2025 AWRA ANNUAL MEETING

APRIL 10 & 11, 2025

CHULA VISTA RESORT • WISCONSIN DELLS, WI

American Water Resources Association – Wisconsin Section

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

AMERICAN WATER RESOURCES ASSOCIATION - WISCONSIN SECTION

48TH ANNUAL MEETING

April 10 - 11, 2025

Support From:

Freshwater Collaborative of Wisconsin

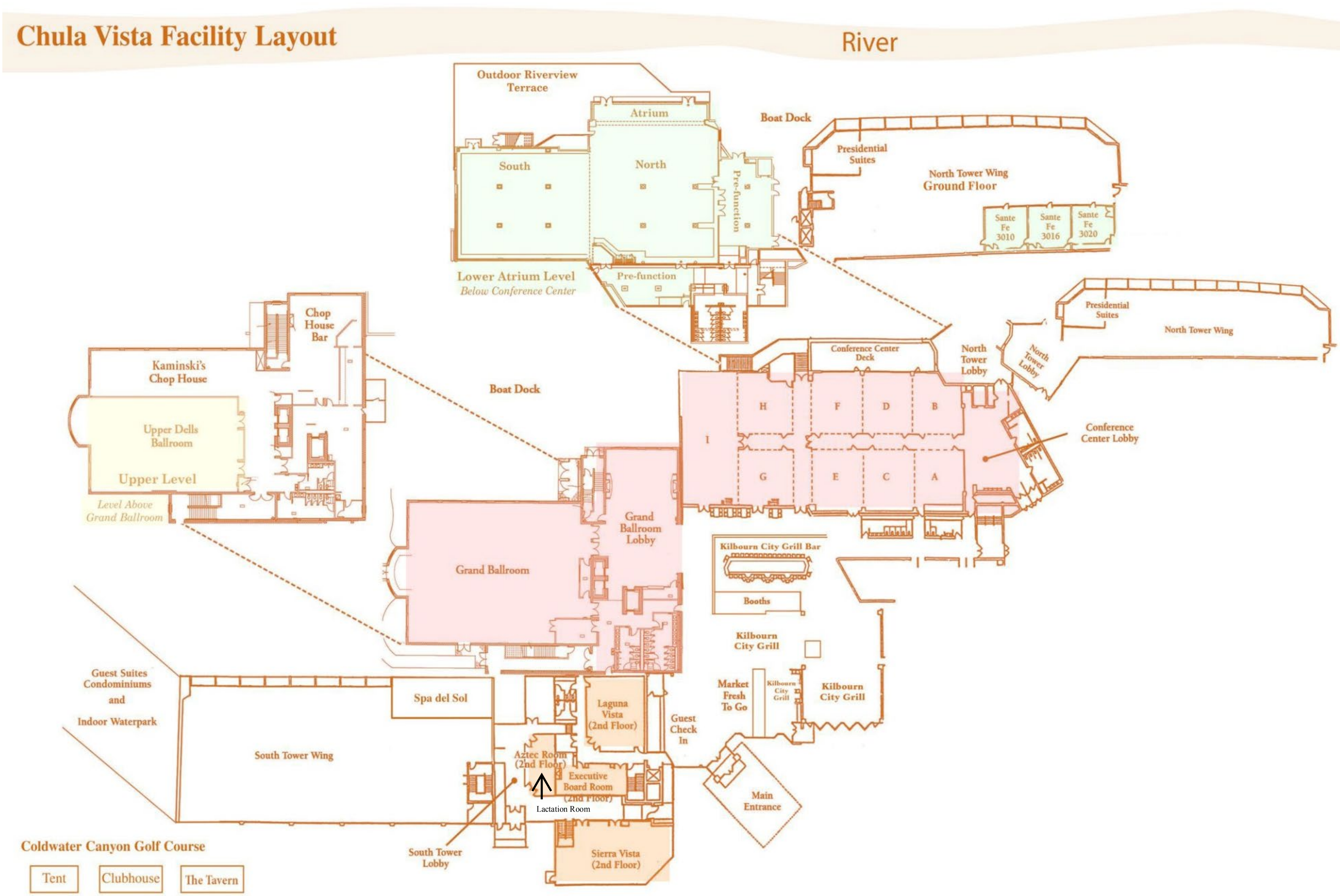
University of Wisconsin Water Resources Institute

Wisconsin Department of Natural Resources

Center for Watershed Science and Education, UW-Stevens Point

Wisconsin Geological and Natural History Survey

U.S. Geological Survey Upper Midwest Water Science Center


Chula Vista Facility Layout
River
Outdoor Riverview Terrace
Atrium
South
North
Pre-function
Lower Atrium Level
Below Conference Center
Pre-function
Boat Dock
Presidential Suites
North Tower Wing Ground Floor
Sante Fe 3010
Sante Fe 3016
Sante Fe 3020
Presidential Suites
North Tower Wing
Chop House Bar
Kaminski's Chop House
Upper Dells Ballroom
Upper Level
Level Above Grand Ballroom
Boat Dock
Conference Center Deck
North Tower Lobby
North Tower Lobby
H
F
D
B
I
G
E
C
A
Conference Center Lobby
Grand Ballroom Lobby
Grand Ballroom
Kilbourn City Grill Bar
Booths
Kilbourn City Grill
Market Fresh To Go
Kilbourn City Grill
Kilbourn City Grill
Guest Suites Condominiums and Indoor Waterpark
Spa del Sol
South Tower Wing
Laguna Vista (2nd Floor)
Guest Check In
Aztec Room (2nd Floor)
Executive Board Room (2nd Floor)
Lactation Room
Main Entrance
South Tower Lobby
Sierra Vista (2nd Floor)
Coldwater Canyon Golf Course
Tent
Clubhouse
The Tavern

BOARD OF DIRECTORS

Aaron Pruitt — Past-President
Wisconsin Department of Natural Resources

Meg Haserodt — President
USGS Upper Midwest Water Science Center

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Jacobs Engineering Group (formerly CH2M), Milwaukee

Madeline Gotkowitz — Director-at-Large
Wisconsin Department of Natural Resources

Amy Wiersma — Director-at-Large
Wisconsin Geological and Natural History Survey

PROGRAM COMMITTEES

Technical Program Committee

Anna Fehling Wisconsin Department of Natural Resources	Technical Co-Chair
Nic Buer USGS Upper Midwest Water Science Center	Technical Co-Chair
Elizabeth White UW-Madison Aquatic Sciences Center	WRI Representative

Communications Committee

Hayley Olds USGS Upper Midwest Water Science Center	Chair & Webpage Manager
Mitch Olds Milwaukee Metropolitan Sewerage District	Digital Communications Manager

Student Engagement Committee

Amy Wiersma Wisconsin Geological and Natural History Survey	Co-Chair
Madeline Gotkowitz Wisconsin Department of Natural Resources	Co-Chair
Bridget Kaemming U.S. Geological Survey	Committee Member
Brooke Payne University of Wisconsin-Stevens Point	Committee Member
Samuel Brockschmidt Department of Agriculture, Trade, and Consumer Protection	Committee Member

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 and conference planning committee. 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.

Mary Anderson
Max Anderson
Andrew Aslesen
Tim Asplund
Jean Bahr
Roger Bannerman
Bill Barnwell
William Batten
Amanda Bell
Gretchen Bohnhoff
Eric Booth
George Bowman
Laurel Braatz
Ken Bradbury
Brent Brown
Bryant Browne
Nicolas Buer
John Cain
Linda Campbell
Mike Cardiff
Chris Carlson
Doug Cherkauer
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Megan Haserodt
Jeff Helmuth
Ron Hennings
Susan Hill
Paulette Homant
Peter Hughes
Randy Hunt
James Hurley
Dave Johnson
Paul Juckem
Pat Jurcek
Steve Karklins
Galen Kenoyer
John Konrad
Kirk Kopitske
Dave Krabbenhoft
George Kraft
Jim Krohelski
Michael Kvitrud
Dale Lang
John Laumer
Andy Leaf
Mike Lemcke
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Carol McCartney
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Chris Mechenich
Maureen Muldoon
Vern Norman
Vladimir Novotny
Hayley Olds
Mitch Olds
Meredith Ostrom
Dave Ozsvath
John Panuska
Mike Parsen
Dale Patterson
Mike Penn
Marie Peppler
Don Pirrung
Austin Polebitski
Ted Powell
Aaron Pruitt
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Bruce Rheineck
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Rada Sandheinrich
Rosalie Schnick
Jo Ellen Seiser
Bill Selbig
Kari Sherman
John Skalbeck
William Sloey
Bill Sonzogni
Earl Spangenberg
Fred Spangler
Bob Stelzer
Jeff Steuer
Ron Stieglitz
Will Stites
Rick Stoll
Todd Stuntebeck
Sue Swanson
Don Theiler
John Tinker
Joan Underwood
Randy Videkovich
Stu Walesh
Kathy Webster
Amy Wiersma
Don Winter
Tom Wirth
Philip Younger

AWRA BOARD OF DIRECTORS POSITION DUTIES

President (Elected, 2-year term, 1st year as Vice President, then continues into 2nd year as President)

Shall preside at meetings, and 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, a summary of the Section's activities to be presented to the annual meeting of the Section.

Vice President (Elected, 2-year term, 1st year as Vice President, then continues into 2nd year as President)

Shall support the President in leading the organization and perform the duties of the President when the latter is absent. The Vice President shall succeed to the office of President in the following year. Some of the duties that the vice-president has helped with in the past include working closely with the President to coordinate the annual meeting, recruiting plenary speakers, recruiting board and committee members, and performing other miscellaneous duties as assigned.

Treasurer (2-year term, elected in odd 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 financial statement for presentation at the annual meeting.

Student Engagement General Board Director (2025 is a special election 1-year term; typically 2-year term that is elected in even years)

Shall advise and support the overall direction of the Section. This position focuses on running and growing the student initiatives at the annual meeting. Example position duties include chairing a student engagement committee to coordinate student activities like judging student presentations, running the student luncheon, and communicating about the chapter’s student opportunities with local universities.

Local Arrangements General Board Director (2-year term, elected in odd years)

Shall advise and support the overall direction of the Section. This position focuses on coordinating the event details with the venue. Example position duties include venue contracts, conference layout at a venue, and coordinating the poster session.

Member and Outreach General Board Director (2-year term, elected in odd years)

Shall advise and support the overall direction of the Section. This position focuses on membership communications and growing the chapter attendance. Example position duties include marketing the organization, drafting chapter communications and forms, and maintaining email and mailing lists.

BIOGRAPHIES OF CANDIDATES FOR THE AWRA WISCONSIN SECTION BOARD

Vice President
Mike Cardiff

Mike Cardiff is Professor of hydrogeology at the Department of Geoscience, UW-Madison. He holds BA degrees in Geology and Mathematics from Oberlin College (2001), as well as MS and PhD degrees in Civil and Environmental Engineering from Stanford University (2005, 2010 respectively). He has 20+ years of experience in the water resources field, including work related to contaminated site remediation, hydrologic and geophysical aquifer characterization, numerical modeling, and the social science of hydrology. Prof. Cardiff is the current department chair for geoscience at UW-Madison, and has had leadership roles in organizations including Water@UW-Madison. As vice president, his goals include building the membership base, building ties with other water-oriented professional societies, and expanding educational and career opportunities for student members.

Treasurer
Carla Romano

Carla Romano is the Groundwater Section manager at the Wisconsin Department of Natural Resources, where she focuses on groundwater quality through source water protection, rulemaking, data management, and coordination with the Groundwater Coordinating Council. Collaboration is central to her work, as she engages with various stakeholders to advance water quality initiatives. Before joining the DNR, Carla worked extensively on groundwater quality, coordinating monitoring programs, analyzing data—particularly for pesticides and nitrate—and modeling flow in fractures. She holds an M.S. in Geophysics from the University of Naples, Italy, and a Ph.D. in Civil and Environmental Engineering from the University of Strathclyde, UK. Passionate about all things water, Carla loves canoeing and enjoys hiking in her free time.

Student Engagement General Board Officer
Amy Wiersma

Amy Wiersma is a hydrogeologist at the Wisconsin Geological and Natural History Survey. Her current work at the WGNHS focuses on developing groundwater data for communities at local and county scales, including maps of water-table elevation and groundwater susceptibility to contamination. Prior to starting at the WGNHS, Amy earned a B.S. in Geosciences from Virginia Tech and a Ph.D. in Environmental Chemistry and Technology from UW-Madison. She has expertise in hydrogeochemistry and the mobility of naturally occurring groundwater contaminants. Amy joined the Wisconsin AWRA Chapter as a graduate student and is excited to contribute to the growth of the organization as a board member.

Local Arrangements General Board Officer
Nic Buer

Nic Buer is a hydrologist with the U.S. Geological Survey in Wisconsin with considerable experience in measuring the quantity and quality of point and nonpoint source runoff. Nic specializes in urban hydrology and research focused on the hydrologic and chemical response of stormwater to structural and non-structural practices designed to mitigate stormwater pollution and nonpoint source runoff in urban environments. In particular, Nic is interested in Green Infrastructure benefits and failings; salt and nutrient interactions in the urban environment; and testing new methods and technologies for potential pollution mitigation in urban environments. Nic enjoys sharing his wonder of the natural world with others and works to ignite curiosity and enthusiasm in the next generation of young scientists.

Membership and Outreach General Board Officer
Kirsten James

Kirsten James is a civil engineer at Hey and Associates, focusing on hydrologic, hydraulic, and water quality modeling, permitting, and design of stormwater, floodplain, planning, recreation, and restoration projects. Kirsten received her degree in hydrology, business, and environmental management applications of GIS from the UW-Stevens Point, where she served on her student chapter of AWRA and worked in the UW Extension Lakes Program. Since, she has earned her Professional Engineering licensure, graduated from the Wisconsin Lake Leaders Institute, and is recognized as a Certified Lake Manager through the North American Lake Management Society. As an avid hiker and kayaker, exploring forests, creeks, and backwaters has inspired her to restore and protect natural areas for years to come.

PLENARY SPEAKERS

Curt Meine

Curt Meine is a conservation biologist, environmental historian, and writer. He serves as Senior Fellow with the Aldo Leopold Foundation in Baraboo and the Chicago-based Center for Humans and Nature. He is a Research Associate with the International Crane Foundation in Baraboo and Associate Adjunct Professor in the UW-Madison Department of Forest and Wildlife Ecology. For more than three decades he has worked with a wide array of organizations at the intersection of conservation, agriculture, water, climate change, environmental justice, and community resilience. He served formerly as Director of Conservation Programs for the Wisconsin Academy of Sciences, Arts and Letters. In this capacity Meine oversaw the Academy's "Waters of Wisconsin" initiative, a comprehensive, state-wide review of the status and needs of Wisconsin's aquatic ecosystems and resources. Meine has authored and edited several books, including the award-winning biography "Aldo Leopold: His Life and Work" (1988/2010) and "The Driftless Reader" (2017). In his home landscape, he is a founding member of the Sauk Prairie Conservation Alliance.

Mike Wiggins, Jr.

