This model, for the first time, will provide a new perspective for stakeholder and decision makers to make appropriate alert strategies to mitigate potential damages stemming from dangerous currents.

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4. Water Quality Conditions and Harmful Algal Blooms in Utah Lake, Provo, UT

Michelle Zeien, University of Wisconsin- Parkside, zeien002@rangers.uwp.edu*
Bryanna Ehmke, University of Wisconsin- Parkside
John Skalbeck, University of Wisconsin- Parkside

Utah Lake is currently a eutrophic, slightly saline lake located west of Provo, Utah. Utah Lake is relatively shallow (max. 12 ft) and is located in an arid region. Historically, the water within Utah Lake has been used for crop irrigation by the surrounding farms. In recent years, Utah Lake has been subject to large Harmful Algal Blooms (HABs). These HABs consume much of the dissolved oxygen within the water system making this water resource unusable for irrigation and recreation. This loss of agricultural water must then be drawn from municipal water supply. In response, the Utah Division of Water Quality has implemented the Utah DWQ HAB network which includes 3 water quality buoys in Utah Lake. Water quality parameters including algae counts are collected every 15 minutes and transmitted to a cloud-based server. A number of HABs that occurred in summers of 2016 and 2017 that triggered public advisories that included lake use restrictions. The water quality and algae data from these buoys were used as input to a mobile phone application (Algae Estimator) which calculates potential HABs. Primary input parameters for the Algae Estimator (AE) include: surface and bottom lake temperature, initial total Chlorophyll a (Chl a) and Cyanobacteria Chl a values, and light intensity. The AE output includes an estimate of total and Cyanobacteria Chl a over time. HABs appear to increase as the climate warms and thus their prediction becomes vital for water management in arid regions.

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5. Nitrate and Chloride Leaching Below Irrigated Agroecosystems

Kevin Masarik, University of Wisconsin - Stevens Point & University of Wisconsin - Extension, kmasarik@uwsp.edu
Elizabeth McNamee, University of Wisconsin - Madison
Christopher Kucharik, University of Wisconsin - Madison

Nitrogen fertilizers and other nutrient sources (e.g., manure, bio-solids, and legume credits) are valued for their ability to increase yields, however a portion of these nitrogen inputs leach to groundwater as nitrate. Understanding the impact current agricultural practices have on groundwater is difficult particularly in Wisconsin where nitrate losses below well-drained soils to groundwater is the primary concern rather than losses via tile drainage and export to surface waters.

Equilibrium tension lysimeters measured drainage and solute leaching below an irrigated agroecosystem in the Central Sands region. Sweet corn was planted in 2016 and potatoes in 2017. Sampling was performed bi-monthly, year-round thus allowing for detailed temporal resolution of leaching losses and determination of annual solute fluxes. In addition to commercial fertilizer inputs, we collected irrigation water via funnel collection systems to quantify the amount of nitrogen delivered in irrigation water for the 2017 growing season.

Results illustrate solute leaching patterns from the root zone relative to the timing and amount of inputs. Comparing nitrate and chloride solute fluxes lends insight into the effects of mineralization and other processes on nitrogen losses to groundwater. This information will be useful for calibrating models that simulate the effectiveness of crop rotations, cover crops and other management practices to reduce groundwater nitrate.

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6. The Geochemistry of Nitrate Contamination

Amy Nitka, University of Wisconsin-Stevens Point Water & Environmental Analysis Lab, anitka@uwsp.edu
Paul McGinley, University of Wisconsin-Stevens Point

The most pervasive groundwater contaminant in Wisconsin is nitrate from nitrogen application to land in fertilizer and wastes; however, because nitrogen is not inert in the soil profile, nitrate contamination will likely lead to other changes in groundwater chemistry. We examined the connection between nitrate and other geochemical changes to groundwater by repeatedly sampling twenty monitoring wells in central Wisconsin and chemically characterizing the groundwater. These wells were in areas where nitrate concentrations routinely exceed 20 mg N/l. The nitrate concentration in nine wells varied by 10 mg N/l. These variations in nitrate likely reflect variations in the timing of both fertilizer addition and residue decomposition with the timing of soil percolation and groundwater recharge. We hypothesize that the geochemical changes that accompany nitrate contamination travel with nitrate in the soil profile and aquifer and through examination of the correlation between nitrate and groundwater geochemistry, we can understand the geochemical implications of nitrate contamination. Our results show that wells with a relatively large nitrate concentration variation over time had significant positive correlations between nitrate and increased groundwater mineralization. Calcium and magnesium concentrations strongly positively correlate with nitrate concentrations. That is consistent with the acidity from nitrification accelerating rock weathering in dolomitic glacial drift.

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7. Linking Hydrology, Spectroscopy, and Floristic Quality of Fens

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

Calcareous fens are a type of wetland that are fed by groundwater and store carbon in the form of peat and/or carbonate precipitates. In Wisconsin they are rare, and are also home to a rich diversity of plant species, many of which are endangered. Fen specialists are adapted to survive under the stressors of low oxygen, low nutrient availability, and chemical toxicity that are associated with a high water table, rich in cations. When the hydrology of a fen changes, e.g. due to a lowering of the water table, these stressors may be reduced, and exploitative competition can alter the plant community dynamics, often resulting in monotypical stands of invasives, such as reed canary grass and glossy buckthorn.

The focus of this research is to establish links between the hydrology, floristic quality, and chemistry of fens, with the aid of spectroscopy. We are monitoring 22 plots for hydrologic and edaphic conditions within each of the six fens being studied in southern Wisconsin. Floristic composition has also been determined at each of these plots, and clip samples of the vegetation present have been collected. These clip samples are being analyzed for nitrogen, phosphorous, and metals content. We also performed lab-based spectroscopy on the ground clip samples to link these in-situ measurements with airborne hyperspectral imagery. The results may help us to more easily identify pristine fens, as well as to better understand their potential degradation.

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8. Delineation of the Dead Tree Wetland at the University of Wisconsin-Parkside, Kenosha WI

Sabrina Tusa, University of Wisconsin Parkside, tusa0001@rangers.uwp.edu*
Erin Hurst, University of Wisconsin Parkside
Hera Hulsey, University of Wisconsin Parkside
Dr. John Skalbeck, University of Wisconsin Parkside

The Dead Tree Wetland at the University of Wisconsin-Parkside was delineated in accordance with the Wisconsin State Statutes: Sec 23.32 Wetland Mapping protocols. The wetland is located on campus northeast of Tallent Hall in the Village of Somers, Kenosha County, Wisconsin. This study was done as part of GEOS 445: Environmental Sampling, Monitoring, and Assessment. Using plant communities, we selected upland (golden rod, big blue stem, milkweed), wetland (cattails), and transition (edge of cattails and prairie plants) plots along a transect at the southern wetland boundary. The soil profile was characterized in test pits to depths of 30 to 60 cm by documenting texture, Munsell Color, moisture content, organic content, and redox features. The depth to water from ground surface was measured in each test pit. The delineation protocol was repeated at transects along the eastern, northern, and western boundaries of the wetland. Hydric soils were absent in the upland test pits and water levels were measured 50-55 cm below ground surface (bgs). In the wetland test pits hydric soils were found at the surface and the water levels were measured 14-20 cm bgs. Hydric soils were absent within the root zone (0-30 cm bgs) at transition test pits and the water levels were measured around 33 cm bgs. The edge of the cattails was deemed the wetland boundary and outlined with the Google Earth Pro polygon tracer tool to estimate Dead Tree Wetland area at approximately 10,900 m2 (2.7 acres).