Mike Wiggins served as Tribal Chairman and Executive Director of the Bad River Band of Lake Superior Chippewa for 12 years, ending his final term in 2023. Prior to this role, he served as a conservation warden for the Great Lakes Indian Fish and Wildlife Commission and as a home-school coordinator for the School District of Ashland, WI. He earned a bachelor's degree in criminal justice from UW-Superior. Mike is a major advocate for the conservation of natural resources, with a particular interest in maintaining safe groundwater and protecting the Penokee Hills. He is also an avid hunter, fisherman, and harvester.

Marissa Jablonski

We share one water, one soil, one air across the globe. To address water challenges such as PFAS, phosphorus pollution and other issues, water research must be highly collaborative. It must pull together stakeholders who are invested to solve a problem.

Jablonski will share how the Freshwater Collaborative fosters collaborations across the state. She is an accomplished water engineer, environmental advisor, and executive director who has worked in more than 45 countries. She has a strong vision for the future of water in the world that includes stakeholder engagement.

CONTENTS

PROGRAM SUMMARY

48th Annual Meeting of the
American Water Resources Association—Wisconsin Section

<u>**THURSDAY, April 10, 2025**</u>

9:30 – 11:00 am — **Meet and Greet (Grand Ballroom Lobby)**
Informal networking time with light refreshments and opportunities to win prizes, all attendees welcome and encouraged to participate.

9:30 – 11:00 am — **Registration (Grand Ballroom Lobby)**

11:00 – 12:50 pm — **Lunch (Grand Ballroom)**
Welcome and Announcements
Business Meeting and Board Election
Lunchtime plenary: Curt Meine

1:05-2:45 pm — ***Concurrent Sessions 1A, 1B, 1C***

Session 1A — **Tool and Application Development**
Room: E/F
Moderator: Doe Han

1:05 pm — **Enhancing Emergency Management Preparedness with Seasonal Climate Forecasts in Rural Wisconsin**
Felix Boeing,* University of Wisconsin-Madison

1:30 pm — **Spatial Analysis of Regional Nitrate Data**
Thea Showalter,* University of Wisconsin-Madison, Wisconsin Geological and Natural History Survey

1:55 pm — **A Web Application to Facilitate the Understanding of Contributing Zones, Land Cover, and Transit Times for Groundwater Management Decisions**
Trey Coury,* Wisconsin Geological and Natural History Survey

2:20 pm — **We Have the Data - Now What? A Data-Driven Tool for Groundwater Contamination Solutions**
Dave Johnson, Wisconsin Department of Natural Resources

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* Student presentation.

Session 1B | **Groundwater Quality Modeling**
Room: A/C
Moderator: Chris Zahasky

1:05 pm | **Machine Learning Applications for Groundwater Quality Prediction in the Midwestern Cambrian-Ordovician Aquifer System**
Juliet Ramey-Lariviere,* University of Wisconsin – Madison

1:30 pm | **Vertical Reactive Transport Cycling of Salts Across Heterogeneous Vadose Zones**
Charles Paradis, University of Wisconsin – Milwaukee

1:55 pm | **Using an Analytical Transport Model to Constrain PFAS Dynamics at French Island, WI**
James Summers,* University of Wisconsin – Madison

2:20 pm | **Reconstructing the Extent of the 1964 Alaska Tsunami on Vancouver Island: Implications for the Salinization of Groundwater Resources in Northern Cascadia**
Stephen Bartlett,* Simon Fraser University

Session 1C | **Urban Hydrology**
Room: B/D
Moderator: Helena Tiedmann

1:05 pm | **Chloride Attenuation in Green Infrastructure and Implications for Receiving Waters in Urban Environments**
Nicolas Buer, U.S. Geological Survey

1:30 pm | **Identifying Drivers of Hydrologic Regimes and Ecosystem Services in Stormwater Detention Ponds in Wisconsin**
Hannah Curtis, U.S. Geological Survey

1:55 pm | **Determining Flow Rates and Flow Sources in Pipes Using Temperature Data**
Omar Hegazy,* Marquette University

2:20 pm | **Toward Community-Informed Perspective on Floods and Management**
Marian Azeem-Angel,* University of Wisconsin – Madison

* Student presentation.

2:45 -3:00 pm	**Break: Grand Ballroom Lobby**
3:00-4:40 pm	***Concurrent Sessions 2A, 2B, 2C***

Session 2A	**Regulation of Wisconsin's Water Resources** Room: E/F Moderator: Tim Asplund
3:00 pm	**How the Clean Water Act Works to Protect and Restore Waters in Wisconsin** Tim Asplund, Wisconsin Department of Natural Resources
3:25 pm	**DNR's Agricultural Runoff Programs: Implementation and Partnerships** Chris Clayton, Wisconsin Department of Natural Resources
3:50 pm	**Clearing the Waters: Understanding Wisconsin's Groundwater Standards and Future Pathway** Carla Romano, Wisconsin Department of Natural Resources
4:15 pm	**Regulation and Research: Tackling Wisconsin's Water Quantity Challenges** Adam Freihoefer, Wisconsin Department of Natural Resources

Session 2B	**Surface Water Quality** Room: A/C Moderator: Brent Brown
3:00 pm	**Analyzing Drivers of Nutrient Loss Disproportionality Using a Survey-Informed SWAT+ Model** Andrew Hillman,* University of Wisconsin-Madison
3:25 pm	**Sources and Storage of Streambed Sediment and Sediment-P in an Agricultural Tributary to the Lower Fox River, 2024.** Heidi Broerman, U.S. Geological Survey
3:50 pm	**An Assessment of the Integrity of the WAV Citizen Monitoring Macroinvertebrate Biotic Index in Wisconsin** Farron Bussian,* University of Wisconsin-Parkside

* Student presentation.

4:15 pm	**Integrating Biological Indicators into Watershed Management: A Case Study of Opportunities and Challenges** Laura Bates, University of Wisconsin-Madison
Session 2C	**Hydrogeology & Hydrology** Room: B/D Moderator: Michael Cardiff
3:00 pm	**Assessing the Potential to Enhance Infiltration on Driftless Area Hillslopes and Reduce Downstream Flood Peaks** Eric Booth, University of Wisconsin – Madison
3:25 pm	**Revealing Flow Patterns Through Driftless Area Stratigraphy Using End Member Mixing Analysis and Catchment Monitoring: Wyalusing State Park, WI** Rachel Breunig,* University of Wisconsin-Madison
3:50 pm	**Simulating Groundwater Recharge and Flow in the Fractured Dolomite of Kewaunee and Southern Door Counties** Anna Fehling, Wisconsin Geological and Natural History Survey
4:15 pm	**Projecting Protective Potential for a PFAS-impacted Island: Hydro-geophysical Characterization of Stratigraphy Beneath French Island, WI** Michael Cardiff, University of Wisconsin-Madison
4:40-5:30 pm	**Networking (Grand Ballroom Lobby)**
5:30-7:00 pm	**Dinner (Grand Ballroom)** **Distinguished Service Award** **Collaborating to Protect Wisconsin's Water Systems** Marissa Jablonski, Freshwater Collaborative **Evening Plenary** Mike Wiggins, Jr.
7:00-9:00 pm	**Poster Session (Room G/H/I)**
7:00-10:00 pm	**Networking and Social (Room G/H/I)**

Poster Session

Simulating the Water Quality Benefits of Crop Diversification Under Historical and Future Precipitation Scenarios, Lourdes Arrueta, University of Wisconsin-Madison, arruetaanteq@wisc.edu

Beyond Wellhead Protection: How Can Research and Collaboration Advance Source Water Protection? Brian Austin, Wisconsin Department of Natural Resources, brian.austin@wisconsin.gov

Assessing the Impact of Groundwater Level Changes on Metals Contamination, Sean Babasin,[*] University of Wisconsin - Green Bay, babash18@uwgb.edu

An Evaluation of Drinking Water Quality in Rural Eau Claire County, Catherine Blair,[*] University of Wisconsin-Eau Claire, blaircm0604@uwec.edu

Expanding the Hydrogeologic Context of Wells Showing Highly Variable Nitrate Concentrations in Western Wisconsin, Isabelle Carlson,[*] University of Wisconsin-River Falls, isabelle.carlson@my.uwrf.edu

City of Abbotsford Nitrate Reduction Project, Pete Chase, Wisconsin Geological and Natural History Survey, pete.chase@wisc.edu

Exploring Chloride Trends in Wisconsin Lakes and Their Relationship to Road Salt Usage, Mary Chesnut,[*] University of Wisconsin-Stevens Point/Water and Environmental Analysis Lab, mches278@uwsp.edu

Biogeochemical Processes Controlling Geogenic Contaminant Transport and Transformation in a Hydrocarbon Contaminated Aquifer, Peter Christ,[*] University of Wisconsin - Madison, pechrist2@wisc.edu

Towards Open and Reproducible Groundwater Modeling: Lessons from Real-World Applications, Nicholas Corson-Dosch, U.S. Geological Survey, Upper Midwest Water Science Center, ncorson-dosch@usgs.gov

Anthropogenic impacts on painted turtles (Chrysemys picta): Effects of human-derived sounds on nesting and development, Sara Crow,[*] Northeastern Illinois University, ssfrance@neiu.edu

Remote Sensing Analysis of Intercropped Cover Crops in Wisconsin Potatoes, Logan Ebert, University of Wisconsin - Madison, laebert@wisc.edu

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[*] Student presentation.

Unraveling the Origins and Mobilization Mechanisms of Molybdenum in Southeastern Wisconsin Groundwater, Savannah Finley,* University of Wisconsin-Madison, sefinley@wisc.edu

Detection of Pathogens and Fecal Microbes in Paired Large- and Small-Volume Water Samples, Aaron Firnstahl, U.S. Geological Survey, afirnstahl@usgs.gov

Predicting an Overlooked Arsenic Species in Wisconsin Groundwater Using a Random Forest Model, Logan Goulette,* University of Wisconsin - Madison, lbgoulette@wisc.edu

Understanding and Predicting Groundwater-Driven Flooding at a Watershed Scale, Chequamegon-Nicolet National Forest, G. Graham,* Wisconsin Geological and Natural History Survey, grace.graham@wisc.edu

A Single-Field SWAT Model Approach to Evaluate Improvements in Process Representation for Soil Moisture and Soil Temperature Dynamics, Jaya Hafner,* University of Wisconsin-Madison, muehlman@wisc.edu

Investigating the Unique Hydrologic Dynamics of Wisconsin Solar Farms, Kyungdoe Han, Department of Civil and Environmental Engineering, University of Wisconsin - Madison, khan99@wisc.edu

WSLH Adoption of EPA 1633 and Continued PFAS Analysis Challenges, Kristen Hannon, Wisconsin State Laboratory of Hygiene, Kristen.hannon@slh.wisc.edu

Characterizing Spatial Dependency of Transport Parameters Utilizing Tracer Injection Wells, Isabelle R. Haverkampf,* Department of Geosciences, University of Wisconsin at Milwaukee, haverka2@uwm.edu

Establishing a Ridge and Swale Ecohydrological Observatory, Eric Kastelic,* University of Wisconsin - Madison: Geological Engineering, ekastelic@wisc.edu

Quantification of Vadose Zone processes in a PFAS-impacted aquifer: French Island, WI, Samantha Kershner,* University of Wisconsin-Madison, skershner@wisc.edu

Spatiotemporal Influences on Phosphorus Transport in the Hyporheic Zone: Insights from Field Water Monitoring and In situ Column Experiments, Vy Le,* University of Wisconsin-Madison, vple@wisc.edu

Writing Good Code for Robust, Inclusive and Efficient Water Resources Science, Andrew Leaf, U.S. Geological Survey, aleaf@usgs.gov

* Student presentation.

Three-Dimensional Map of Nitrate in Groundwater in Wisconsin With Spatially Adjusted Random Forests, Xindi Lin,* University of Wisconsin–Madison, xlin268@wisc.edu

Drivers of algal abundance in stormwater retention ponds, Zephyr Lopez,* University of Wisconsin - Stevens Point, zephyr.lopez@outlook.com

An Updated Potentiometric Surface for the Confined Sandstone Aquifer in the Northeast Groundwater Management Area of Wisconsin (2023-2024), John A. Luczaj, University of Wisconsin - Green Bay, luczajj@uwgb.edu

Understanding the Role of Freeze-Thaw Processes on Contaminant Transport in the Vadose Zone, Eleanor Mcfarlan,* University of Wisconsin - Madison, mcfarlan@wisc.edu

Challenges of Mapping Hydraulic Head in a Multi-Aquifer Setting Using Domestic Wells, Maureen Muldoon, Wisconsin Geological & Natural History Survey, muldoon@wisc.edu

The Suppression of Wetland Plant Growth by Crayfish: Early Insights and Evidence, Corey Muravnick,* University of Wisconsin-Green Bay, muracj29@uwgb.edu

Investigating Potential Impacts of Groundwater Exchange on Manoomin (Wild Rice) in Northern Wisconsin, Cheyanne Nakutih,* University of Wisconsin -Madison, ckoran@wisc.edu

Impact of Stream Restoration on Chloride Loading in Snow-Affected Urban Watersheds, Sophie Norenberg,* University of Wisconsin Milwaukee: Geosciences (hydrogeology), norenbe4@uwm.edu

Characterizing PFAS Transport in Unsaturated Soil Using Meter-Scale Column Experiments, Adam Ornelles,* University of Wisconsin, Madison, ornelles@wisc.edu

Surface Water Quality in a Restored Wetland, Angie Rayniak,* University of Wisconsin-Parkside, fiebe001@rangers.uwp.edu

Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water in Rural Eau Claire County, Claire Schoenemann,* University of Wisconsin-Eau Claire, schoence8370@uwec.edu

A Multi-Marker Assessment of Sewage Contamination in Streams Using Human-Associated Indicator Bacteria, Human-Specific Viruses, and Pharmaceuticals, Joel Stokdyk, U.S. Geological Survey, jstokdyk@usgs.gov

Evaluating Winter Runoff Estimation in the Wisconsin Phosphorus Index, Emma Strickland,* University of Wisconsin-Madison, egstricklan2@wisc.edu

* Student presentation.

Assessing Distribution Uniformity with UAVs in California Almonds, Jaya Suneja,* University of Wisconsin - Madison, jsuneja@wisc.edu

Impacts of ADAF on PFAS Transport in Groundwater Systems, Kamryn Veith,* University of Wisconsin-Milwaukee, kveith@uwm.edu

Characterizing Groundwater Susceptibility to Contamination in Burnett County, Wisconsin, Amy Wiersma, Wisconsin Geological and Natural History Survey, amy.wiersma@wisc.edu

Using Lumped Parameter Models to Quantify Climate and Anthropogenic Forcings on Static Water Levels in Fractured Low Permeability Bedrock Aquifers, Christopher Zahasky, University of Wisconsin-Madison, czahasky@wisc.edu

Silver-Impregnated Activated Carbon: A Novel Approach for PFBS Adsorption, Ben Zobel, University of Wisconsin – Stevens Point, bzobe336@uwsp.edu

FRIDAY, April 11, 2025

7:30-8:30 am	**Board Breakfast Meeting (Executive Boardroom)**
8:30-10:10 am	***Concurrent Sessions 3A, 3B, 3C***

Session 3A	**Groundwater Quantity** Room: I Moderator: Adam Freihoefer
8:30 am	**Diving into Decades of Baseflow Data in Wisconsin's Central Sands** Aaron Pruitt, Wisconsin Department of Natural Resources
8:55 am	**When should "settled science" be revisited? – connecting pumping and streams** Michael Fienen, U.S. Geological Survey
9:20 am	**Groundwater Sustainability Challenges in the Land of 10,000 Lakes... and Modified Riparian Water Rights** Ellen Considine, Minnesota Department of Natural Resources
9:45 am	**Water Bottling Withdrawals across Michigan and Wisconsin: Their History and Hydrologic Impacts** Bridget Kaemming, U.S. Geological Survey

Session 3B	**Emerging Contaminants** Room: G/H Moderator: Madeline Gotkowitz
8:30 am	**An Assessment of Several Filter Membranes for Filtering Aqueous Per- and Polyfluoroalkyl Substances (PFAS) Samples** Patrick Gorski, Wisconsin Department of Natural Resources
8:55 am	**Statewide Assessment of Pesticides in Wisconsin's Streams and Rivers** Michael Miller, Wisconsin Department of Natural Resources
9:20 am	**Addressing Groundwater Contamination Through Use of Biochar and Zero Valent Iron (ZVI)** Kendra Saunders,[*] University of Wisconsin – Madison

[*] Student presentation.

9:45 am	**Determining Sediment and Porewater Concentrations for Per- and Polyfluoroalkyl Substances (PFAS) from a Diversity of Sites in WI** Patrick Gorski, Wisconsin Department of Natural Resources
Session 3C	**Climate Change** Room: E/F Moderator: Sarah Vitale
8:30 am	**Simulations of Past and Future Water Budget Components for Building Community Resiliency to Climate Change in Minnesota** Martha Nielsen, U.S. Geological Survey
8:55 am	**Implications of Future Rainfall on Stormwater Infrastructure in Wisconsin** Sophie Van Alsburg,* University of Wisconsin-Madison
9:20 am	**Mapping, Modeling, and (Bio)Manipulation of Fish Lake's Groundwater Flooding Problem** Eric Kastelic,* University of Wisconsin-Madison, Geological Engineering
9:45 am	**Characterization of Oxythermal Habitat Across Upper Midwestern Glacial Lakes** Emma Blackford,* University of Wisconsin-Madison
10:10-10:30 am	**Break: Grand Ballroom Lobby**
10:30-12:10 pm	***Concurrent Sessions 4A, 4B, 4C***
Session 4A	**Communication and Management** Room: I Moderator: Erin Berns-Herrboldt
10:30 am	**Are Scientists Engaging in Science the Public Cares about? Exploring Public and Scientific Discourse on Water Quality in a Water-Rich Landscape** Catherine Christenson, US Geological Survey
10:55 am	**Groundwater Governance Conversations in Wisconsin and EPA Region 5** Carrie Jennings, Freshwater

* Student presentation.

11:20 am	**From Secchi Depth to Swimmability: A Framework for Linking Metrics, Perceptions, and Valuation of Lake Water Quality** James Price, University of Wisconsin – Milwaukee
11:45 am	**Incentivizing Household Water Testing in Farm Worker Housing** Melissa Kono, University of Wisconsin-Madison
Session 4B	**Groundwater Quality** Room: G/H Moderator: Carla Romano
10:30 am	**An Evaluation of Multi-decade Groundwater Data from Atrazine Prohibition Areas in Wisconsin** Samuel Brockschmidt, Wisconsin Department of Agriculture, Trade, and Consumer Protection
10:55 am	**Groundwater Quality Monitoring at CAFOs: How DNR Makes Decisions** Ian Anderson, Wisconsin Department of Natural Resources
11:20 am	**Developing Safe-Drinking Water Supplies from Wisconsin's Aquifers** Madeline Gotkowitz, Wisconsin Department of Natural Resources
11:45 am	**Mineralogical Indicators of Groundwater Arsenic Contamination: Linking the Glacial Aquifers of the Upper Midwest United States to the Deltaic Aquifers of Southeast Asia** Athena Nghiem, University of Wisconsin-Madison
Session 4C	**Modeling** Room: E/F Moderator: Anna Fehling
10:30 am	**Watershed Response to Climate Forcing: Insights from the Trout Lake Watershed** Randall Hunt, U.S. Geological Survey
10:55 am	**Balancing Environment and Economy in an Agricultural Basin in Oregon: Moving Beyond Scenarios With Multi-Objective Optimization** Katherine Markovich, U.S. Geological Survey

11:20 am	**Insights from a MODPATH vs MT3D-USGS Comparison of Groundwater Travel Time Distributions in the Wisconsin Central Sands** Paul Juckem, U.S. Geological Survey
11:45 am	**Adding MODPATH to the Groundwater Nitrate Decision Support Tool for Wisconsin wells and streams** Laura Schachter, U.S. Geological Survey
12:10 – 12:30pm	**Closing Remarks and Student Awards (Grand Ballroom Lobby)**
12:30 – 2:00pm	**Student Career Session Lunch (Sierra Vista)** *Student career discussion, prior registration required.*

ABSTRACTS

Thursday, April 10, 2025

Concurrent Sessions

Session 1A: Tool and Application Development

Enhancing Emergency Management Preparedness with Seasonal Climate Forecasts in Rural Wisconsin

Felix Boeing,* University of Wisconsin-Madison, Fboeing@wisc.edu
Paul Block
Steve Vavrus
Ken Genskow

Climate-related disasters are increasingly common, costly, and deadly, posing challenges to communities and emergency managers. These events impact infrastructure, public health, agriculture, and more, resulting in significant social disruption. In recent years, flooding has become more prevalent in Wisconsin and since 1895, precipitation has shown a significant increasing trend across the state. Statewide minimum temperatures have also increased significantly since the 1960s, especially during the winter. These increasing extremes disproportionately impact rural communities due to a lack of capacity and minimal funding. While emergency managers are experienced in disaster response, they are less prepared to take proactive measures in anticipating extremes, despite acknowledging benefits. Existing forecasting tools are viewed as too coarse, poorly performing, or misaligned with decisions by emergency managers. Co-produced prediction tools for season-ahead forecasts of total precipitation, and counts of extreme precipitation or temperature events can provide the vital information emergency managers need to take anticipatory action. We examine emergency managers' use of climate prediction tools in rural Wisconsin to understand how these tools are currently applied to disaster planning and opportunities for improvement. We subsequently develop prediction tools specifically made for emergency managers and hazard planners to enhance rural resilience to increasing climate extremes.

Spatial Analysis of Regional Nitrate Data

Thea Showalter,* University of Wisconsin-Madison, Wisconsin Geological and Natural History Survey, tshowalter@wisc.edu
David Hart, Wisconsin Geological Survey
Trey Coury, UW-Madison/WGNHS

The Central Sands Region of Wisconsin is renowned for its natural beauty, but it is also an important agricultural region for Wisconsin producers. As a result, nitrate concentrations in ground- and surface water are often above the EPA standard of 10mg/L. Our research used a spatial dataset of nitrate levels

* Student presentation.

from throughout the region to seek a measure of correlation between land use and nitrate contamination.

From June-August 2024, we collected nitrate data at over 500 stream-road crossings throughout the Central Sands using a portable UV nitrate sensor. We also measured pH, temperature, and fluid conductivity. These water quality data were used alongside land use data and a regional groundwater flow model to attempt to identify patterns of historical groundwater N loading. Spatial analysis involved delineating the contributing groundwater zones for each nitrate sampling location, identifying the land uses for each contributing zone, and measuring the correlation between nitrate levels and high intensity agriculture, forested and natural land cover, and low-intensity agriculture. We investigated correlations using different clustering of land uses and incorporating groundwater transit times into the analysis.

The ultimate goal of this effort is to use the correlation between land use and nitrate contamination to inform a groundwater flow decision tool for county land and water conservation departments, extension agents and other resource managers in the Central Sands.

A Web Application to Facilitate the Understanding of Contributing Zones, Land Cover, and Transit Times for Groundwater Management Decisions

Trey Coury,* Wisconsin Geological and Natural History Survey, rcoury@wisc.edu
Thea Showalter, Wisconsin Geological and Natural History Survey
Dave Hart, Wisconsin Geological and Natural History Survey

There are many models and databases that can be used to inform groundwater management decisions. For example, MODPATH computes groundwater flow paths and simulates particle transport, and CropScape is a source of crop-specific land cover. Land cover, in turn, can be used to infer levels of contaminants like nitrate. Taken together, MODPATH and CropScape can be used to predict contaminant transport, leading to improvements in management decisions. However, as they require specific tools and technical expertise, the number of people who can use them is limited. To make this information more approachable, we created a web application using R and Shiny that visualizes MODPATH output and CropScape data for Wisconsin's Central Sands Region.

The app displays a map-based interface, allowing users to select an area within the boundary of the groundwater flow model. It then displays groundwater transit times and land cover type, as well as an in-map visualization of flow paths. Additionally, we intend to include nitrate level estimates from a predictive model based on the land cover of the contributing area.

We designed this application for use by local governments to inform their decisions around groundwater management. While this application was created to assist with investigating nitrate levels, much of it can be used to inform general groundwater management.

* Student presentation.

We Have the Data - Now What? A Data-Driven Tool for Groundwater Contamination Solutions

Dave Johnson, Wisconsin Department of Natural Resources, dave.johnson@wisconsin.gov
Robin Wagner, WDNR

Wisconsin faces significant challenges related to groundwater contamination. While contamination is often visualized on 2D maps, it's 3D issue, with concentrations potentially varying by depth. Understanding this complexity is key for stakeholders seeking informed solutions. In response, the Department of Natural Resources has developed new visualization tools to better understand well water sample results and provide well construction recommendations to address water quality issues. This initiative follows a 2014 rule change requiring nitrate and bacteria sampling for new wells, and nitrate, bacteria, and arsenic testing after pump work. Additionally, Transient Non-Community wells (e.g., restaurants, gas stations, campgrounds) are now required to address nitrate contamination between 10 and 20 ppm. The increasing volume of data and stakeholder demands, has highlighted the necessity for advanced analysis to better understand how contaminants vary with well construction details, such as well depth, casing depth and water depth. This presentation will focus on how we access the data, how we perform data cleaning and visualization using R to reveal patterns and trends that can guide decision-making. So far, we have focused on contaminants such as nitrate, iron, and manganese, with additional work underway for bacteria, arsenic, and radium. Future efforts will explore relationships between contaminants, lithologies and specific geological formations

Session 1B: Groundwater Quality Modeling

Machine Learning Applications for Groundwater Quality Prediction in the Midwestern Cambrian-Ordovician Aquifer System

Juliet Ramey-Lariviere,* University of Wisconsin-Madison, juliet.rameylariviere@wisc.edu
Mathew Ginder-Vogel, UW-Madison

The Midwestern Cambrian-Ordovician Aquifer System (MCOAS) is among the principal aquifers in the United States with almost 30 million people relying on it for potable water. Raw water from the MCOAS consistently shows high concentrations of geogenic contaminants including radium and strontium. Regulation mandated groundwater sampling provides a dataset of ion concentrations for municipal wells within the MCOAS. Previous studies have shown accurate and well constrained predictions of contaminant concentrations using machine learning models. Here we use random forest (RF) modeling to predict concentrations of key geogenic groundwater constituents using regulatory samples focusing on Minnesota, Illinois and Wisconsin. RF classification modeling shows the best performance predicting a binary outcome (i.e. above or below a concentration of concern) for cations, notably strontium (balanced accuracy 70% - 90%). RF regression modeling to predict a continuous concentration value yields significant p-values and moderate R-squared values. RF regression performance may improve with additional tuning to adjust the model fit for the data available. The regulatory dataset is promising for predicting geogenic contaminant concentrations across the aquifer. The modeling results may be particularly beneficial in areas with limited samples.

Vertical Reactive Transport Cycling of Salts Across Heterogeneous Vadose Zones

Charles Paradis, University of Wisconsin-Milwaukee, paradisc@uwm.edu,
Cameron Pace, UW-Milwaukee

Groundwater contains dissolved salts that can move upward from the water table and into the overlying unsaturated soil zone via capillary flow. Salty groundwater in the unsaturated zone can evaporate below the ground surface and precipitate salt minerals within soils. Conversely, rain waters can move downward from the ground surface and into the underlying unsaturated soil zone via gravity flow. Rainwaters in the unsaturated zone can dissolve salt minerals within soils and return salts back to the water table. The objective of this research is to visualize, measure, and understand the upward precipitation and downward dissolution of salts in the unsaturated zone. Several data will be presented from heterogeneous laboratory column tests and includes three-dimensional visualization and quantification of changes in porosity, pore-network connectivity, and salt mineral morphology during upward precipitation and downward dissolution. These data will provide mechanistic insights into how salts move and react between the water table and the vadose zone.

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* Student presentation.

Using an Analytical Transport Model to Constrain PFAS Dynamics at French Island, WI

James Summers,* University of Wisconsin Madison, jpsummers2@wisc.edu
Michael Cardiff, UW-Madison
David Hart, Wisconsin Geological and Natural History Survey
Maureen Muldoon, Wisconsin Geological and Natural History Survey
Lee Donahue, Town of Campbell
Christopher Zahasky, UW-Madison

Extensive use of aqueous film forming foams (AFFFs) at or adjacent to the La Crosse Regional Airport in west-central Wisconsin has contaminated local groundwater with per- and polyfluoroalkyl substances (PFAS). Flow and transport models of PFAS in the vadose zone remain challenging to parameterize and often fail to capture impacts of multiscale heterogeneity and transient water saturation conditions. However, the net effect of these complexities is a time-dependent loading of PFAS to the saturated zone.

This study will demonstrate how a simplified inverse model, consisting of an analytical flow and transport model coupled with a constrained optimization module, can estimate PFAS loading from the vadose zone. The utility of this approach will be assessed using synthetic test cases resembling conditions at the Town of Campbell immediately adjacent to the airport. Using sampling results from domestic wells within the Town of Campbell, this method will then be applied to a distinct plume resulting from a 2001 plane crash on airport property. The results will be used to update numerical flow and transport models of PFAS on French Island.

This study illustrates how the large sample dataset collected by residents of Campbell is valuable for constraining parameters affecting PFAS movement in our numerical model. This is crucial for forecasting plume migration and understanding how to protect and use the underlying Mt. Simon aquifer as a long-term water supply.

Reconstructing the Extent of the 1964 Alaska Tsunami on Vancouver Island: Implications for the Salinization of Groundwater Resources in Northern Cascadia

Stephen Bartlett,* Simon Fraser University, s.e.bartlett2@gmail.com
Jessica Pilarczyk, Simon Fraser University
Diana Allen, Simon Fraser University
Catherine Jeffries, Virginia Polytechnic Institute
Michaela Spiske, State Museum of Natural History, Karlsruhe, Germany
Robert Weiss, Virginia Polytechnic Institute

An important consequence of tsunami inundation on a coastline is the salinization of aquifers. Tsunami-related salinization may yield groundwater unusable for several years. Key variables of uncertainty related to the effects of tsunamis on groundwater include tsunami inundation extent and flow depth, and the hydraulic conductivity of affected aquifers. Thus, this problem requires methodologies from the paleoseismological and hydrogeological disciplines. We seek to improve our understanding of the impacts of tsunamis on northern Cascadia, and to quantify the risk they pose to groundwater resources

* Student presentation.

in the coastal community of Port Alberni, British Columbia, Canada. A framework for assessing the risk of tsunami-groundwater contamination is developed using sedimentological analysis, tsunami modeling (TSUFLIND and GeoClaw), and groundwater modeling. Sedimentological analysis and inverse/forward tsunami modeling results suggest seawater up to 1 metre deep may pool for twelve hours following inundation. HYDRUS-1D and MODFLOW are used to simulate the flow of seawater through the vadose zone and near-shore aquifers respectively. These methods suggest it may take eight months for Port Alberni’s groundwater resources to return to acceptable drinking conditions. This combined modeling methodology is applicable to various contexts including river and storm surge flooding, which may mobilize surficial contaminants and threaten both coastal and inland groundwater resources.