* * *

9. Bathymetric Study of Lake Russo, Pleasant Prairie, WI

Ian Nebendahl, Geosciences Department, University of Wisconsin-Parkside, neben001@rangers.uwp.edu*
Joseph Rasmussen, Geosciences Department, University of Wisconsin-Parkside
John Skalbeck, Geosciences Department, University of Wisconsin-Parkside

Lake Russo is a small (22 acres) artificial lake located in Pleasant Prairie Wisconsin. It is used as a recreational area for the surrounding River Oaks P.U.D. and is a freshwater storage area in the Des Plaines River watershed. A neighborhood park allows for community residents and their guests to access the lake for swimming, fishing, boating, and general aesthetic enjoyment. The lake is an important component of the neighborhood which has a positive impact on property values. The goal of this study was to create a bathymetric model of the lake to document the thickness of lake sediment that has accumulated since the lake was created in 1970. Depth to the lake bottom was measured to the nearest inch using a 1-pound weight on a premeasured line and depth to lake sediment was measured using an 8-inch diameter secchi disk. Approximately 200 measurements were collected from canoes along transects of the lake while recording UTM locations using a Garmin etrex GPS. UTM data of the shoreline (0 depth) was also collected by walking the lake perimeter. Depth to the lake bottom and sediment thickness data were contoured by using Golden Software's Surfer® to create a bathymetric map of the lake bottom and isopach map of the lake sediment. A previous study (Copeland et al. 2015) compared the bathymetry of Lake Russo in 1989 versus 2015, but these studies did not document lake sediment thickness. The bathymetric and isopach maps from this study help assess the trophic state of the lake.

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10. Comparison of Phosphorus and Nitrogen within an Algae-Dominant and a Macrophyte-Dominant Marsh

Sarah Fuller, UW Madison, sfuller3@wisc.edu*
Anita Thompson, UW Madison

Wisconsin's deepest natural inland lake, Green Lake, and its major tributaries are listed as impaired because of high phosphorus and sediment loads. Two marsh systems with differing biological communities are primary inputs to the lake. Silver Creek Estuary is macrophyte-dominated and County K Marsh is algae-dominated. Limited analysis exists on phosphorus (P) and nitrogen (N) dynamics within these marshes. The goal of this study is to combine existing USGS and WDNR monitoring data with additional water quality measurements to characterize: (1) sediment, P, and N concentrations and loads through the two marshes and (2) P variation within and the potential for P release from sediments within the two marshes. Monthly water samples analyzed for TSS, TP, TDP, and TN were collected July – October 2016 and April – October 2017 at 5 sites in Silver Creek Estuary and at 7 sites in County K Marsh. Other data include P concentrations within both marshes and flows at each marsh outlet and at select tributaries. Sediment samples collected from each marsh were analyzed for P release following a dilute salt extraction and for equilibrium P concentration (EPC0). These data establish baseline conditions for County K Marsh and will be used to evaluate differences in nutrient loads from each marsh. Findings will lead to a better understanding of sediment, P, and N retention (or release) within the marshes, enabling more informed management for reducing nutrient loading to Green Lake.

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11. Classifying Land-Use Temperatures Using Drone Imagery

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

Stream impairments for temperature are an increasing concern across the U.S. and constitute the largest share of impairments in many western states. Wisconsin is not immune from this issue as it currently has 39 streams impaired for temperature across the state. In addition, the combination of climate change and land development activities are projected to increase the scope and magnitude of the problem. In order to develop any solutions to this problem, it is critical that accurate and reliable models be developed that can determine how future land development and land use change will impact stream temperatures. Stream temperatures can be estimated using a number of runoff temperature models; however, much of the empirical data in these models relies on point measurements that fail to capture the spatial heterogeneity of surface temperatures across land surface types. One solution to this issue is to capture the complete spatial distribution of surface temperatures using drones equipped with thermal cameras. To this end, this study presents a methodology to estimate temperatures attributed to land uses based upon thermal data derived from drones. A case study on Marquette University campus demonstrates the value of high spatial resolution temperature data for accurately classifying land use temperatures, and results further highlight how this data can be applied to improve surface temperature models and estimate the impact it has on stream temperatures.

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12. Review of a Utility-Led Agricultural Based Adaptive Management Pilot Study in Silver Creek– Green Bay, WI

Erin Houghton, NEW Water: Green Bay Metropolitan Sewerage District, ehoughton@newwater.us
Jeff Smudde, Watershed Programs Manager, NEW Water, jsmudde@newwater.us

Silver Creek is in a subwatershed of Duck Creek, located one mile west of Green Bay, WI, where a suite of best management practices (BMPs) are addressing high levels of nutrient and sediment runoff. NEW Water, the brand of the Green Bay Metropolitan Sewerage District, is leading the agricultural-based Adaptive Management (AM) pilot project to evaluate if it is more cost effective to spend $60-150 million on wastewater treatment plant improvements or work with agriculture to reduce the amount of phosphorus and sediment reaching Green Bay. Reductions in the watershed are likely to improve local water quality far beyond what improved wastewater treatment plant effluent could, at a much lower cost. Baseline data and inventory of the watershed are being used to develop enhanced nutrient management plans and conservation plans to aid implementation of BMPs that reduce phosphorus and total suspended solids in Silver Creek. Implementation of most large and small practices have been completed. Water quality data, in-stream sediment data, and invertebrate surveys will aid in evaluating the success of these practices. The pilot study is utilizing innovative tools to execute field-level assessments, gather soil and water data, work closely with landowners and growers, and leverage local agronomist experience to target the most effective practices. This effort will guide framework for implementing a future full scale AM program to achieve continued permit compliance for NEW Water.

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13. Measuring and Modeling Stormwater Runoff from Residential Blocks in Milwaukee, WI

Carolyn Voter, UW-Madison, cvoter@wisc.edu*
Steven P. Loheide II, UW-Madison

In urban areas, slowing and reducing stormwater runoff is a perennial management concern. To address this, many cities are increasing investments in green infrastructure practices that manage rainfall where it falls and better approximate natural conditions. The success of these practices depends on private homeowners adopting them in residential areas, but we lack an understanding of what the optimal combinations and arrangement of green infrastructure practices are in different types of neighborhoods. Scenario modeling can answer these questions, but requires obtaining runoff data at relatively small scale (i.e., that of a residential block) for model calibration.

We designed a v-notch weir and channel that can be installed near a storm sewer grate shortly before a storm event and immediately removed post-storm. We present runoff data collected from several different neighborhoods in Milwaukee in Fall 2017, as well as calibration and validation results. We compare modeled results generated using ParFlow.CLM to measured results. Future model simulations of these neighborhoods will be used to explore how to optimize the adoption of green infrastructure practices in residential areas of the City of Milwaukee.