Session 1C: Urban Hydrology

Chloride Attenuation in Green Infrastructure and Implications for Receiving Waters in Urban Environments

Nicolas Buer, USGS UMid, nbuer@usgs.gov

Green Infrastructure (GI) effectiveness in treating dissolved pollutants appears to be minimal. Chloride is one such pollutant often found in the urban environment resulting from de-icing practices, with accumulation coinciding with the onset of winter precipitation in temperate climates. USGS monitoring of chloride in GI practices such as permeable pavement, biofiltration basins, and retention basins indicate that although timing of chloride accumulation remains fairly constant across GI practices throughout the winter, flushing and attenuation of chloride vary across practices, with stormwater effluent from GI returning to baseline concentrations between one and five months after peak concentrations. GI practices involving infiltration showed more rapid attenuation of chloride in effluent and shallow groundwater, while impoundment practices exhibited longer attenuation periods. Variations in attenuation may be due to soil porosity, soil type, contact time, initial concentration, and connection to native soils, among other factors. Short term capture of chloride in GI is evident during subzero conditions, yet sequestration is unattainable due to the pollutant's conservative nature. Although evidence supports that infiltration-based GI practices may offer some initial treatment to surface waters, as indicated by reduced chloride loads at the end of the pipe, this pollutant may instead reach groundwater and affect chloride concentrations to receiving waters via baseflow.

Identifying Drivers of Hydrologic Regimes and Ecosystem Services in Stormwater Detention Ponds in Wisconsin

Hannah Curtis, United States Geological Survey, hcurtis@usgs.gov
Steven Loheide, University of Wisconsin-Madison

As urbanization continues to increase, cities are faced with challenges including watershed flashiness, degraded water quality, loss of biodiversity, and destabilized channels. Stormwater detention ponds are a ubiquitous type of stormwater infrastructure used to mitigate these challenges by temporarily storing stormwater to reduce downstream flooding and improve water quality. Beyond these primary functions, detention ponds support biodiversity, maintain downstream flow regimes, and provide aesthetic value and recreational opportunities. The effectiveness of these ecosystem services (ES) depends on watershed characteristics, engineering design, and the hydrologic regime of ponds, which together introduce both synergies and tradeoffs among and between in-pond and downstream ES. In this study, we used Partial Least Squares Regression to explore relationships between design, watershed, and hydrologic variables and ES in 20 stormwater detention ponds in Dane County, WI. The analysis highlighted engineering design variables as the strongest predictors of hydrologic regimes and hydrologic and design variables as the strongest predictors of ES. Key predictors included outlet restrictiveness, pond size, residence time, and vegetation surrounding ponds, along with hydrologic factors like water level fluctuations and temperature variance. These findings suggest that strategic adjustments to design features can optimize hydrologic regimes and enhance both in-pond and downstream ES.

Determining Flow Rates and Flow Sources in Pipes Using Temperature Data

Omar Hegazy,* Marquette University, omar.hegazy@marquette.edu
Walter Mcdonald, Marquette University

Sanitary sewer systems are subject to infiltration and inflow (I/I) from rainfall events where unwanted stormwater enters the sewer network. This can lead to sewage backups and overloads at wastewater treatment plants, posing serious risks to human and environmental health. Determining I/I sources requires extensive monitoring that is either limited to discrete points that infer upstream processes or subject to dry weather methods (CCTV, smoke testing, etc.) that cannot capture I/I during peak events. This study aims to overcome these shortcomings through a novel approach, monitoring the volume of I/I entering sewer systems through Distributed Temperature Sensing (DTS). It can estimate flow rates at 1-m increments throughout a sewer system. Additionally, this study seeks to improve the accuracy of previous approaches by optimizing the I/I temperature values to best fit the observed hydrograph downstream of the monitored sewer. This was done through a mathematical optimization model created using the SciPy library, yielding an RMSE of 12 gallons per minute between the modeled and the observed hydrographs. Furthermore, the optimized I/I temperature exhibited similar patterns to the observed temperatures of infiltrated stormwater in other studies that have comparable characteristics to the monitored site. Overall, this approach's outcomes may capture sewer flows at unmatched spatial and temporal scales, thereby improving accuracy and reducing costs of determining I/I sources.

Toward Community-Informed Perspective on Floods and Management

Marian Azeem-Angel,* University of Wisconsin - Madison, azeemangel@wisc.edu
Paul Block, UW - Madison

Unequal development of stormwater infrastructure can lead to disproportionate impacts on low-income households and communities of color. Extreme precipitation events exacerbate these inequalities, intensifying flooding and straining local adaptive capacity. In lieu of traditional approaches focused primarily on physical factors, we propose considering both social and physical factors to better understand flood outcomes across neighborhoods. We first construct a localized flood-specific social vulnerability index for Madison, WI, based on various physical, health, environmental, and socioeconomic factors using census data. By testing various weighting schemes, we uncover factor importance and variation across neighborhoods and socioeconomic conditions. Second, we leverage locally conducted surveys and interviews elucidating perceptions on current flood impacts and management strategies to further our understanding of how well residential perceptions confirm or misalign with indexes constructed on census data. Quantitative survey results are used to inform weights applied to index factors to identify spatial and physical drivers of flood vulnerability. Our findings highlight the benefits of integrating local perceptions into social vulnerability measures, contextualize heterogeneity across neighborhoods, and support equitable infrastructure redevelopment.

* Student presentation.

Session 2A: Regulation of Wisconsin's Water Resources

How the Clean Water Act Works to Protect and Restore Waters in Wisconsin

Tim Asplund, Wisconsin Department of Natural Resources, tim.asplund@wisconsin.gov

What's a TMDL? What's the 303(d) list? What does it mean for a waterbody to be impaired? What role do surface water quality standards play in helping protect and restore water quality? How does one determine whether lakes, rivers and streams are attaining their designated use (and what does that even mean)? How does the Clean Water Act address non-point source pollution (hint - it doesn't)? This presentation will provide an overview of how the Wisconsin DNR administers the Federal Clean Water Act in Wisconsin to protect and restore waterbodies - setting standards, monitoring and assessment, listing impaired waters, developing TMDL's, issuing wastewater and stormwater permits, and incentivizing voluntary BMP's through grants. We will focus on two case studies - phosphorus and PFAS - illustrating the challenges and opportunities for innovation that Wisconsin has faced with these two pollutants.

DNR's Agricultural Runoff Programs: Implementation and Partnerships

Chris Clayton, Wisconsin DNR, christopherr.clayton@wisconsin.gov

The regulatory framework in Wisconsin to address agricultural runoff includes local, state, and federal authorities. The Wisconsin DNR administers two programs at the state level to address water quality issues at farms. The CAFO Program, which is supported by federal authority under the Clean Water Act, issues WPDES permits to livestock farms with 1,000 or more Animal Units. The Nonpoint Program uses grant funding and enforcement tools to drive compliance with state agricultural performance standards. Collaboration with DATCP and the counties are vital to successful implementation of the Nonpoint Program. I will describe how the DNR implements both programs, highlighting the important role of partnerships with state, local, and federal agencies, as well as with farmers.

Clearing the Waters: Understanding Wisconsin's Groundwater Standards and Future Pathway

Carla Romano, Wisconsin Department of Natural Resources, carla.romano1@wisconsin.gov
Bill Phelps, Wisconsin Department of Natural Resources

The development and application of Wisconsin's groundwater protection framework stems from Act 410 (1983), which created Chapter 160 of the Wisconsin Statutes and the Wisconsin Administrative Code Chapter NR 140. This presentation will explore the meaning and evolution of these Wisconsin groundwater regulations. Chapter 160 contains detailed methodologies for establishing groundwater quality standards and mandates that the DNR set groundwater standards in consultation with the Department of Health Services (DHS) through Chapter NR 140. This administrative code chapter defines groundwater standards, which differ from NR 809 Safe Drinking Water Act maximum contaminant levels, and outlines their applicability to regulated activities such as spills, wastewater discharges, concentrated animal feeding operations, landfills, and the land application of waste. Recent proposed revisions to NR 140, in Cycle 10, aimed to establish standards for emerging contaminants such as per- and polyfluoroalkyl substances (PFAS) but, in 2022, these code revisions were not approved by the Natural Resources Board. In 2023, the DNR reproposed rulemaking to set PFAS standards; however, this rulemaking process was stopped due to the economic impact analysis rule provisions in Wisconsin Statute Chapter 227. Looking ahead, efforts remain focused on tackling the challenges posed by emerging contaminants, including PFAS and pesticides, reaffirming Wisconsin's dedication to protecting groundwater resources.

Regulation and Research: Tackling Wisconsin's Water Quantity Challenges

Adam Freihoefer, Wisconsin Department of Natural Resources, adam.freihoefer@wisconsin.gov

Over the past five years, several pivotal developments have significantly shaped water quantity management in Wisconsin, including a 2021 Wisconsin Supreme Court decision and the 2021 Central Sands Lakes Study. While these events have provided valuable guidance and recommendations, the Wisconsin DNR has faced ongoing challenges in reviewing the over 550 high-capacity well applications submitted since July 2021. Today's technical reviews of these applications are complicated by factors such as conceptual and parameter uncertainty, climate change, increasing water use in low-yield regions, a need to balance water quality and quantity concerns, and the demand for timely analysis to address complex conditions. This presentation explores these challenges, the initial steps the DNR has taken to address them, and the opportunities for applied research and collaboration among Wisconsin's agencies and institutions.

Session 2B: Surface Water Quality

Analyzing Drivers of Nutrient Loss Disproportionality Using a Survey-Informed SWAT+ Model

Andrew Hillman,* University of Wisconsin-Madison, adhillman@wisc.edu
Margaret Kalcic, UW-Madison
Anita Thompson, UW-Madison
Joe Bonnell, Wisconsin DNR
Ken Genskow, UW-Madison

In agricultural settings, a small number of fields have the potential to generate an outsized amount of nutrient loading. This disproportionality in nutrient loss would ideally be considered when crafting non-point pollution policy. The scale of disproportionality is difficult to track, given that these hot spots are generated by a combination of the physical landscape and farmer decision making and behavior. This study aims to better understand how these factors relate to each other, and, to nutrient loading, using a field-scale SWAT+ (Soil and Water Assessment Tool Plus) model with a unique setup informed by a farmer survey to model the Sinsinawa Watershed in the Driftless area of Wisconsin. A management scenario was created using farmer survey responses about management choices and how those choices are related to field-specific physical landscape attributes. This scenario reflects current management in the watershed. This model will be used to assess nutrient losses from farm fields, determine the level of disproportionality present in the watershed, and investigate the drivers of that disproportionality by running various management scenarios. Uncovering the combinations of management choices and physical factors that result in disproportionate nutrient losses, as well as how both behavior and the landscape drive disproportionality, could help inform policy and outreach initiatives to more efficiently mitigate nutrient loss.

Sources and Storage of Streambed Sediment and Sediment-P in an Agricultural Tributary to the Lower Fox River, 2024.

Heidi Broerman, U.S. Geological Survey - Upper Midwest Water Science Center, hbroerman@usgs.gov
James Blount, U.S. Geological Survey - Upper Midwest Water Science Center
Tanja Williamson, U.S. Geological Survey - Ohio-Kentucky-Indiana Water Science Center
Faith Fitzpatrick, U.S. Geological Survey - Upper Midwest Water Science Center
Rebecca Kreiling, U.S. Geological Survey - Upper Midwest Environmental Science Center
Matthew Komiskey, U.S. Geological Survey - Upper Midwest Water Science Center

East River, an agricultural tributary to the Lower Fox River in Wisconsin, has excessive phosphorus (P) and suspended-sediment loads that contribute to habitat-related impairments and downstream algal blooms in the Lower Green Bay Area of Concern. In August 2022, field surveys estimated soft streambed sediment storage and eroding streambank contributions along 15 reaches to characterize in-channel sources of sediment and sediment-bound phosphorus (sed-P) and used to build a stream-corridor sediment budget, completed in 2024. Budget results indicate that fine-grained streambank erosion (<63

* Student presentation.

micron) contributed 7,400 megagrams/year (Mg/yr) of sediment and 7,200 kilograms/year (kg/yr) of sed-P, compared to mean annual stream gage loads of 5,400 Mg/yr of suspended sediment and 10,000 kg/yr particulate-P. Fine-grained streambed storage was 1,400 Mg, with 1,500 kg sed-P, indicating downstream transport of most eroded sediment and sed-P. Sediment fingerprinting results indicated spatial differences in eroding streambank-sourced streambed sediment (20-100 percent), with greater than 95 percent apportionment in high storage reaches. Individual reaches also had streambed contributions from cropland, gullies, and woodlands. Results implicate eroding streambanks as a P source to streambed sediment in the East River. Transferability of these methods is being used to compare sources and storage of streambed sediment and sed-P in multiple tributaries to the Lower Fox River.

An Assessment of the Integrity of the WAV Citizen Monitoring Macroinvertebrate Biotic Index in Wisconsin

Farron Bussian,* University of Wisconsin Parkside, bussi001@rangers.uwp.edu
Jessica Orlofske, University of Wisconsin Parkside
Christopher Tyrrell, Milwaukee Public Museum

Community Based Monitoring (CBM) or citizen science, in which the public participates to some degree in the scientific process, is a rapidly growing resource in water science. In Wisconsin, the Water Action Volunteers (WAV) was established as a citizen science program in which volunteers collect stream data that can be used by the Wisconsin Department of Natural Resources (WDNR). The WAV Community Macroinvertebrate Biotic Index (CMBI) is a simplified version of the Hilsenhoff Biotic Index (HBI), which is used by the WDNR for laboratory analysis. Nineteen streams were sampled in the Spring and Fall of 2023 in Southeastern Wisconsin in accordance with the WAV protocols, and we will compare our field data to the laboratory data collected at the same streams by the WDNR.

Preliminary data analysis shows that the WAV Community Macroinvertebrate Biotic Index is not performing similarly to the HBI. We will be conducting further analysis of a larger, shared data set from the WDNR and WAV to see if the results remain consistent so that we can offer possible recommendations to improve the WAV program and best utilize the volunteers' efforts.

Integrating Biological Indicators into Watershed Management: A Case Study of Opportunities and Challenges

Laura Bates, University of Wisconsin-Madison, lmbates2@wisc.edu
Ken Genskow, UW-Madison
Anita Thompson, UW-Madison

With over half of rivers, streams, and lakes in the United States listed as impaired, nonpoint source pollution remains a primary concern among watershed managers. Addressing the complexities of nonpoint source pollution requires deliberate efforts from local stakeholders and community members. This study assessed the institutional landscape and stakeholder coordination in Wisconsin's Green Lake

* Student presentation.

Watershed to evaluate how biological data inform watershed management decisions and the related organizational capacity needs. A mixed-methods approach was employed, comprising content analysis, a diagnostic coordination framework for local stakeholders, and a conceptual framework for stakeholder engagement. Key challenges identified include inconsistent data tracking and organization, cross-jurisdictional coordination, socio-economic divides, and gaps in data collection and reporting. The conceptual framework's recommended process design features include diverse participant representation, dialogue exchange, knowledge co-production, skilled facilitation, and scalar fit. Implementing these ideal design features can promote consistent water quality monitoring, enhance analysis of ecosystem interactions and biological species, and incorporate a temporal component to achieve desired environmental outcomes in watershed management. The findings of this study provide guidance for watershed managers seeking to integrate biological data into efforts to meet nutrient reduction goals.

Assessing the Potential to Enhance Infiltration on Driftless Area Hillslopes and Reduce Downstream Flood Peaks

Eric Booth, University of Wisconsin - Madison, egbooth@wisc.edu
Luca Cecere, UW - Madison

Large flood events have increased in frequency in the Driftless Area of southwestern Wisconsin in recent years driven primarily by more frequent heavy rainfall events in a warming climate. Local communities and watershed organizations are keenly interested in exploring and implementing land management practices that are both effective and relatively likely to be adopted on a large scale. Decades of scattered research have provided evidence of the unique soil and geologic properties of the region's steep hillslopes – composed of coarse soils overlying fractured and/or permeable bedrock – that likely result in high infiltration and recharge rates relative to other parts of the landscape. While most of these hillslopes have been forested since the mid-20th century – a process that fundamentally changed the hydrology of the region by enhancing infiltration and recharge and reducing flood peaks relative to the early 20th century baseline of overgrazed and gullied pasture – there are opportunities to enhance the infiltration mechanisms through forest management, detention structures, and gully / forest road repair. Using LiDAR data across the Kickapoo and Coon Creek watersheds, we investigate the current state of these practices and structures and then map out locations where interventions may be most effective. Future research will focus on experimental runoff monitoring of different management practices and interventions to assess their efficacy during heavy rainfall events.

Revealing Flow Patterns Through Driftless Area Stratigraphy Using End Member Mixing Analysis and Catchment Monitoring: Wyalusing State Park, WI

Rachel Breunig,[*] University of Wisconsin - Madison, rachel.breunig@wisc.edu
Ken Ferrier, UW - Madison
Michael Cardiff, UW - Madison

Wisconsin's Driftless Area hosts layered bedrock that has been deeply incised, promoting complex flow patterns via perched aquifers and surface water-groundwater interactions throughout much of the stratigraphic column. We investigate surface and subsurface water chemistry as it relates to the shallow layered stratigraphy at Wyalusing State Park (Driftless Area, WI) to characterize flow paths, mixing of water sources, and chemical weathering. Our study area is a small (0.24 sq. km), steep headwater catchment where the main stream channel bisects Peoria loess, Galena, Decorah, Platteville, Glenwood, St. Peter, and Shakopee formations which exhibit heterogeneous chemical composition and hydrologic properties. Here, we apply End Member Mixing Analysis on geogenic cation content monitored in the stream, springs, and hillslopes of the study catchment over the course of a year to determine stream water source contribution and dominant flow paths through the catchment during both wet and dry periods.

[*] Student presentation.

Simulating Groundwater Recharge and Flow in the Fractured Dolomite of Kewaunee and Southern Door Counties

Anna Fehling, Wisconsin Geological and Natural History Survey, anna.fehling@wisc.edu
Maureen Muldoon, Wisconsin Geological and Natural History Survey
Kenneth Bradbury, Wisconsin Geological and Natural History Survey

Rapid groundwater infiltration and preferential flow paths in the fractured Silurian dolomite in northeast Wisconsin present challenges for understanding, protecting, and simulating the groundwater system. The fractured dolomite aquifer is extremely vulnerable to groundwater contamination from land-use activities, especially the disposal of human wastewater and dairy manure. We are developing models of groundwater recharge and flow for Kewaunee and southern Door Counties, Wisconsin using a conceptual hydrostratigraphic framework developed for central Door County. Groundwater recharge is being simulated using the Soil-Water-Balance model code, with zones of increased recharge where karst features in the shallow bedrock facilitate focused infiltration. The groundwater recharge, along with an improved geodatabase of well records and new bedrock surfaces, will be incorporated into a preliminary MODFLOW groundwater flow model for the region. In a future phase of the project, the model will be used to identify areas of uncertainty to target field testing and validation of the hydrostratigraphic framework. Understanding flow patterns in this sensitive aquifer will improve the ability of water resource managers to respond to water quality concerns.

Projecting Protective Potential for a PFAS-impacted Island: Hydro-geophysical Characterization of Stratigraphy beneath French Island, WI

Michael Cardiff, University of Wisconsin-Madison, cardiff@wisc.edu
Chris Zahasky, UW-Madison
Dave Hart, WGNHS
Moe Muldoon, WGNHS
Randy Hunt, USGS
Paul Summers, UW-Madison
Sam Kershner, UW-Madison
Lee Donahue, Town of Campbell

Firefighting actions at the La Crosse Municipal Airport has resulted in several PFAS plumes that have migrated beneath the Town of Campbell, WI (French Island), contaminating the shallow sand and gravel aquifer used currently by all residents for water supply. Because of this, as of the end of 2024, residents of French Island have been using bottled water for drinking for more than 3 years. The Town plans to develop a more sustainable long-term source for drinking water by tapping the deeper Mt. Simon sandstone aquifer – which is protected from contamination by the Eau Claire shale – via a high-capacity municipal well on the island that is cased within the upper aquifer. Our research seeks to understand the future behavior of existing PFAS plumes as the Town implements their municipal water system.

Vertical hydraulic gradients across confining units will be produced by pumping from the new municipal well, and this has the potential to drive deeper migration of PFAS if confining units are discontinuous. In this presentation we present results from integration of hydrogeologic, geophysical, and geologic observations used to constrain the deeper aquifer and aquitard units beneath French Island. We report on current conceptual models for subsurface hydrostratigraphy based on combined use of borehole logging, passive seismic data, and EM methods. This presentation represents work in progress, funded by the County of La Crosse.

Poster Session

Thursday, April 10, 2025

Simulating the Water Quality Benefits of Crop Diversification Under Historical and Future Precipitation Scenarios

Lourdes Arrueta, University of Wisconsin-Madison, arruetaanteq@wisc.edu
Margaret Kalcic, UW-Madison
Jay Martin, The Ohio State University
Asmita Murumkar, The Ohio State University
Vinayak Shedekar, The Ohio State University
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Phosphorus (P) loadings from agricultural nonpoint sources have promoted the expansion and persistence of harmful algal blooms (HABs) in Lake Erie. Conservation practices are widely used as measures to reduce non-point source pollution from agricultural landscapes. The implementation of perennial crops, such as alfalfa (Medicago sativa L.), might reduce subsurface discharge and nutrient loads in tile drainage relative to annual row crops. However, climate change may counteract these benefits. Projections for the Western Lake Erie Basin suggest an increase in the amount and intensity of precipitation by the mid-21st century, potentially exacerbating nutrient losses and HABs. Therefore, the goal of this study was to assess how changes in precipitation may impact the effectiveness of alfalfa on subsurface discharge and nutrient loads (nitrate and dissolved reactive P) using a field-scale calibrated Soil Water Assessment Tool (SWAT) model. To achieve this, we compared simulated subsurface discharge and nutrient losses from crop rotations with and without alfalfa under a historical precipitation scenario and three potential future precipitation scenarios. Results from this study suggest that alfalfa will provide robust reductions of subsurface discharge and nutrient loads under historical and elevated precipitation conditions, although these reductions may not fully offset the potential increases in discharge in nutrient loading that may be expected in a future climate.

Beyond Wellhead Protection: How Can Research and Collaboration Advance Source Water Protection?

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Source Water Protection (SWP) is a critical component in protecting groundwater resources, extending beyond the statutory boundaries of Wellhead Protection (WHP). This poster explores these two concepts and highlights the limitations of current approaches. Key issues include resource and policy limitations, lack of key groundwater data, inadequate source water protection delineation methods, limited public education and awareness, and insufficient integration of existing programs. Case studies from across Wisconsin illustrate the opportunities for collaborative and innovative strategies to advance SWP efforts. Examples from counties with growing interest, such as Pierce and Marathon, as well as initiatives like National Water Quality Initiative and private well testing programs, serve as indicators of

a positive change. By inviting feedback and engaging Wisconsin's scientific community, this work aims to stimulate discussions focused on exploring integrated approaches and research-backed methodologies, along with funding opportunities to support SWP efforts. With the goal of improving policy and resource management, we strive to develop an integrated, data-driven strategy that goes beyond minimal regulations, creating a more comprehensive framework for the protection of groundwater and public health.

Assessing the Impact of Groundwater Level Changes on Metals Contamination

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Many metals are naturally bound within aquifer materials and remain stable under undisturbed conditions. Aquifer drawdown can lead to the exposure of these materials to oxygen, which in turn, can trigger the release of bound metals through oxidation. The extent of metals mobilization during aquifer drawdown is poorly understood, and the primary goal of this study is to evaluate the difference in metals leaching from aquifer materials under oxic and anoxic conditions. To achieve this objective, batch leaching experiments were conducted in a set of serum bottles to evaluate metals release rates from well cuttings under different redox conditions. Well cuttings were added to a synthetic groundwater, and the headspace gas was purged with air for oxic experiments and nitrogen gas for anoxic experiments. Samples were collected for trace metals over four months. Results indicate that aqueous iron is elevated in anoxic experiments, confirming expectations. Nickel and cobalt increased over time in oxic experiments, but not anoxic experiments, and negligible arsenic was observed over the experimental timeframe. This study provides initial results that support an improved understanding of the sequence and timing of metals release from oxidized aquifer sediments. Findings from this study will inform the development of effective groundwater management strategies, ensuring the sustainability and safety of water resources in the Fox Cities area.

An Evaluation of Drinking Water Quality in Rural Eau Claire County

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To better understand the groundwater quality in rural Eau Claire County, we have collected water samples from 244 private water wells from June 2023 through December 2024. Water samples were tested for nitrate, coliform and e. coli, hardness, and a variety of metals, including arsenic, lead, copper, and manganese, at the Eau Claire Public Health Laboratory. This adds to the existing water quality information in the Eau Claire City-County Health Department database. We also used all available well construction logs to identify well depth and geologic information to evaluate spatial patterns associated with groundwater contaminants.

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[*] Student presentation.

In 2018 the Eau Claire County Groundwater Advisory Committee outlined recommendations in the "State of the Groundwater Report," including systematic private well testing, identifying regions of greater risk for groundwater contamination, and reviewing ordinances and regulations for groundwater quality protection based on water quality data.

This project was designed directly in response to the report recommendations. While approximately 9000 private wells provide drinking water to 25% of the Eau Claire County population, most wells are rarely tested. Factors contributing to undertesting include financial burden or lack of educational materials that fit individual reading level or language needs. This project was supported through a county-distributed American Rescue Plan Act grant to support environmental public health in rural communities.

Expanding the Hydrogeologic Context of Wells Showing Highly Variable Nitrate Concentrations in Western Wisconsin

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Nitrate contamination of groundwaters across Wisconsin is concerning for public health and local economies. In western Wisconsin a farmer-led watershed council, the Western Wisconsin Conservation Council (WWCC) has collaborated with the University of Wisconsin River Falls to monitor nitrate concentrations in member wells since 2018. Wells are tested 1-4 times per year depending on the behavior of nitrate concentrations. Average nitrate concentrations are above the 10 mg/L standard in over 40% of monitored wells. Wells with higher nitrate concentrations also tend to exhibit a greater degree of variability in concentrations through time. The large changes in nitrate concentrations in some WWCC wells suggests that they may be receiving inputs of younger water and therefore could be more sensitive to land use practices in the surrounding area. In this study we conducted 4 rounds of testing on a subset of 4 wells from the WWCC network in August 2024. Selected wells had elevated and/or highly variable nitrate concentrations. In addition to standard parameters (temperature, pH, specific conductance, and nitrate) we measured samples for major elements, nitrogen and phosphorus containing pesticides, and neonicotinoids. Calcium, magnesium, sodium, and silica varied the most across the 4 wells suggesting differing aquifers and or water source. We also detected neonicotinoids in 2 of the 4 wells, which has not yet been reported in the literature for western Wisconsin.

City of Abbotsford Nitrate Reduction Project

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The City of Abbotsford uses 24 wells and 3 treatment plants to provide water for ~2,500 people. This large number of wells for a city this size is due to the unique geology of central Wisconsin. Given the limited availability of groundwater, protecting water quality is critically important.

* Student presentation.

Sampling of individual wells by the city identified wells with high nitrate levels. Three of the wells are located adjacent to a 17-acre agricultural field owned by the Abbotsford School District. The city and the school district transitioned the land out of agricultural production and planted native vegetation and trees.

To evaluate the effectiveness of the land use conversion at reducing groundwater nitrate levels, the three municipal wells are monitored monthly. In addition, the Wisconsin Department of Natural Resources (DNR) contracted with the Wisconsin Geological and Natural History Survey (WGNHS) to install four shallow water-table wells and one deep piezometer to better define local hydrologic conditions. The WGNHS, in partnership with DNR, Wisconsin Rural Water Association, and the City of Abbotsford, has involved school staff and students in this process and plans to support the school district in incorporating groundwater-related activities into the classroom.

This project can help determine the effectiveness of land use change on nitrate reduction in groundwater and inform future decision making for the City of Abbotsford as well as communities in similar situations.

Exploring Chloride Trends in Wisconsin Lakes and their relationship to Road Salt Usage

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Elevated chloride levels in Wisconsin lakes can have negative impacts on plant communities, aquatic life, surface water and groundwater. This study analyzes trends in chloride data over approximately 15 years as an indicator of road salt contamination in dimictic lakes across Wisconsin. We also investigated seasonal differences in chloride levels and changes in chloride concentrations based on lake type. Water samples were collected by lake association groups and property owners during spring and fall turnover and tested for a variety of analytes including chloride. Lakes were situated in both populated and rural areas in the glaciated regions of the state. Our preliminary results indicate increasing chloride levels in lakes located in more densely populated regions, where road salt use is more widespread. As a next step, we would like to conduct further research on the impacts of warming winter temperatures on chloride levels in Wisconsin lakes. With this work we hope to highlight the need for better road salt management practices.

Biogeochemical Processes Controlling Geogenic Contaminant Transport and Transformation in a Hydrocarbon Contaminated Aquifer

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* Student presentation.

Hydrocarbon mixtures that reach the subsurface have a large capacity to donate electrons, leading to modifications of the redox chemistry of the aquifer. The resulting changes associated with organic contaminant spills can result in reductive dissolution of metal (hydr)oxides, and subsequent mobilization of geogenic contaminants to groundwater, particularly those with strong sorption affinity to Fe(III) and Mn(IV) (hydr)oxides. The objectives of this research are to elucidate biogeochemical processes that control the deposition of dissolved Fe(III) and Mn(IV) (hydr)oxides in the Tunnel City Group, to locate those processes within the established redox environments of the contaminant plume, and to generate a reactive transport model of these processes. Groundwater samples from a contaminated site in Cottage Grove, Wisconsin will be analyzed and laboratory leaching studies will be conducted to investigate contaminant mobility mechanisms. This research will lead to the quantification of potential mobilization, transport, and sequestration of Ra, As, Sr, Ba, and U in the Tunnel City Group. Results will provide guidance to water quality managers and regulators on the sources of geogenic contaminants in the Midwestern Cambrian-Ordovician Aquifer System (MCOAS) in Wisconsin.