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14. Denitrification from Land-Applied Vegetable Processing and Cheese Making Wastewater

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Francisco Arriaga, University of Wisconsin-Madison Soil Science
Geoff Siemering, University of Wisconsin-Madison Soil Science

The expanding food processing and cheese making industries have resulted in increased wastewater generation. The most practical and cost-efficient way to dispose of this wastewater is through on-site land application. Governing agencies regulate land applications to insure surface and ground waters are not contaminated by surface applied wastewater. Nitrogen is one constituent that limits loading, as nitrate in drinking water is a major health concern. Current regulations permit nitrate application of plant uptake amounts with little allowance for denitrification. However, the frequent application of wastewater in these systems leads to wet, frequent anaerobic conditions, in which denitrifying bacteria thrive. For regulators to increase nitrogen load denitrification allowances, the nitrogen lost through denitrification needs to be quantified. An automated chamber sampling system combined with the acetylene inhibition method was used to measure soil gas emissions continuously from six wastewater land application sites during application cycles. These sites had a variety of soil textures and application techniques. Three sites used center pivots to apply wastewater, and 3 used a ridge and furrow system. In each application system, 2 sites had a silt loam soil and 1 site had a sandy soil. Denitrification was measured in each application season and extrapolated for the year to determine yearly, potential denitrification losses.

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15. Streamflow Trends and Timing of Peak Discharge in Wisconsin

Guenevere Adams, University of Wisconsin-Whitewater, AdamsG12@uww.edu*
Dale Splinter, University of Wisconsin-Whitewater

Wisconsin is home to a diverse ecological environment with distinct seasons and various landform regions that influence streamflow hydrology. Climate models for the upper Midwest and Wisconsin suggest that high magnitude precipitation events are likely to occur in the next few decades, which may increase the potential for high magnitude streamflow across the state. In order to better understand the past spatial and temporal variability of flow across Wisconsin, a study was designed to examine the timing and trends of peak streamflow by ecoregion. Thus far, streamflow data has been collected and analyzed from 11 gages across four ecoregions. The results indicate that peak streamflow occurs most often in April, followed by March and June. The next phase of the project will be to add additional streams in the analysis, precipitation data, and then examine peak streamflow by ecoregion and decade to decipher if the timing of peak streamflow is changing. In addition, the economic impacts of flooding and whether these vary by ecoregion and stream system will be assessed.

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16. Petrology of the Cambrian Strata in Northeastern Wisconsin

Tyler Hischke, University of Wisconsin-Green Bay, hisctj29@uwgb.edu*
John Luczaj, UW-Green Bay

The Cambrian-Ordovician aquifer of northeastern Wisconsin is utilized by domestic and high capacity wells. Although Cambrian strata have been studied extensively in western Wisconsin, exposures are limited east of the Wisconsin Arch where the strata are broadly divided into the Elk Mound, Tunnel City, and Trempealeau Groups. Previous research in northeast Wisconsin has focused on Ordovician and younger strata, with little attention given to Cambrian rocks, despite their stratigraphic and hydrologic importance. Geogenic contaminants include radium, arsenic and associated heavy metals, strontium, and fluoride, which are dependent on aquifer rock chemistry. We provide the first review of the petrography of the Cambrian strata in northeastern Wisconsin using thin-section and scanning electron microscopy of outcrop, core, and well cuttings.

These rocks are predominantly mature quartz arenites, with arkosic and glauconitic arenites recognized in parts of the Tunnel City Group. Abundant dolomite is observed in sections of the Trempealeau and Tunnel City Groups. The authigenic mineralogy of these sandstones is complex. K-feldspar is abundant as overgrowths and authigenic cements. Carbonate cements include dolomite, calcite, and minor ankerite. Sulfide mineralization includes pyrite/marcasite, chalcopyrite, and sphalerite. Sulfate cements include gypsum, celestine, and barite. Diagenetic kaolinite, illite, and glauconite are also observed, as well as authigenic titania minerals.

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17. Dissolved Boron, Lithium and a Groundwater δ^{11}B Isoscape in Paleozoic Bedrock Aquifers of Northeastern Wisconsin

John Luczaj, University of Wisconsin-Green Bay, luczajj@uwgb.edu
Caitlin Brown, Stony Brook University
E. Troy Rasbury, Stony Brook University

Large natural variations in major and minor ions occur in the confined Cambrian-Ordovician sandstone aquifer in eastern Wisconsin. We present regional B and Li data, along with a new B-isoscape map (δ^{11}B) to better understand groundwater flow.

Dissolved B concentrations increase eastward from <10 µg/L to 3320 µg/L, while Li increases from <5 µg/L to 305 µg/L along a similar trend. B and especially Li correlate well with Na, K, Cl, conductivity and each other, but not with Sr, Ba, or F, (controlled by mineral solubility). B and Li moderately correlate with Ca, Mg, and SO_4. δ^{11}B values range from <10‰ in the

west to over 30‰ in the east where the sandstone aquifer is confined by the Maquoketa Shale. Limited data from the Silurian karst aquifer show intermediate $\delta^{11}B$ values.

Host carbonates contain insufficient B or Li to account for all dissolved B and Li. Authigenic K-feldspar might be a source for B, based upon whole-rock chemistry. Most Li and some dissolved B result from dilution of residual Michigan Basin brines. This is consistent with several $\delta^{11}B$ values near 20‰ and two exceeding 30‰ (modern seawater is +39‰). The range in $\delta^{11}B$ values seen farther westward represents one or more end-member isotopic compositions controlled by host carbonates, K-silicates, or glacial sediments. Groundwater chemistry, the $\delta^{11}B$, $\delta^{2}H$, and $\delta^{18}O$ isoscapes, and ^{14}C ages are consistent with groundwater flow from northwest to southeast over the past 40,000 years mixing with residual brine.

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18. Extensive Fecal Contamination of Public Wells as Determined by the Human Gut Bacteria Bacteroides

Aaron Firnstahl, USGS, afirnstahl@usgs.gov
Susan Spencer, USDA
Joel Stokdyk, USGS
Anita Anderson, Minnesota Dept. of Health
Mark Borchardt, USDA

The commensal (“friendly”) gut bacteria Bacteroides is shed in human fecal material in high concentrations (10^10 cells/gram), and transport of Bacteroides to groundwater with fecal contamination has been documented. Although human Bacteroides is used as a fecal indicator in wastewater and storm water, it is not often used in assessments of groundwater quality. Our objective was to examine the extent of groundwater contamination using human Bacteroides. Groundwater samples (800 L) were collected using ultrafiltration bimonthly from 146 public wells, totaling 964 samples. Quantitative PCR (qPCR) targeting the HF183 16S rRNA gene cluster using the TaqMan HF183/Bac287 assay was used for detection of human Bacteroides, and 10 pathogens were also tested by qPCR. Overall, 408 samples (42%) and 134 wells (92%) were positive for human Bacteroides. The high occurrence of Bacteroides suggests that groundwater contamination may be more common than previously thought. However, Bacteroides alone may not indicate health risk. Concentrations were low (median of positives <1 genomic copy/L), and only 27% of Bacteroides-positive samples were also positive for a pathogen. Moreover, significantly fewer total samples were positive for pathogens (21%) than for Bacteroides. Therefore, while human Bacteroides may be a good indicator of vulnerability to fecal contamination, establishing the relationship between Bacteroides and illness (i.e., maximum contamination level) is an area of ongoing study.

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19. Infiltration of Sodium Chloride into Deep Dolomite Wells Located near the Upper Fox River and Its Implications

Jane Pfeiffer, UW-Milwaukee, pfeiff42@uwm.edu*
Tim Grundl, UW-Milwaukee

The Fox River in Waukesha County, WI receives a large amount of effluent, which is being discharged from three municipal wastewater treatment plants located on the river. Previous studies have shown that effluent is infiltrating into shallow sand/gravel wells located directly adjacent to the Fox River. This deduction was made by an observed increase over time in Na and Cl. This observation paired with an observed high B/Cl ratio distinguishes the effluent from road salt, the other primary source of excess Na and Cl in urban areas.