Towards Open and Reproducible Groundwater Modeling: Lessons from Real-World Applications

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Environmental models are invaluable decision-making tools, but model development is time consuming and subject to changing data and priorities. The effort required to manually incorporate new data or revise conceptualizations can disrupt the modeling process and delay progress, impeding the use of the model to make time-sensitive decisions. In addition, without clear documentation of model development decision points, errors can easily go unnoticed. We can overcome these challenges by using open-source tools within a repeatable workflow. Here, we present several repeatable workflows that support groundwater resource decision-making, including a risk-based source water protection analysis and the optimization of a proposed groundwater contamination remediation system. We sought to make these workflows transparent and open, applying open-source tools (such as Flopy, PESTPP, Snakemake, and more) and exploring ways to improve the accessibility and usability of the data, code, and models. We highlight some of the key advantages found using this approach, including the capacity to quickly and rigorously incorporate new data, test alternative hypotheses, and preserve a record of the modeling process. We also discuss some of the practical challenges we encountered, related to collaboration and reproducibility, and some of the strategies we used to cope with those challenges.

Anthropogenic Impacts on Painted Turtles (*Chrysemys picta*): Effects of Human-Derived Sounds on Nesting and Development

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As human populations grow, wildlife increasingly adapts their behaviors to survive in human-modified environments. Understanding these behavioral adaptations is critical for predicting and mitigating the impacts of global change on biodiversity. Painted turtles (*Chrysemys picta*) are an ideal model species for studying such phenomena due to their widespread distribution, long lifespans, and well-documented life histories. Building on prior research, I analyzed five years of historical camping data from the Thomson Causeway, a public campground and key nesting site, to assess how human activity impacts turtle nesting. I expect that an increase in occupied camping sites will correlate with a decrease in nesting female turtles. Additionally, I conducted an experiment to assess how anthropogenic sounds affected turtle nesting behavior and offspring development at Thomson Causeway using recorded sounds (nature, traffic, construction, and people talking) affect turtle nesting behavior and offspring development. I expect that turtles exposed to anthropogenic sounds will have shorter nesting times, higher levels of boldness behavior, and higher egg retention rates than the turtles exposed to nature sounds. I also expect to find that hatchlings exposed to anthropogenic sounds during development will have lower survival rates, and higher levels of boldness behavior, than those exposed to nature sounds.

Remote Sensing Analysis of Intercropped Cover Crops in Wisconsin Potatoes

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Wisconsin is the third-largest producer of potatoes (*Solanum tuberosum*) in the United States, with production concentrated in the Central Sands region. The region's sandy soils and reliance on irrigation pose challenges for nutrient and moisture retention, often leading to nutrient losses. A potential strategy to mitigate these losses is the use of cover crops in the furrows between potato beds. Intercropped cover crops can provide additional root biomass and structure, potentially enhancing nutrient and moisture retention. However, their impact on potato growth and yield requires further investigation.

This randomized block study evaluated the effects of intercropping barley, millet/oats, rye, and a combination of all three against a control (no cover crops) in two commercially managed potato fields. Cover crops were established in furrows after the final hilling. At the end of the growing season, data were collected on potato yield, cover crop biomass, and nitrogen retention. Drone-based imagery was used to assess crop health throughout the season, including NDVI, surface temperature, and evapotranspiration at three critical growth stages.

These findings will provide insights into the potential benefits and trade-offs of intercropping cover crops in potato production systems.

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* Student presentation.

Unraveling the Origins and Mobilization Mechanisms of Molybdenum in Southeastern Wisconsin Groundwater

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Molybdenum (Mo) is an essential nutrient; however, elevated concentrations in drinking water (>70 ppb) pose significant health risks. This study focuses on southeastern Wisconsin, where Mo concentrations are notably high, with ~30% of wells exceeding 70 ppb. While coal ash leaching from coal re-use sites was initially suspected as the primary contamination source, conflicting evidence suggests a geogenic origin.

Initial research into the geogenic origins of Mo in this region has suggested that Mo was mobilized from the Maquoketa Shale. Despite this hypothesis, analyses of the solid phase geochemistry remain non-existent. Moreover, Mo concentrations appeared to be higher particularly in groundwater extracted from depths of 0–200 ft, corresponding to glacial till and/or Silurian dolomite.

Our work investigates this geogenic hypothesis via analysis of Mo found in the solid phase from a core in the region; preliminary results from sequential selective chemical extractions suggest that carbonate dissolution may be a key process driving Mo release. To further elucidate Mo origins and mobilization mechanisms, this research also examines its co-occurrence with arsenic in the environment. By resolving the dominant geochemical processes, this work aims to inform strategies for mitigating Mo contamination in private wells across southeastern Wisconsin.

Detection of Pathogens and Fecal Microbes in Paired Large- and Small-Volume Water Samples

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For detection of waterborne pathogens, concentrating large volumes of water can improve analytical sensitivity. However, large-volume samples require specialized equipment, trained personnel, and long sampling times, making small-volume samples more feasible. We collected paired small- (1 L) and large-volume (mean, 1077 L) samples and compared detection of pathogens and fecal microbes. Large-volume samples were collected by ultrafiltration. Small-volume samples were collected as grab samples from private wells (n = 138) and as time-integrated samples from public wells (n = 183) and rivers (n = 14). Microbial detections for the large- and small-volume methods rarely coincided with each other. Large-volume samples yielded substantially more pathogen detections than small-volume samples in paired well water samples, whereas the number of detections for nonpathogenic fecal microbes differed less. Compared to groundwater, the difference between methods was generally less for surface water, where microbes occurred at greater concentrations. Concentration was also determined to be a significant factor when comparing recovery of microbes in small volume samples. Laboratory recovery experiments for both methods showed that losses of microbes during sample analysis did not account for the underperformance of small-volume samples. Depending on a study’s goals, setting, logistics, and expected microbial contamination, it may be sufficient to collect small-volume samples.

* Student presentation.

Predicting an Overlooked Arsenic Species in Wisconsin Groundwater Using a Random Forest Model

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Nearly two-thirds of Wisconsin (WI) residents get their drinking water from groundwater resources. However, arsenic (As), a geogenic contaminant, has been detected throughout the state with concentrations exceeding the EPA Maximum Contaminant Level of 10 μg/L being commonplace. Arsenic in WI is sourced mainly from oxidized pyrite which releases As-oxyanions; however, in the presence of free sulfur, thiolated species such as monothioarsenate (MTA), may form. Alarmingly, thiolated arsenic species are more mobile in groundwater compared to oxyanions and thus can accelerate drinking water contamination. Because this mechanism has not been considered in WI, we utilized the machine learning algorithm Random Forest (RF) to predict the presence of MTA in local groundwater. Our model was trained with a groundwater dataset from Bangladesh, representing the largest collection of MTA measurements. Analogous data for WI were acquired from the DNR Groundwater Retrieval Network. In a preliminary RF model, geochemical parameters were used to predict the presence of MTA, in a groundwater sample, with an 87.1% accuracy. Our model predicted MTA presence in 479 unique wells across WI. Further work will refine our predictions to inform a sampling campaign and measurements to confirm our model. This study represents the first time thioarsenic species have been considered in WI groundwater and will provide a valuable addition to the understanding of As mobility in WI groundwater systems.

Understanding and Predicting Groundwater-Driven Flooding at a Watershed Scale, Chequamegon-Nicolet National Forest

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The Shunenberg Creek watershed is an 80 square mile area with seepage lakes and disappearing streams but no surface water inlets or outlets. Above average precipitation from 2013-2020 and extreme rain events in 2018 led to unprecedented flooding at Pigeon Lake and other seepage lakes within this watershed. The relatively gentle slopes and permeable surface materials imply that surface water hydrology is driven primarily by groundwater behavior rather than surface runoff processes, and groundwater modeling is thus necessary to understand and predict future lake flooding, despite limited available well records from the region. In this presentation, we demonstrate the use of isotopic data and aerial imagery to constrain groundwatershed behavior where other data are lacking. By combining aerial imagery with elevation data, we inform water level targets and also reveal spatially varied sensitivity to water level fluctuations across the landscape. We traced the shorelines of 160 seepage lakes using images from 2010 and 2020. We also mapped the extent of drowned forested shoreline adjacent to each lake interpreted from the 2020 imagery. Results show that while some lakes experienced flooding comparable to Pigeon Lake (an 18 feet rise from 2010-2020), other lakes were virtually unaffected by high water. Local groundwater monitoring and stable isotope mass balance analysis at Pigeon Lake complement these remote observations by providing confidence in groundwater contributing areas.

* Student presentation.

A Single-Field SWAT Model Approach to Evaluate Improvements in Process Representation for Soil Moisture and Soil Temperature Dynamics

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The Soil and Water Assessment Tool (SWAT) is widely used by the scientific community and government agencies to evaluate the impact of land use and climate on hydrology. Many states rely on SWAT to determine phosphorus and sediment total maximum daily loads (TMDLs) for managing water pollution and helping them meet water quality targets. SWAT has limitations in simulating water and heat transport in frozen and partially frozen soils, and addressing them will improve its performance in cold regions (e.g., the Midwestern United States) for prediction of associated nutrient transport. Our previous work replaced an empirical soil temperature module in SWAT with physically-based equations to better simulate key hydrological variables (surface flow, tile flow, and volumetric water content) and nutrient exports in cold regions. This project applies the improved SWAT source code to simulate the hydrology of two fields across the Midwest region—one in Wisconsin and one in Ohio. We are investigating SWAT's simulation of soil moisture and temperature dynamics and corresponding edge-of-field discharge and nutrient loads through a rigorous calibration approach using high resolution in-field and edge-of-field monitoring data to assess the accuracy of the model. These findings will be scaled up to improve site-specific recommendations for best management practices that stakeholders can implement to enhance water quality across the Upper Midwest.

Investigating the Unique Hydrologic Dynamics of Wisconsin Solar Farms

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The hydrologic response of solar farms differs markedly from surrounding landscapes due to their altered land cover and modified microclimate. The presence of solar panel arrays redistributes precipitation, influences soil temperature and moisture regimes through shading, and ultimately changes the pathways and rates of runoff and deep percolation. As a result, the net effects on groundwater recharge, soil moisture, and evapotranspiration within solar farms can diverge significantly from adjacent, non-covered areas.

* Student presentation.

In this study, we present preliminary results from three solar farm installations in Wisconsin, each characterized by distinct soil types and site conditions. We continuously monitor groundwater levels, soil moisture, local meteorological parameters, and vegetation responses to quantify the hydrologic characteristics of solar farms under temperate climate conditions.

Our initial findings indicate that solar farms exhibit unique hydrological patterns that can have both beneficial and potentially adverse implications for local water resources and ecosystems. Although all three sites experience broadly similar climatic conditions, differences in soil properties appear to strongly influence their respective hydrologic responses. These early insights lay a foundation for a more comprehensive understanding of solar farm hydrology, informing future site design, management practices, and impact assessments.

WSLH Adoption of EPA 1633 and Continued PFAS Analysis Challenges

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Until the EPA published Method 1633 for analysis of Per- and Polyfluoroalkyl Substances (PFAS) in aqueous, solid, biosolids, and tissue samples by LC-MS/MS, the Wisconsin State Laboratory of Hygiene (WSLH) relied on an in-house isotope dilution method certified by the Wisconsin Department of Natural Resources. EPA 1633 is currently the only non-drinking water PFAS method that has been validated across multiple laboratories and offers a universal method. Additionally, "performance-based" method allows modifications, provided that all performance criteria (sensitivity, selectivity, precision, recovery, etc.) are met. Our lab has made several modifications to this method to reduce sample collection volumes, simplify the extraction process, and optimize extraction times. For aqueous samples, we reduced sample size from 500 mL to 250 mL, allowing for more efficient sample collection and extraction. For all matrices, the EPA method uses a manual extraction procedure. We utilize an automated procedure that allows us to forgo extract concentration and results in greater consistency. Extensive validation was performed that meets EPA 1633 method criteria with similar or lower method detection limits (MDLs). This method is being implemented in a research capacity across a broader range of organic matrices. Future work will involve expanding to other matrices, such as leachates and further improvements to reduce matrix effects are being explored.

Characterizing Spatial Dependency of Transport Parameters Utilizing Tracer Injection Wells

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Tracer-based transport tests typically ignore the breakthrough curve in the injection well due to the complicated flow field and incomplete recovery, instead relying solely on down-gradient wells to characterize the spatial dependency of transport parameters. However, utilizing the injection well breakthrough curve could offer additional data to improve characterization of transport parameters, particularly velocity and

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* Student presentation.

dispersivity; this utilizes the injection well to a fuller potential. To this end, field tracer tests were conducted in an unconfined aquifer where non-reactive solutes were injected into a well and monitored during natural-gradient conditions in the injection well and several down-gradient wells. The breakthrough curves were inversely modeled for velocity and dispersivity using MODFLOW and MT3D. Preliminary data analysis and modeling suggested that average linear groundwater velocity decreased with space, likely due to increased tortuosity. Mechanical dispersivity increased with space, again, likely due to increased tortuosity. This study demonstrated that utilizing injection well breakthrough curves can offer additional data, and when combined with modeling, can realize a fuller potential for characterization of transport parameters.

Establishing a Ridge and Swale Ecohydrological Observatory

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Ridge and swale complexes are series of shore parallel dunes (former beaches) and wetlands that developed due to changing Great Lakes water levels (GLWL). In Door County, WI these transition zones between the region's karst landscape and Lake Michigan serve as ideal locations to use dendrochronology to study the movement and storage of groundwater. The lake dominated variation in coastal groundwater paired with the availability of historical GLWL data and presence of ring forming trees such as Red Pine, White Pine, and Red Cedar allows us to use tree ring width as a proxy for historical groundwater levels. Our goal is to identify the impact of GLWL on groundwater and coastal forests. The Ridges Sanctuary in Door County, WI is the largest and most intact ridge and swale complex with thirty ridges that formed over the last 1,400 years spanning a kilometer from the current shoreline to the oldest ridge. We've installed 10 groundwater wells, one surface water monitoring station and have sampled and analyzed 40 White and Red Pine trees. Preliminary groundwater and tree ring analysis have shown differing groundwater response to precipitation and variation in tree growth among and along ridges. Future work at the Ridges Sanctuary will expand monitoring to additional swales, gather additional tree growth data, decipher the relationship between tree growth and groundwater levels, and map locations of trees susceptible to changes in groundwater extremes.

Quantification of Vadose Zone Processes in a PFAS-Impacted Aquifer: French Island, WI

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Several source zones of per- and polyfluoroalkyl substances (PFAS) are known to exist beneath the La Crosse Regional Airport on the northern portion of French Island, WI. The town of Campbell, WI, located on the southern and western portions of the island, faces contamination of their shallow drinking water aquifer due to the leaching of PFAS from the vadose zone into saturated groundwater. Because PFAS leaching to groundwater is highly dependent on unsaturated zone processes, this project seeks to better understand the dynamics of vadose zone moisture movement in the sandy soils beneath French Island. For this study, installation and use of a 1 meter SoilVUE10 TDR Probe helped characterize infiltration in

[*] Student presentation.

the region. This installation provides readings of volumetric water content at different depths to provide a granular understanding of how rainfall events stimulate recharge and potential PFAS movement from source zones. Using numerical models, we use SoilVUE10 data to estimate rates of recharge to groundwater over a season as well as the expected retardation behavior of PFAS within the unsaturated zone profile.

Spatiotemporal Influences on Phosphorus Transport in the Hyporheic Zone: Insights from Field Water Monitoring and In situ Column Experiments

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Elevated phosphorus (P) in surface water contributes to eutrophication, harming aquatic ecosystems, human health, and local economies. Hyporheic zones, where surface water and groundwater interact, are important reservoirs for P. In dam-controlled rivers, fluctuating water levels can disrupt hyporheic flow, potentially destabilizing P retention. This study investigates P fate and transport in the hyporheic zone of the Wisconsin River, north of Wisconsin Dells, where river stage fluctuations occur. Monthly porewater data show seasonal P concentration patterns, influenced by depth below water table and water chemistry. Sediment samples were analyzed for P bound to various phases and other geochemical and physical properties. Batch sorption experiments were conducted to assess P release mechanisms under varying geochemical conditions. Column experiments were then conducted to test the effects of river-groundwater exchange and transient redox conditions on P transport in in situ sediment cores. Results show that legacy P, along with surface-derived P, can be mobilized under reducing conditions during high river stages. Together, these findings help refine reactive transport models of P, providing a deeper understanding of the factors controlling P mobilization in the hyporheic zone. This knowledge has important implications for land and water management strategies aimed at mitigating eutrophication in dam-controlled river systems.

Writing Good Code for Robust, Inclusive and Efficient Water Resources Science

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Computer code is more ubiquitous than ever in water resources science, and the benefits of scripted workflows have been widely touted. But does any code improve a workflow? What does it mean to be reproducible? What is “good code,” and how do we write and share it efficiently? Does adopting “best practices” for code development come with its own set of challenges and barriers to inclusivity? At what point is it worth developing project code into a software package that can be readily tested, shared and maintained? How do we do that? This presentation will examine these issues in the context of real-world projects that seek to inform stakeholders. Strategies for writing robust, reusable and hopefully understandable code will be discussed, along with the basics of software packaging. A common theme is

[*] Student presentation.

that cognitive load—the effort used in our working memory—presents a fundamental challenge to scientific workflows. Good code reduces cognitive load by succinctly communicating workflow details one piece at a time, and abstracting details so we can see how the pieces fit together. Good code promotes inclusivity by being easier to understand and work on. Open science has enormous potential, but it's not always easy. Extra time and effort are required by everyone—not just authors but also by readers and collaborators to learn and keep up with new ways of working, and by the broader scientific community to develop standards that foster collaboration, and train new members.

Three-Dimensional Map of Nitrate in Groundwater in Wisconsin With Spatially Adjusted Random Forests

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Despite decades of attention, nitrate remains the most widespread groundwater contaminant in Wisconsin. Exceedances of the nitrate MCL are a major public health concern costing Wisconsin residents millions of dollars per year to avoid, mitigate, or remediate contaminated groundwater. Effective intervention and reduction of nitrate requires accurate distribution of nitrate in groundwater across Wisconsin. However, existing maps of nitrate contamination are mostly two-dimensional and often neglect spatial dependencies. This study combines random forests and kriging to create a three-dimensional nitrate distribution map for groundwater in Wisconsin. Random forest is a machine learning model that measures the influence of predictive variables for nitrate contamination and kriging captures the spatial dependency of nitrate levels. The model is trained using publicly-available groundwater nitrate measurements from 2014 to 2024 in Wisconsin and incorporates predictive variables such as land use, precipitation, soil drainage, concentrated animal feeding operations, static water levels, and well depth. Our model produces the predicted nitrate concentration at a given location in three-dimensional space and the model is validated by cross-validation. The resulting three-dimensional maps provide new insights about nitration contamination for local decisions makers and can inform the location and depth of new well installations or replacements to meet public health standards.

Drivers of algal abundance in stormwater retention ponds

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Algae blooms are a major concern in urban ponds for both overall water quality and pond aesthetics. Urban ponds often have algae blooms due to large stormwater inputs that carry nutrient rich sediments into the system. Management of urban ponds typically consists of routine herbicide applications with little consideration for potential effects on algae growth. Twenty urban ponds in Bloomington, MN were sampled from 2010 to 2024 as part of the city's stormwater management program. The drivers of algae assessed were total phosphorus, average monthly temperature, total monthly precipitation and herbicide applications. Chlorophyll-a values were used as a surrogate for relative algae abundance. The best model, as assessed by AICc, contained total phosphorus and average monthly temperature. Total

* Student presentation.

phosphorus explained 11% of the variance in chlorophyll-a while temperature explained an additional 1%. The results demonstrate that algae blooms are driven by nutrient loading rather than specific management activities such as herbicide application.

An Updated Potentiometric Surface for the Confined Sandstone Aquifer in the Northeast Groundwater Management Area of Wisconsin (2023-2024)

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Excessive use of aquifer water resources can cause a decrease in potentiometric surface, impacting water quantity and quality. The Northeast Groundwater Management Area (GMA) of Wisconsin is located in parts of Brown, Calumet, and Outagamie counties. In this GMA, two distinct cones of depression within the confined Cambrian-Ordovician sandstone aquifer have developed historically in central Brown County (northern cone) and near the Fox Cities (southern cone). Two cycles of drawdown and recovery have occurred within the northern cone, separated by a 50-year timespan, resulting from shifts from groundwater to surface water use by various municipalities. In contrast, continued long-term steady use of groundwater in the southern Fox Cities cone has led to an expanded and deepened cone of depression over the past two decades.

We compiled new static water level maps for 2023-2024 using well construction reports, well filling and sealing reports, municipal well data, USGS data, and known flowing artesian wells. Water levels in the northern cone have stabilized, and a smaller cone has developed in far northeastern Brown County. The southern cone is mostly stable, with water levels constant or rising in some cities and falling in others. We also present mapped areas showing locations where the confined sandstone aquifer was partially dewatered from municipal pumping cones, which could potentially mobilize arsenic and other metals.

Understanding the Role of Freeze-Thaw Processes on Contaminant Transport in the Vadose Zone

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Freeze-thaw cycles are common in cold climates, and can impact groundwater quality and recharge. The cycles create freezing and melting fronts that propagate into the vadose zone and cause spatial and temporal variations in water quality and recharge. These coupled hydrologic and thermodynamic changes drive a range of processes including enhanced capillary flow from cryosuction, solute quenching, and pore space expansion. While freeze-thaw cycles and the associated processes are frequent in areas like Wisconsin, a key knowledge gap exists in how the cryosuction process affects groundwater movement in the vadose zone.

[*] Student presentation.

To quantify the influence of freeze-thaw cycles, we created a 3D tank (Hele-Shaw cell) filled with glass beads that will undergo freezing and thawing. We predict that freeze-thaw cycles will create spatially localized zones that experience cryosuction, a process that increases capillary force, resulting in temporary upward fluid migration and likely increasing solute dispersion. We will add a dye tracer to the beadpack to track solute transport and monitor flow in the tank throughout the cycles. Time lapse photography will record movement of the dye as the melting/freezing fronts progress in different trials. Image processing will allow us to quantify the coupled tracer movement and cryosuction-driven flow. The results of this study will provide valuable insights into water quality and recharge of near-surface aquifers in areas that experience seasonal freezing.

Challenges of Mapping Hydraulic Head in a Multi-Aquifer Setting Using Domestic Wells

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Water-table mapping in Grant County is challenging because the region is characterized by varied topography and a complex multi-aquifer system with individual aquifers separated by leaky confining units. Local flow systems, with short groundwater flow paths, are common in the bedrock uplands, but perched systems may also exist beneath narrow ridges. In wider ridges, fully saturated conditions have developed. Static water levels from domestic wells indicate a wide range of hydraulic head values for wells in close proximity, but completed to different depths. A confounding factor is that many wells are screened across several aquifers and provide ambiguous head data.

To address these challenges, our approach is emphasizing:
•Defining areas where the Sinnipee flow system is present using a bedrock geology and locations of springs,
•Analysis of air photos and field visits to assess whether streams draining the Sinnipee Group are perennial or intermittent,
•Contouring the upper flow system using surface-water elevations and wells completed in the Sinnipee Group,
•Contouring the deeper aquifer using surface-water elevations and the shallowest well in a given area.
A poster will present a preliminary water-table map and cross-sections illustrating the interrelationship between geology, well construction, and hydraulic head. A main observation is that the elevations of perennial surface-water features are the least ambiguous data to use in drafting water-table elevation contours.

The Suppression of Wetland Plant Growth by Crayfish: Early Insights and Evidence

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Constructed wetlands are used to remove nutrient contamination and suspended sediment from agricultural runoff. Floating treatment wetlands are especially advantageous as they can adapt to changing flows and water depth, support native plant species, and facilitate wetland invertebrates. Research suggests that moderate aboveground herbivory may stimulate plant growth in terrestrial

* Student presentation.

systems, however, few discoveries have been made in regard to the potential effects of subsurface herbivory. This pilot study aims to provide insights into the potential effects of subsurface herbivory on water quality, plant growth, and subsequent sequestration of nutrients in floating mat plants and sediment. Wetland mesocosms were constructed and stocked with Calico Crayfish (*Faxonius immunis*), native Wisconsin wetland plants in floating treatment mats (*Leersia oryzoides*, *Asclepias incarnata*, and *Acorus calamus*) and emergent wetland macrophytes (*Phragmites australis* and *Typha angustifolia*). Preliminary data indicates that crayfish may suppress growth of both algae and emergent macrophytes, however no significant effect on the growth of floating mat plants or nutrient concentrations was detected. Nitrogen limitation in treatment tanks inhibited plant growth in floating mats, causing a lack of significant differences between treatments. We plan to optimize our study for next year by refining treatment plant mixtures and releasing the system from nitrogen limitation.

Investigating Potential Impacts of Groundwater Exchange on Manoomin (Wild Rice) in northern Wisconsin

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For generations, manoomin (wild rice) has been an essential natural resource for Indigenous communities across the Great Lakes Region. However, manoomin abundance has declined over recent years. The decline could be due to various factors, such as decreased water quality, pollution, recreational water activities, invasive species, and dams. One factor that has yet to be explored extensively is groundwater and its impact on manoomin growth. This project investigates groundwater flow and manoomin growth in four connected lakes in Three Lakes, Wisconsin. GLIFWC manoomin survey data was used to identify field sites with manoomin growth limited to one side of the lakes. Then, using locally collected field data and other existing data sources, we investigate the local water chemistry and groundwater exchange dynamics in the vicinity of these rice beds. The goal is to determine the relationship between groundwater and manoomin abundance by investigating water chemistry, characterizing groundwater data, and identifying groundwater inflow, outflow, and flow rate for each lake. Attempts to gather seepage meter and mini piezometer data failed due to mucky lake beds. Water samples were collected at sites with and without manoomin for water chemistry analysis. Conductivity and temperature data were collected via ProDSS meter. Repeat sampling is planned for future seasons to assess temporal dynamics of groundwater-surface water interactions that may affect manoomin growth and abundance.

Impact of Stream Restoration on Chloride Loading in Snow-affected Urban Watersheds

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Urban stream restoration is widely used to combat urban stream syndrome, yet its impact on chloride loading remains poorly understood. This study investigates how reconnecting streams with their floodplains influences chloride concentrations and mass discharge in restored urban watersheds affected by heavy road salt use. Monitoring data from inflow and outflow points of restored stream sections reveal that post-restoration chloride concentrations and mass discharge have nearly doubled, suggesting that groundwater

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* Student presentation.

may constitute a new and meaningful source of chloride. To better understand groundwater contributions, samples from monitoring wells along restored stream sections are being analyzed for chloride concentrations. This analysis will help characterize how groundwater interacts with surface water to influence chloride loading throughout the year. Additionally, comparisons with unrestored streams will clarify how restoration alters chloride transport and seasonal dynamics. These findings highlight potential unintended consequences of stream restoration on water quality. They underscore the importance of comprehensive, long-term monitoring and adaptive management strategies to mitigate chloride pollution in snow-affected urban watersheds, especially those that discharge into sensitive ecosystems.

Characterizing PFAS Transport in Unsaturated Soil Using Meter-Scale Column Experiments

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This study characterizes the subsurface flow of per- and poly-fluoroalkyl acids (PFAS) through the unsaturated zone using large partially saturated column experiments composed of sediment from Northern Wisconsin.

PFAS are a persistent environmental contaminant with potential to bioaccumulate and adversely affect human health due to their highly polar nature. The polar characteristics of PFAS also make partially saturated air water interfaces a controlling factor in the delay of PFAS contaminant transport. Air water interfaces are typically not accounted for in traditional groundwater models.

To address this gap, we conducted partially saturated column experiments using sediment from Rhinelander, WI. Various PFAS species were injected into the columns, with breakthrough and pore water sampling conducted to quantify retardation rates and plume behavior. Experiments indicate that increased saturation levels lead to expedited breakthrough. Sediment heterogeneity and grain size resulted in variable capillary pressures and water saturation gradients, influencing breakthrough timing. Other factors, such as salinity, and fluctuating water table levels, are also observed to influence PFAS retention.

Ultimately, these lab scale experiments aim to improve our understanding of PFAS infiltration in source zones, and the development of the groundwater models used for PFAS remediation and research.

Surface Water Quality in a Restored Wetland

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Surface water quality is a concern in natural areas. Contamination of surface water can negatively affect plant and wildlife health causing management of contaminants to be vital. This study took place at Hawthorn Hollow, a nature sanctuary and arboretum, located at 880 Green Bay Road, Kenosha WI, 53144. Hawthorn Hollow serves as an 88-acre nature sanctuary for the biodiversity in the area and it is

* Student presentation.

characterized by its farmland surroundings. This work was done as a Community-Based Learning project through the University of Wisconsin Parkside.

With the surrounding farmland, contaminants like phosphates, nitrates, sulfates, and chloride can infiltrate the surface water in the area. Elevated contaminant levels can negatively impact aquatic ecosystems. Because of this, beginning on May 6, 2018, Hawthorn Hollow began a remediation project with the goal of rerouting agricultural runoff to a series of micro-basins before draining into the Pike River. The goal of our research was to evaluate the success of Hawthorn Hollow's remediation work by testing different locations around the restored wetland area. Samples were collected at four different surface water bodies around the site and analyzed for various contaminants caused by agricultural runoff. Based on the results in comparison with surface water standards, various mitigation techniques were suggested. As a nature sanctuary, understanding these dynamics is critical to protecting the site.

Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water in Rural Eau Claire County

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PFAS are a collection of contaminants, widely used, and have been coined as "forever chemicals" due to their long-lasting nature in the environment. Impacts on human health are thought to be associated with the development of cancers, thyroid issues, and reproductive issues.