The current study explored the possible infiltration of municipal effluent into two other wells located near the Fox River that draw water from a deeper dolomite aquifer. The methods utilized in this experiment include analyzing the temporal changes in major ion content via AA, IC and ICPMS techniques.

Our findings indicate that the two deep dolomite wells display Na and Cl levels that rise to 2 and 3 times above background levels within the deep dolomite aquifer. Background conditions in the dolomite aquifer were established by examining a third well distal from the river that pumps pristine aquifer water. Furthermore, the B/Cl ratio observed in these wells indicates that road salt is likely entering the system, as opposed to treated effluent. The background well demonstrates neither of these trends.This study shows that road salt directly affects water quality of municipal wells in the Waukesha area.

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20. A Method to Assess Infiltration Properties of Farm Fields in Support of a Soil Health and Water Quality Study in the Great Lakes Basin

Kevin Fermanich, UW-Green Bay and UWEX, fermanik@uwgb.edu
Molly Meyers, UW-Green Bay

The infiltration capacity of a soil is an emergent soil property related to soil texture, OM content, bulk density, pore size distribution, aggregate stability and other factors. It has been identified as a key attribute for assessing soil health. To support a muiti-state project aimed at linking soil health to edge-of-field water quality we developed methods to determine infiltration capacity at 21 sample points per field, per day. Sample points were located at 5 m intervals along 100 m transects that spanned major soil type boundaries and generally aligned along a flow path from the field to the surface water monitoring flume. The monitoring system consisted of 15 cm diameter insertion rings, a custom fabricated 2 L passive pre-soaking device and a dual head infiltrometer (SATURO, METER Group Inc,.). At each sampling point presoaking (5 cm ponding depth) was conducted for approximately 75 minutes followed by 43 minutes of dual-head flux measurements. We used this type of setup to measure the infiltration rate and water saturated hydraulic conductivity (Kfs) at 12 field sites across the Great Lakes. A total of more than 250 infiltration measurements were made. The 21 measurements per field provided a robust but minimal data set for characterizing the highly variable nature of infiltration within a field. Sample points with significant macropores and thus very large infiltration rates were difficult to accurately characterize with our system.

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21. A Physically-Based, Lumped Sediment Washoff Model for Urban Watersheds

Sazzad Sharior, Marquette University, sazzad.sharior@marquette.edu*
Walter McDonald, Marquette University
Anthony Parolari, Marquette University

Non-point source pollution of urban and agricultural runoff is a major challenge in stormwater management. To address this challenge, pollutant washoff models (e.g., EPA-SWMM and WinSLAMM) are used to predict pollutant loads from storm event to annual scales. These models use a similar lumped framework known as the exponential washoff model which was developed in the 1970s by fitting coefficients to experimental data from numerous sites. In practice, this model is limited by its empirical basis and failure to represent erosion, deposition, and transport processes in the watershed, which leads to

uncertainties when this model is transferred between sites. Here, we propose a physically-based, lumped washoff model that captures physical washoff processes in urban watersheds. The model structure is based on a continuum-scale formulation of overland generation and washoff processes which is averaged over the catchment. The model is applied to an urbanized catchment in Milwaukee, WI where runoff and sediment inputs are measured continuously in a receiving stormwater pond. The results are compared to SWMM and WinSLAMM simulations for both event-scale pollutographs and annual loadings.

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22. A Tool to Receive Daily Plant Evapotranspiration (ET) Data for Irrigation Water Management

John Panuska, Biological Systems Engineering Department, Natural Resources Extension Specialist
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Growers using irrigation scheduling to manage root zone water content need reliable estimates of plant leaf water loss or evapotranspiration (ET). Since the mid 1980's the UW Extension Agricultural Weather Service (AGWX) web site has provided a daily evapotranspiration data email service. The ET email service was recently upgraded to a user friendly, self-service system. In the new system a grower provides their email address along with the location of their irrigation center pivot(s) (latitude and longitude) and the AGWX web site automatically emails the previous day's evapotranspiration value to them. A new user simply enters their email address into the registration box. Those not currently in the database will be sent an email confirmation that contains a verification link. Clicking on the link provides access to set up an email subscription that includes a user's site name(s) and irrigation pivot location(s). If a user's email is already in the database, the system will send a single-use random 6 digit security code to enter into the verification box. Entering the verification code into the box grants the user access to their existing subscription. Once complete, daily ET emails are sent to the user's email address between November 15th and April 1st each year. The subscription can be canceled at any time via a link on the ET email. The new easy-to-use self-service ET email system provides daily ET data to assist growers with irrigation scheduling. Funding for this project was provided by the Wisconsin Potato and Vegetable Growers Association (WPVGA).

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Session 3A:
Streams
Friday, March 11, 2018
8:30 – 9:50 a.m.

Water Quality Assessment of Beaver Creek Subwatershed and Beaver Dam Lake, WI

Suzan Limberg, University of Wisconsin-Madison, slimberg09@gmail.com*
Anita Thompson, UW-Madison Advisor
and Haley Briel, Jack Cotrone, Marty Dillenburg, Alexandra Delvoye, Sarah Fanning, Falon French, Yiyi Hu, Alex Jeffers, Thor Jeppson, Yu Li, Suzan Limberg, Ryan McGuire, Thomas Pearce, Catherine Schumak, Yi Wang, Anita Thompson

In partnership with the Beaver Dam Lake Improvement Association and WI Department of Natural Resources, the University of Wisconsin – Madison Nelson Institute Water Resources Management graduate students conducted monitoring and data analysis in Beaver Dam Lake and in Beaver Creek, a tributary to the lake, which are both 303d impaired waterways. The study addressed issues in the uplands, within the stream, in the lake, and with stakeholders. The Erosion Vulnerability Assessment for Agricultural Lands (EVAAL) model was used to determine areas in the Beaver Creek subwatershed that are most vulnerable to erosion. Agronomic soil tests were conducted on samples collected in fields near Beaver Creek. Lake water quality was monitored and the WiLMS model used to better understand various sources of phosphorus that contribute to seasonal eutrophication of Beaver Dam Lake. In Beaver Creek, water quality was monitored, sediment cores were collected and analyzed for phosphorus, and macroinvertebrate and habitat surveys were conducted. Finally, the community was engaged to better understand stakeholder priorities, current management solutions, and to guide feasible recommendations towards an improved management plan for Beaver Creek and Beaver Dam Lake. Key study results and management recommendations will be presented.

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Multi-Instrument Stream Surveys with Continuous Data for Better Groundwater/Surface Water Understanding in Wisconsin

Catherine Christenson, University of Wisconsin - Madison, cchristenso4@wisc.edu*
Dave Hart, Wisconsin Geological and Natural History Survey
Sue Swanson, Beloit College
Michael Cardiff, University of Wisconsin - Madison

Models of regional water resources are increasingly being called upon to help support informed decision-making. In many cases, interactions between groundwater and surface water (GW-SW) are a crucial process within these models, and key to understanding tradeoffs in water decisions. The representation of the properties and processes that control GW-SW interactions are thus increasingly important in models.

We are collecting dense data sets from representative streams across Wisconsin's physiographic regions. The data include stream stage, width and depth, stream bottom type, basic stream chemistry and temperature, video of the stream, and geophysical properties such as resistivity. Instruments mounted in a canoe in a controlled float collect data, which is georeferenced to provide detailed information about spatial variability. This creates snapshots of GW-SW interactions, stream parameters governing interactions, and stream ecology at a point in time continuously over miles-long sections of the streams.

The ultimate objective of this project is to create a comprehensive methodology for rapid and accurate data collection on streams, as well as to develop a process for interpreting the large data sets to efficient and readily provide inputs for models. Collected data will also apply to other objectives such as understanding the impacts of spatial water and sediment changes on stream ecology where temperature and channel morphology are already known to play major roles.

* * *

Evaluating Ecosystem Services in the Yahara Watershed under Land-Use Change, Varying Land Management, and a Changing Climate

Tracy Campbell, University of Wisconsin, tacampbell@wisc.edu*
Chris Kucharik, University of Wisconsin-Madison
Eric Booth, University of Wisconsin-Madison

In order to evaluate the nexus of land management, land cover, and climate change, long-term environmental projections will be required. Scenario development and ecosystem models can provide possible future projections. The Yahara watershed, an agricultural and urbanizing watershed spanning 1,345 km2 in Wisconsin, which provides a suite of ecosystem services to the surrounding community, including the capital city of Madison, serves as a case-study. Using a coupled-model approach, we quantified the impact of drivers of change on ecosystem services within the Yahara Watershed incorporating both spatial and temporal analysis.Through the use of the agroecosystem model, Agro-IBIS, we quantified Yahara watershed level averages of key ecosystem services over the next 50+ years for 30 scenarios. Scenarios include climate change projections, incremental increases in perennials on the landscape (10%, 25%, 50%), and incremental decreases in nutrient application (10%, 25%, 50%). While a suite of ecosystem services are present in agroecological systems, we focus on water quality metrics, crop production, biomass yield, and carbon sequestration. Results indicate that through large-scale transitions to perennial grasses, phosphorus yields can be reduced by half, improving water quality significantly. Through this research, we provide predictive analytics that will allow for more informed decisions to be made, both at the policy level and at the field scale.

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Session 3B:
Groundwater-Surface Water
Friday, March 11, 2018
8:30 – 9:50 a.m.

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

Zhixuan Wu, University of Wisconsin at Madison, zwu223@wisc.edu*
Noah Lottig, Center for Limnology, University of Wisconsin Madison
Catherine Hein, Wisconsin Department of Nature Resources

Changes in lake levels can have critical implications for lake environment and water use. Therefore, it is important to understand the hydrological regime of lakes in Wisconsin and the key factors that influence the lake levels. Working closely with multiple government agencies and research institutes, this research first complied the lake and groundwater monitoring data across the state which contain observations of about 2000 lakes and groundwater wells between 1900 and 2015. As a more precise analysis needs insights into the regional pattern of the water levels, we studied the spatial and temporal coherence of the lakes and groundwater wells with a machine learning algorithm called dynamic time warping. The lakes and wells were clustered into several groups which delineates the state into many hydrological regions. We continued on identifying the factors that have impact on the clustering and found that the climate factors were the main causes of this regional division. These findings serve as the fundamental knowledge of the Bayesian hierarchical modeling on the lake levels. The model enables us to predict the historical lake levels for the lakes with limited record. Finally, the existing and predicted data will be used to study the hydrological regime of the lakes in Wisconsin. This research not only enriches our understanding on the behaviors and fates of the lakes but also provides robust scientific support to the lake management in Wisconsin.

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Groundwater-Surface Water Interaction in Agricultural Watershed that Encompasses Dense Network of High Capacity Wells

Ammara Talib, University of Wisconsin Madison, talib@wisc.edu*
Desai Ankur, University of Wisconsin Madison

The Central Sands region of Wisconsin is characterized by productive trout streams, lakes, farmland and forest. However, stream channelization, past wetland drainage, and ground water withdrawals have disrupted the hydrology of this region.

Climatically driven conditions in last decade (2000-2008) alone are unable to account for the severely depressed water levels. Increased interception and evapotranspiration from afforested areas in central sand Wisconsin may also be culprit for reduced water recharge. Hence, in this study to understand these cumulative effects, coupled model approach was applied at large spatio-temporal scale. The coupled model fully integrates a watershed model (SWAT) with a groundwater flow model (MODFLOW). Surface water and ground water flows were simulated interactively at daily time step to estimate the groundwater discharge to the stream network. The model was calibrated (2015) and validated (2016) based on streamflow, groundwater extraction, and water table elevation. As the long-term trends in some of the primary drivers is presently ambiguous in Central Sands under future climate, as is the case for total precipitation or timing of precipitation, we relied on a sensitivity analysis to quantitatively access how primary and secondary drivers may influence future net groundwater recharge. This approach could then be coupled with decision-making models to evaluate the effectiveness of groundwater withdrawal policies under a changing climate.

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Toward Better Simulation of Ecohydrology: Forecasting Pumping Effects to Fens

Randall Hunt, USGS Upper Midwest Science Center, rjhunt@usgs.gov
Daniel Feinstein, USGS Milwaukee Office
David Hart, WGNHS
Sarah Gatzke, The Nature Conservancy

Fen formation and persistence are by definition driven by characteristics of the groundwater system. Simulating fen-groundwater simulation, however, has not been well developed. In this work an existing regional groundwater model constructed for regional water supply was refined to relate changes in high-capacity groundwater pumping to changes in fen hydrology. The refinement included perimeter boundary conditions, stream and lake network, and groundwater recharge. To simulate fens, the Unsaturated Flow Package (UZF) for the USGS groundwater code MODFLOW was used. The UZF Package uses a computationally efficient kinematic wave formulation to simulate infiltration flow through the unsaturated zone. Less recognized, the UZF Package has the capability of handling the location and timing of groundwater discharge at the land surface.

Our research demonstrates that the intersection of the land surface and water table simulated with the UZF Package generally agreed with locations of identified fens. A UZF variable (SURFDEP) was used to tune this relation. Changes to the groundwater system from high-capacity wells are easily handled by MODFLOW; how changes to the groundwater system translate to fen quality and persistence is less developed. Steady-state and transient approaches were considered, and evaluated for their ability to represent potential effects and their suitability for communicating findings to stakeholders.

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Findings of the 2014-2017 Wisconsin Springs Inventory

Grace Graham, Wisconsin Geological and Natural History Survey, grace.graham@wgnhs.uwex.edu
Susan Swanson, Beloit College
Kenneth Bradbury, Wisconsin Geological and Natural History Survey
David Hart, Wisconsin Geological and Natural History Survey

The Wisconsin Geological and Natural History Survey recently completed a statewide inventory of springs. The effort consisted of one-time surveys of springs with flow rates of about 0.25 cubic feet per second (cfs) and higher and biannual visits to reference springs located in representative hydrogeological regions of the state. About two thirds (68%) of the 415 surveyed springs are located on private land and over half of the springs (53%) display moderate to high levels of disturbance. Almost all of the springs are rheocrene, or springs that discharge to defined channels, and 1% of the surveyed springs are limnocrene, or springs that discharge to lakes. The mean of the spring flow measurements collected is 0.96 cfs and the median of the measured flows is 0.68 cfs. Spatial patterns in geologic origin, topographic position, and water chemistry reveal six categories of spring systems in Wisconsin. Most springs in Wisconsin form as a result of preferential groundwater flow through fractures in exposed or shallowly buried Paleozoic sedimentary strata. Other springs form at the break in slope along end and interlobate moraines in glaciated regions of the state. Spring flux, a metric defined as spring discharge divided by the orifice area, was developed during this project. This new metric complements the spring categories and helps distinguish between focused and diffuse groundwater discharge to springs and other hydrologic features.

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Session 3C:
Coastal Modeling
Friday, March 11, 2018
8:30 – 9:50 a.m.

A Resilient Wave Forecast System in the Apostle Islands, Lake Superior, WI

Michael Meyer, University of Wisconsin - Madison, mpmeyer2@wisc.edu*
Joshua Anderson, University of Wisconsin - Madison
Chin Wu, University of Wisconsin - Madison

The Sea Caves in the Apostle Islands on Lake Superior is a popular destination for recreational kayakers. The site is prone to unexpected dangerous wave conditions that have capsized boats and kayaks, causing several fatalities in the past and creating a public health concern. To address this concern, efforts have been paid to provide real-time information on wave conditions online and at a kiosk installed at Meyers Beach, the location from which kayakers paddling to the Sea Caves depart. There remain two outstanding issues. First, in-situ wave measurements are not consistently available due to intermittency of wireless connection. Second, modeled wave conditions are underestimated due to coarse temporal resolutions of weather observations. In this study, we aim to develop a resilient wave forecasting system that synthesizes data from multiple sources including real time wind observations, real time wave data from a wave buoy in west Lake Superior, and predicted wave heights from several wave models. A neural network is calibrated based on historical measurements and used to synthesize the data to produce accurate wave height predictions. Even when one or more of the data sources is unavailable, this resilient system can provide reliable and accurate wave climate prediction for the public.

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Forecasting Extreme Water Level Oscillations Induced by Fast-Moving Storms in Lake Michigan

Alvaro Linares, UW Madison, alvaro.linares@wisc.edu*
Chin Wu, UW Madison

Fast-moving storms can yield large amplitudes water level fluctuations, leading to a great deal of fatalities and property losses and posing considerable hazards to coastal communities in Lake Michigan. Recent studies show that this type of extreme oscillations are caused by the abrupt changes in air pressure and wind speed associated with convection storms.

To forecast extreme events, we first estimate the initial water level amplitude induced by the storms from air pressure and wind speed observations with high temporal and spatial resolutions. Subsequently, hydrodynamic modeling is employed to determine the expected amplification of the water level amplitude based on the storm propagation speed and direction. Results show good agreement between forecasted and observed extreme water level oscillations in north (Port Inland), east (Holland), south (Calumet), and west (Milwaukee) of Lake Michigan. Overall, a new and efficient methodology is developed to forecast rapid moving water level oscillations for timely warning in Lake Michigan.

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An Integrated Nowcast and Forecast Operation System (INFOS) for Dangerous Currents and Extreme Waves at Sheboygan, WI

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

Dangerous currents and extreme waves induced drowning incidents in Lake Michigan are one of the major hazards of the city of Sheboygan, Wisconsin. Since 2010, more than 10 related drownings have occurred along the shoreline, drawing the request of the timely and accurate warnings. Currently, a daily warning of beach hazard for Sheboygan is issued by the National Weather Service based on the coarse grids of the NOAA Great Lakes Costal Forecasting System (GLCFS), which has yet resolve the fine spatial (~20 meters) and short temporal (~10 minutes) resolutions of extreme and fast-moving storms induced hazards. In this talk, an Integrated Nowcast and Forecast Operation System (INFOS) is developed to nowcast and forecast dangerous currents and extreme waves based on the local structures and bathymetry at Sheboygan. State-of-the-art models that couple wave and current information are employed. A nested grid with a fine spatial nearshore resolution is implemented to delineate coastal structures, river outlets, and beach sandbars that are susceptible to dangerous currents. Furthermore, a non-hydrostatic model is used to address complex nearshore wave processes including reflection and diffraction for generating extreme waves. As a web-based cyber infrastructure, INFOS can effectively deliver to the public. Overall, INFOS – Sheboygan serves as a critical warning tool to dangerous currents and extreme waves, aiming to inform the local community and enhance the waterfront safety.

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An Upgraded Forecast System of Wave Climate and Hydrodynamics for Lake Winnebago, WI

Joshua Anderson, University of Wisconsin - Madison, janderson1@wisc.edu
Chin Wu, University of Wisconsin-Madison

Lake Winnebago, Wisconsin's largest inland water body, plays an important role in many societal and environmental issues including recreation, shoreline preservation, municipal drinking water, and nutrient loading to the Fox River. Waves are an important component to managing these issues as they affect safety, coastal erosion, and sediment/nutrient resuspension. Currently, the National Weather Service at Green Bay provides wave forecast information for Lake Winnebago based on a model developed by the Great Lakes Environmental Research Laboratory (GLERL) several decade ago. While the model continues to provide a great service, the 2.5 km resolution and model physics cannot resolve nearshore wave processes under rapidly changing wind conditions such as those occurring during storms. Working with the NWS at Green Bay and GLERL, we develop an upgraded forecasting wave model with a state-of-the-art coupled wave-current hydrodynamic model. Due to strong influences on wave properties in shallow nearshore areas in Lake Winnebago, currents are included. As a result, lake circulations, seiches, and wind-wave characteristics can be forecasted. Furthermore, the state-of-the-art wave-current forecast model for Lake Winnebago not only addresses the need of recreational purposes but also presents the opportunity to examine multiple other hydrodynamic related issues like flood inundation, sediment resuspension, and nutrient transport.

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Session 4A:
Agriculture and Watershed Management
Friday, March 11, 2018
10:20 – 11:40 a.m.

Nutrient and Sediment Management for Sub-Watersheds in NE Wisconsin Using ArcAPEX

Forrest Kalk, University of Wisconsin-Green Bay, kalkfs01@uwgb.edu*
Kevin Fermanich, University of Wisconsin-Green Bay
Paul Baumgart, University of Wisconsin-Green Bay

During rain events, runoff from non-point sources increase concentrations of sediment and nutrients in surface waters that feed the Great Lakes Basin. Due to the negative consequences of elevated nutrients, research in the Lower Fox River Watershed has been focused on monitoring, quantifying, and defining techniques to reduce nutrient and sediment runoff. To support these efforts, USGS and UWGB have been collecting data during runoff events at edge of field locations for several years. Our research uses this critical data to create an Agricultural Policy/Environmental Extender (APEX) model to predict runoff, nutrient loads, and sediment loads from cropland. Data from five sites were used to calibrate the model, and five different sites were used in the validation of the model. Previous research at UWGB provided a model based on several of these locations. Since then, APEX has had several modifications leading to the release of updated software. With this new version, in addition to validating APEX at a variety of sites in NE Wisconsin, we are evaluating the predictability of soluble phosphorus in tile drainage and the predictability of increased flow during freeze-thaw periods.

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Save the Bay Initiative: Two Congressmen's Effort to Improve Water Quality

Pauline Meyer, Congressman Gallagher's Office, Pauline.Meyer@mail.house.gov

The Save the Bay Initiative was started by former Congressman Ribble and continues under Congressman Gallagher. The power to convene and a desire to solve problems locally was the motivation to begin the Save the Bay initiative. The goal is to convene people to work together to identify, share and promote regional solutions to water quality issues, specifically related to phosphorus, nitrogen and sediments in Northeast Wisconsin. Representatives from agriculture, industry, agencies, academia and nonprofits are working together sharing information on conservation practices, discussing new issues and impediments facing producers, and determining action plans to expand the scope of best practices to more

producers. The congressmen and partners hosted farm tours, Bay water quality testing boat runs, shared positive actions on social media and video, and made strides to remove perceived impediments. The initiative is a great example of how convening diverse stakeholders with a common desire to improve water quality can have positive results.

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Mobile Tools for Watershed Management and Adaptive Management Verification

Brent Brown, CH2M, brent.brown@ch2m.com
Jeff Smudde, Watershed Programs Manager, NEW Water, jsmudde@newwater.us
Megan Bender, megan.bender@ch2m.com

Key tools have been developed to plan and verify best management practice (BMP) implementation and project progress on the Silver Creek Adaptive Management Pilot Project. These tools include a combination of high-tech mobile applications, experienced personnel, and tried and true sampling techniques. The team has effectively implemented the ArcGIS Online Collector Application on handheld devices for use during site reconnaissance pre-construction, construction, and for post-construction BMP maintenance. The project has found using mobile tools has allowed personnel at all levels within the project to effectively contribute to the overall project successes, including workload planning with key staff, BMP planning, design, verification, and collaboration in the multiple facets of BMP implementation, all in real-time. Water quality sampling throughout the watershed has shown the watershed response demonstrating water quality improvement as BMP implementation has progressed. Water quality improvement to date has improved the frequency of meeting the phosphorus standard from 33% to 54% of the time in a year-over-year comparison. The presentation will focus on the effective use of these tools and ideas for future improvements.

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Evaluating Edge-of-Field Water-Quality Monitoring Techniques: Relating Data Quality to Long-Term Monitoring Costs

Mari Danz, US Geological Survey, medanz@usgs.gov
Matthew Komiskey, US Geological Survey

The Great Lakes Restoration Initiative (GLRI) was developed to accelerate efforts to protect and restore the quality of Great Lakes waters. One focus of GLRI is to increase implementation of agricultural conservation practices and document resultant water-quality changes. Edge of field (EOF) can be an effective scale to quantify changes, however, lack of standardization in techniques and monitoring costs make it difficult to identify approaches that both meet data objectives and fit funding constraints.

As part of GLRI, the U.S. Geological Survey, in partnership with the Environmental Protection Agency and the Natural Resources Conservation Service, established two identically instrumented EOF monitoring stations to evaluate a range of approaches to quantify water quality. One station was located in the Lower Fox River watershed, Wisconsin, the second in the Maumee River watershed, Ohio. At each station, three autosamplers were triggered using different algorithms: time-based discrete, time-based flow composite, and volume-based flow composite. A depth-integrated sampler arm was concurrently used at each site.

An evaluation of the concentrations and computed loads from three years of data collection for each sampling technique will be discussed. A discussion of potential issues with each technique and general impact on long-term monitoring costs will be provided.

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Session 4B:
Groundwater Quality II
Friday, March 11, 2018
10:20 – 11:40 a.m.

Source Investigations of Nitrate for Private Wells in Eau Claire County, Wisconsin

Audrey Boerner, Eau Claire City-County Health Department, voukvr1365@uwec.edu
Laura Suppes, University of Wisconsin - Eau Claire
Shane Sanderson, Eau Claire City-County Health Department

This research explores sources and risk factors of nitrate contamination in private wells in Eau Claire County, Wisconsin. Nitrate is a naturally occurring compound found in groundwater, but also has anthropogenic sources. It can be harmful to human health if ingested above 10 mg/L. Nitrogen-containing fertilizers, manure and septic tank effluent are potential sources of nitrate contamination. To date, 33 private wells in Eau Claire County have been tested for seven agricultural indicators and three septic system indicators. Well sites have been surveyed to collect information on potential risk factors of nitrate contamination, like well depth, age of septic system, and distance from agricultural fields. This project is ongoing and expected to be complete in spring, 2018. To date, over 25% of sites have tested positive for agricultural indicators. Caffeine and carbamezepine have been the only septic indicators detected. Fifteen of 33 sample sites were within 300 ft. of an agricultural field and 4 of the 15 wells tested positive for agricultural indicators. Eighteen of 33 wells were farther than 300 ft. from an agricultural field and only three of the 18 samples tested positive for agricultural indicators. Results to date suggest agricultural indicators are more frequent in wells closer to agricultural fields and agricultural indicators are more frequent than septic indicators in private well water.

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Making Sense of Microbial Indicator Data Using Medical Test Performance Metrics: Assessing the Relationship Between Total Coliforms and Pathogens

Joel Stokdyk, USGS, jstokdyk@usgs.gov
Anita Anderson, Minnesota Dept. of Health
Susan Spencer, USDA
Aaron Firnstahl, USGS
Mark Borchardt, USDA

Total coliforms and E. coli, the microbial indictors used to monitor public water supplies, often show poor correlations with pathogens. However, general correlation provides a limited assessment of the indicator-pathogen relationship that can confound the interpretation of indicator results. There are four indicator performance metrics that more fully describe pathogen-indicator relationships. Sensitivity, specificity, and positive and negative predictive value demonstrate the value and limitations of indicators and guide the interpretation of their results. These metrics will be explained, and indicator performance was assessed using data from analyses of public wells. Samples (n = 964) collected from 146 wells were analyzed for total coliforms, E. coli, and 17 qPCR pathogen targets. Overall, the performance metrics show that indicators were a good predictor of pathogen absence but a poor predictor of pathogen presence. Specifically, 79% percent of samples negative for total coliform were also negative for pathogens, and 95% of pathogen-negative samples were also negative for total coliform. In contrast, 62% of total coliform-positive samples were negative for a pathogen, and 90% of pathogen-positive samples were negative for total coliform. The evaluation of pathogen-indicator relationships by these metrics informs water resource managers that rely on microbial indicators.

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Prevalence of Cryptosporidium in Groundwater from Community and Non-Community Wells

Susan Spencer, USDA, Susan.Spencer2@ars.usda.gov
Joel Stokdyk, USGS
Anita Anderson, Minnesota Dept. of Health
Jim Walsh, Minnesota Dept. of Health
Aaron Firnstahl, USGS
Mark Borchardt, USDA

Data on the occurrence of Cryptosporidium in groundwater is scarce, yet the presence of these protozoa is one of the criteria used to classify a "groundwater source under the influence of surface water" (GWUDI). Our objectives were to 1) determine the occurrence rate of Cryptosporidium oocysts in groundwater to ascertain GWUDI classifications and 2) compare the traditional immunofluorescent assay (IFA) to quantitative PCR (qPCR). We sampled 118 wells bimonthly for 1

year and 28 wells for 2 years totaling 146 wells and 964 samples. Approximately 800 liters of groundwater were collected from community and non-community wells in Minnesota using ultrafiltration. Two detection methods were used: microscopic counts of oocysts using a FITC-labeled antibody to Cryptosporidium and qPCR targeting Cryptosporidium 18S rRNA. Forty percent of wells were positive for Cryptosporidium by qPCR, including 11 of 25 suspect GWUDI wells (44%) and 47 of 121 non-GWUDI wells (39%). Correlations between IFA counts and qPCR concentrations are pending. It has been assumed that the natural barrier of groundwater supplies filters out larger organisms such as Cryptosporidium. The qPCR results show that Cryptosporidium may be more common in groundwater than generally believed. Results will help us understand the suitability of Cryptosporidium for classifying a GWUDI well. In addition, use of both analytical methods will allow correlation of results from the traditional IFA method with results from qPCR.

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Land Use, Weather, Hydrogeologic, and Well Construction Risk Factors Associated with Private Well Contamination in Kewaunee County, Wisconsin

Mark Borchardt, USDA, Mark.Borchardt@ars.usda.gov
Joel Stokdyk, USGS
Burney Kieke, Marshfield Clinic
Davina Bonness, Kewaunee County Land and Water Conservation Dept
Aaron Firnstahl, USGS
Randy Hunt, USGS

Recent research by our group has shown that household private wells in Kewaunee County are contaminated by human and cattle fecal wastes. Among 131 wells sampled, 79 (60%) were positive for fecal-borne microbes. We are now using statistical modeling to identify risk factors associated with well contamination. Land use practices surrounding each study well (e.g., number of septic systems, acres of agricultural fields) were obtained from GIS layers managed by Kewaunee County. Meteorological data (e.g., temperature, precipitation) were provided by NOAA radar estimates and on-the-ground measurements. Groundwater recharge was calculated by the water-table-fluctuation method using data from a local monitoring well. Well construction data (e.g. casing depth, well age) were abstracted from reports filed at the Wisconsin Department of Natural Resources. Associations of risk factors with 1) the probability of well contamination and 2) well concentrations of microbial contaminants were evaluated by logistic and gamma regression models, respectively. Agricultural-related land uses such as the acreage of agricultural fields within 3,000 feet of a well or the proximity of manure pits are important risk factors. Groundwater recharge and depth-to-bedrock are also important. Well construction factors were generally not related to contamination in the analysis. This information is useful for developing policies to minimize contamination of private wells in the fractured dolomite aquifer.

Session 4C:
Groundwater Modeling
Friday, March 11, 2018
10:20 – 11:40 a.m.

Evaluating Effects of Model Design and Complexity on Simulated Groundwater Ages

Paul Juckem, U.S. Geological Survey - Upper Midwest Water Science Center, pfjuckem@usgs.gov
Jeffery Starn, U.S. Geological Survey - New England Water Science Center
Daniel Feinstein, U.S. Geological Survey - Upper Midwest Water Science Center

Understanding groundwater ages in the glacial aquifer of the USA is important for estimating susceptibility and vulnerability of the aquifer to contaminants. Machine-learning tools, developed from compliance samples and flow model simulations, have been shown to be capable of mapping the depth of vulnerability to anthropogenic contaminants, such as nitrates. Now, the USGS plans to use hundreds of generalized, or simplified, groundwater flow models spanning most of the glaciated USA to build machine-learning metamodels (models of models) that can estimate groundwater ages in three dimensions across the glacial aquifer. Although groundwater flow models are powerful tools for simulating ages in aquifers and in water discharging to pumping wells and surface waters, additional understanding of how simulated ages are affected by differing model designs and degrees of simplification is needed. Preliminary results illustrate that simplified models can adequately simulate groundwater ages in the glacial aquifer if the full thickness of the flow system is simulated, including bedrock, and that the simulated age of groundwater discharging to streams requires proper reproduction of perennial headwater streams. Comparisons with measured age tracer concentrations are on-going. Conclusions from this study are aimed at identifying model design and complexity factors that influence simulated groundwater ages, and inform adjustments that may improve metamodeling results.

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Professional Judgement in Hydrogeology - A "Blink" Test

David Hart, Wisconsin Geological and Natural History Survey, dave.hart@wgnhs.uwex.edu
Kallina Dunkle, Austin Peay State University

The role of professional judgement in hydrogeology is nearly inescapable. We depend on our sense of what looks and feels right when designing research projects, creating conceptual models and hypotheses, and reviewing data, reports and

manuscripts. Often hydrogeology is said to be as much art as science, implying that our observations and hypotheses have themes, variations, and rhythms that when done well satisfy an aesthetic sense and when done poorly, offend.

For an observation to be useful in science, it should at a minimum be consistent. In this presentation, a test will be performed to attempt to determine whether hydrogeologic professional judgement is consistent by presenting realizations of sediments from Glacial Lake Oshkosh. Generated by training images, these realizations are conditioned to match dimension and orientation observations so that no realization has a better or poorer match to the observations than the others. The only differences are in the spatial distributions of the sediment, specifically clay verses sand. The audience will be queried to rank the different realizations from most to least realistic and asked if any of the realizations invoke a visceral reaction. Finally, participants' experience and knowledge of Wisconsin glacial geology will be recorded.

We hope the results of this short test will prove informative to our understanding of how we do our science and provide a measure of the consistency of professional judgement.

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Comparing MODFLOW 6 to MODFLOW-2005 Child Models Extracted from a Parent Analytic Element Model

Megan Haserodt, U.S. Geological Survey, mhaserodt@usgs.gov Randall Hunt, U.S. Geological Survey
Andrew Leaf, U.S. Geological Survey
John Coleman, Great Lakes Indian Fish & Wildlife Commission

A regional groundwater flow model was developed for the St. Louis River watershed in northern Minnesota using the analytic element model code, GFLOW. Regional analytic element models are relatively easy to construct and can be used to provide defensible and regionally representative perimeter boundary conditions for a local finite difference MODFLOW model inset within them. For this project, a child MODFLOW-2005 model was created from an extract of the regional St. Louis Basin model; the child model was initially constructed using the GFLOW graphical user interface (GUI) and then refined outside the GUI with an updated stream network, layering, and additional geologic complexity. The child MODFLOW-2005 model was then converted to a MODFLOW 6 model using the USGS utility, Mf5to6. MODFLOW 6 is the latest production version of MODFLOW and was released in September 2017. This presentation highlights some of new functionality of this latest MODFLOW release.

This presentation will provide a brief overview of how to use a regional, parent analytic element model to build a local, child model as well as a comparison between MODFLOW 6 and MODFLOW-2005 results. Insights on the steps needed to convert existing MODFLOW models to MODFLOW 6 models will also be discussed.

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Developing a Geologic Framework for Aquifer Geometry through Modeling of Gravity and Aeromagnetic Data

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Geophysical modeling of the Precambrian surface that is the base of the sandstone-dolomite bedrock aquifer improves understanding of the hydrogeology of south-central Wisconsin. Basement topography impacts aquifer thickness, volume of stored groundwater, and geometry of a "no-flow" aquifer boundary. Constraining aquifer thickness aids modeling of pumping effects on groundwater and surface water and delineation of well-head protection areas. Existing basement topographic interpretations are based on sparse outcrops and boreholes with limited spatial distribution. We incorporate gravity and aeromagnetic data with existing borehole and outcrop data to produce a Precambrian topographic interpretation that is consistent with gravity and aeromagnetic anomalies away from well control and consistent with the regional geologic framework. Our work focuses on Columbia County and ties in modeling results from Dodge and Fond du Lac counties.

We perform forward modeling of gravity and aeromagnetic data using GM-SYS 3D modeling software in Geosoft Oasis Montaj. We use geologic mapping and cross-sections, drill core, magnetic susceptibility and density measurements, petrography and geochemistry, and well construction reports to refine physical modeling constraints. Preliminary results indicate (1) regional Precambrian geology may be interpreted from geophysical data and (2) Precambrian topography is controlled by Precambrian geology and is therefore somewhat predictable.

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Index