In July 2021, PFAS were identified in the Eau Claire municipal well field (northwest Eau Claire County), thought to be linked to the use of firefighting foam. In 2023, PFAS were detected in exceedance of regulatory recommendations in several private wells in rural southwest Eau Claire County, leading to county-wide systematic testing of select private wells in collaboration with the Eau Claire City-County Health Department. Private wells were selected based on land use practice, homeowner permission, and availability of a digital well construction log. A public service announcement was also released by the Health Department to facilitate broadscale testing across the county, not limited by land use. Between June 2023 and December 2024, student researchers at UWEC sampled 97 private wells for PFAS. Samples were analyzed at the Wisconsin State Laboratory of Hygiene for the 33 PFAS in the Wisconsin Expectations document. Approximately 30% of the samples collected during that time showed a PFAS detection, with 8% exceeding the EPA proposed limit of 4 ppt for PFOA and PFOS combined. 2% exceeded the Wisconsin Hazard Index.

* Student presentation.

A Multi-Marker Assessment of Sewage Contamination in Streams Using Human-Associated Indicator Bacteria, Human-Specific Viruses, and Pharmaceuticals

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Human sewage from leaking sanitary sewers or overflows contaminates water with nutrients, pathogens, and chemicals. Contaminants and sewage indicators are measured to assess water quality but have variable utility for detecting sewage contamination. We measured microbial (n=21) and chemical (n=106) sewage markers in five-day composite water samples (n=98) at two streams in Milwaukee (Underwood Creek, UW; Menomonee River, MC) from 2017-2019. Five sewage markers were consistently detected, including microbial (pepper mild mottle virus, human Bacteroides, human Lachnospiraceae) and chemical (acetaminophen, metformin) markers. These markers were used to evaluate temporal patterns of contamination. Estimates of in-stream sewage pollution varied across markers by up to two orders of magnitude, but four of five sewage markers indicated that UW had a lower sewage proportion than MC (UW = 0.0025-0.075%; MC = 0.013-0.14%). Chemical markers were correlated and yielded higher estimates of sewage pollution than microbial markers, which exhibited greater temporal variability. Transport, attenuation, and degradation processes influence chemicals and microbes differently, resulting in variable sewage contamination estimates. Given the variety of human and ecological health effects from sewage contamination and the range in sewage contamination estimates from different markers, assessing multiple lines of evidence from a suite of markers is a valuable technique to aid management decisions.

Evaluating Winter Runoff Estimation in the Wisconsin Phosphorus Index

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The Phosphorus Index is a tool used to assess how vulnerable agricultural fields are to phosphorus loss. In Wisconsin, the Phosphorus Index (WPI) has been integrated into the SnapPlus software to estimate phosphorus loss and improve nutrient management planning for croplands. During the winter, there is significant phosphorus loading to streams and lakes, contributing to water quality degradation. However, there are limitations in how runoff volume from snowmelt and rainfall on frozen and thawing soils is estimated in SnapPlus. The accuracy of this volume is crucial for calculating dissolved phosphorus loss in the WPI and identifying fields at high risk for winter runoff. To address this, the WPI has implemented an updated procedure for calculating winter available water and snowmelt event runoff using an adjustment of the runoff curve number method. The goal of this study is to evaluate the

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accuracy of the adjusted method in predicting winter runoff compared to measured data. Data collected from Discovery Farm fields equipped with edge-of-field surface runoff monitoring are being used for comparison. Identifying crop and field conditions that are not accurately represented by this adjustment will contribute to future improvements of the WPI. This will allow Wisconsin farmers to more effectively manage nutrient application and reduce phosphorus loading to nearby surface waters.

Assessing Distribution Uniformity with UAVs in California Almonds

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Woody perennial crops, such as almond orchards in California's Central Valley, require 104 cm annually to meet irrigation needs. This high crop-water demand in a region also undergoing aridification presents a unique challenge for growers and regulators. Irrigation Distribution Uniformity (DU) is an important assessment for monitoring the performance of irrigation systems. Frequent and accurate assessments of DU help conserve water by evaluating irrigation systems and revealing areas of a field where irrigation is working as it should or if adjustments need to be made for a more efficient system. This assessment is important to run periodically to monitor sprinkler and emitter damage, but the ground-based methods, such as the catch-can method are time and labor consuming. Because of this, up to 66% of nut orchards in CA's Central Valley may have suboptimal DU. The objective of this project is to assess DU using Unoccupied Aerial Vehicle (UAV) data. There are remote sensing tools for mapping evapotranspiration (ET) and crop water stress using both satellites and drones, but these techniques have not been applied to assigning a DU coefficient on a field scale. This study aims to compare ET uniformity with a ground-based DU test in two almond orchard sites in California's Central Valley . The results of this study will help automate DU assessment using drones for almond orchards, which would encourage more frequent irrigation system assessments and water conservation.

Impacts of ADAF on PFAS Transport in Groundwater Systems

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Per-and polyfluoroalkyl substances (PFAS) are persistent environmental contaminants with known adverse human and ecological health effects. Airports are recognized as substantial sources of PFAS,

* Student presentation.

largely through aqueous film-forming foams (AFFFs) for firefighting and training activities. This study investigates the potential impact of aircraft deicing and anti-icing fluids (ADAF), commonly used in large quantities in airports, on the transport of PFAS through groundwater systems. A series of column experiments were conducted using soil collected from a firefighting test area (FTA) located in Dane County, Wisconsin. The columns were wet packed with prepared soils and groundwater (with and without Type IV anti-icing fluid) was injected into the columns. The effluents from the columns were collected over time and concentrations of selected PFAS in the effluent samples were measured using ultra-high-performance liquid chromatograph (UHPLC Shimadzu Nexera X2) coupled with an ultra-fast triple quadrupole mass spectrometer (UFMS Shimadzu LCMS-8060).Our results showed that airplane ADAF at environmentally relevant concentrations could significantly enhance the release of PFAS from contaminated soils collected from AFFF sites, and competitive adsorption was the likely underlying mechanism driving PFAS release. Our findings provide valuable insights into the environmental fate of PFAS in airport settings and inform management strategies for mitigating PFAS contamination in groundwater.

Characterizing Groundwater Susceptibility to Contamination in Burnett County, Wisconsin

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In 2024 the Wisconsin Geological and Natural History Survey assessed the groundwater resources in Burnett County in parallel with Quaternary geologic mapping at the 1:100,000 scale. Prompted by changes in land use, the primary goal was to identify areas where groundwater is vulnerable to contamination. Groundwater susceptibility maps are semi-quantitative and indicate the relative ease for water and contaminants to move from the land surface to the water table. Groundwater susceptibility was evaluated using an overlay process that combined four factors known to influence the vulnerability of shallow aquifers, including 1) recharge rate, 2) depth to the water table, 3) surficial geologic material, and 4) depth to bedrock. Classifications within each factor were ranked 1 to 5 based on whether the conditions provide aquifer protection (‘1’ for least susceptible) or allow for easy migration to the water table (‘5’ for most susceptible). Factor rankings were added together and divided by four, for a maximum score of five. Groundwater is most vulnerable in the north, along the St Croix River, and along stream valleys in the southeast part of the county. These locations generally correspond to areas with sandy surficial sediments, high recharge rates, and shallow depth to groundwater. Elevated nitrate concentrations (>2 mg/L) generally correspond to moderate or high susceptibility areas. Results will assist local/county governments with land-use decisions and groundwater planning.

Using Lumped Parameter Models to Quantify Climate and Anthropogenic Forcings on Static Water Levels in Fractured Low Permeability Bedrock Aquifers

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Madeline Gotkowitz, WDNR
Ben Degner, WDNR and UW-Madison

Aquifers in Marathon County Wisconsin are characterized by both bedrock depths and static water levels that on average are less than 20 ft below land surface. Bedrock throughout much of the county is composed of fractured low porosity and low permeability granite and metavolcanic rocks. These characteristics result in a surficial aquifer system with low water storage, often leading to very large water level fluctuations in pumping wells and strong water level responses in nearby wells. In this study, lumped parameter models—specifically Transfer Function Noise (TFN) models—are used to identify and quantify the influence of precipitation, snowmelt, evapotranspiration, and nearby well pumping on the static water level in different monitoring wells in Marathon County. These models accurately capture water level trends that have been measured with high frequency data loggers for over a year. Model results highlight the different timescales and magnitudes of response functions and compare these functions across different monitoring sites. These models provide an interpretable data-driven method to quantify the influences of climate and pumping wells on water levels in fractured low permeability aquifers. This approach can inform management of groundwater resources across much of northcentral Wisconsin, where food processing plants, dairy farms, and small villages seek more abundant, reliable potable water supplies.

Silver-Impregnated Activated Carbon: A Novel Approach for PFBS Adsorption

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Short-chain per- and polyfluoroalkyl substances (PFAS) contain fewer than seven carbon atoms, with perfluorobutane sulfonate (PFBS) being a widely used variant in industries such as aviation, automotive, firefighting, food processing, electronics, and textiles. Like other PFAS, PFBS is highly persistent in the environment and bioaccumulates over time, posing significant health risks, including cancer, developmental issues in children, hormonal imbalances, and reproductive disorders.
Adsorption is a well-established method for PFAS removal from water. This study investigates the effect of silver nanoparticle impregnation on the adsorption performance of activated carbon (AC) for PFBS removal. Four AC samples with varying silver contents were prepared to determine the optimal silver loading. The samples were characterized using BET surface area analysis and scanning electron microscopy (SEM). Results indicate that silver impregnation reduces the BET surface area of AC; however, it enhances PFBS adsorption capacity. The highest adsorption efficiency was observed at a silver content of approximately 2 wt%. These findings suggest that silver-modified AC could be a promising material for PFBS removal from contaminated water sources.

Friday April 11, 2025

Concurrent Sessions

Session 3A: Groundwater Quantity

Diving into Decades of Baseflow Data in Wisconsin's Central Sands

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Targeted baseflow data collection can provide useful insight into the hydrogeologic system, and baseflow data collected over an entire region in a variety of climatic conditions can be even more valuable. The University of Wisconsin – Stevens Point has been collecting near-monthly streamflow measurements during baseflow conditions since 2005 in various streams throughout the Central Sands, and since 2020 has also been collecting synoptic measurements along stream reaches during late summer months when flows are typically lowest and most likely to be impacted by pumping.

To compare trends in baseflow to precipitation and pumping, we delineated contributing areas for each stream reach using particle tracking in the steady-state regional Central Sands Lake Study MODFLOW model under a 'no-pumping' scenario. Preliminary analysis indicates that while precipitation within the basin is generally the biggest driver in baseflow trends, pumping impacts do have a discernible impact on baseflow, but those pumping impacts are not constant across time or space. This approach also allows us to identify "high recharge" subbasins in the Centrals Sands, as well as "negative recharge" subbasins, or areas where groundwater extraction exceeds recharge volumes.

When Should "Settled Science" Be Revisited? – Connecting Pumping and Streams

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The USGS Little Plover River study and movie in the 1960s was an effort to demonstrate the connection between groundwater withdrawals and streamflow depletion in the Central Sands region of Wisconsin. The science communication benefits of that work continue to resonate through the hydrogeology community. However, field observations can seem to contradict what the models used to regulate water use indicate about connections between irrigation pumping and streamflow depletion. An example of such a contradiction is checking depth to water before and after irrigation pumping and observing fast recovery which seems to indicate rapid replenishment. We, as members of the community making such models, have reached out to growers in Wisconsin and Michigan to work together to design a field experiment for observing the entire water balance of an irrigated field near a baseflow-fed stream. We propose to monitor all aspects of the water balance, including the aquifer, field, and stream, and to then fit multiple models to the data. The goal is to start at first principles, work together to design and implement the field study, and then bridge the gap to the models. We expect surprises because the principles in the analytical models used for streamflow depletion have not been revisited for many years.

Groundwater Sustainability Challenges in the Land of 10,000 Lakes... and Modified Riparian Water Rights

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Jennifer Rose, Minnesota DNR
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In spite of our reputation as a water-rich state, Minnesota is facing new challenges as groundwater use increases. We foresee more conflicts between competing groundwater users, more well interferences, and more pressure on groundwater-dependent ecosystems. The Minnesota Department of Natural Resources (DNR) is responsible for evaluating and managing groundwater appropriation permits. Permits for groundwater use cannot be issued unless the DNR determines that the use is sustainable to supply the needs of future generations, and the proposed use will not harm ecosystems, degrade water, or reduce water levels beyond the reach of public water supply and private domestic wells. The DNR faces the challenge of upholding these values in a real-world setting, where the climate is changing, groundwater demand is increasing, and resources are limited.

We describe case studies which demonstrate the groundwater challenges in a water-rich state with a water law system of modified riparian rights. Case studies will include the small, limited aquifers of western Minnesota where there is not always enough water to meet demand and the productive sand plain aquifers of central Minnesota where seasonally high pumping can impact streams and wetlands.

Water Bottling Withdrawals across Michigan and Wisconsin: Their History and Hydrologic Impacts

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Laura Schachter, U.S. Geological Survey, Upper Midwest Water Science Center
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Water bottling leads the bottled beverage industry in consumption across the United States but is often socially controversial. The U.S. Geological Survey (USGS) is studying the hydrologic impacts of water bottling across the country, and this study focuses on the Great Lakes region. In Michigan and Wisconsin, applications for water bottling permits have been challenged by the public for economic, cultural, and hydrologic reasons. This research seeks to understand the breadth of groundwater withdrawals for bottled beverages in Wisconsin and Michigan and quantify the impacts of a water bottling facility in central Michigan on groundwater levels and streamflow. According to the USGS national bottled beverages facilities dataset, breweries are the dominant type of bottled beverage facility in Michigan and Wisconsin, followed by water bottling, and most facilities use water from municipal supply. A two-dimensional, steady-state GFLOW model was used to quantify groundwater impacts in central Michigan and was calibrated to water-levels and baseflow using the Parameter

ESTimation software (PEST, v18). The analysis shows that the impacts are very localized, with withdrawals creating a small amount of drawdown and reducing headwater streamflow in the immediate vicinity of the pumping. When put in the context of other withdrawals in the model area, such as public supply and irrigation, pumping for water bottling is relatively small, making up approximately 5% of the total withdrawals.

Session 3B: Emerging Contaminants

An Assessment of Several Filter Membranes for Filtering Aqueous Per- and Polyfluoroalkyl Substances (PFAS) Samples

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Currently, most PFAS surface water samples are unfiltered and therefore represent both the "dissolved" and particulate-bond fractions of PFAS present in the water. To assess the differences between these two fractions, an appropriate filter would be both PFAS-free and able to filter particles without retaining PFAS on their membrane. In this study, we assess 47 mm diameter, 0.45 µm pore size filters of various matrix types. The matrix types of membranes were Glass Fiber Filter (GFF), Polyether sulfone (PES), Cellulose Acetate, Polypropylene (PP) and Nylon. Results across multiple extractions showed PES and GFF performed the best and retained very few PFAS, which was limited to select longer chains (>C8) and in the lowest percentages (<5%). Cellulose Acetate and PP retained long-chain PFAS and most Perfluoroalkane sulfonamido substances (e.g., N-MeFOSA, N-MeFOSE) at 10-15%. Nylon had the lowest performance, retaining the most PFAS and in the highest percentages (20-30%), so use of this type of filter could give artificially low PFAS concentrations in dissolved water samples due to their high PFAS-retention on the nylon membrane. One liter was also determined to be the ideal volume of sample for filtration, especially for samples with low amounts of particulates. Results from filtered field samples over three years will also be presented to demonstrate differences between dissolved and particulate-bond PFAS.

Statewide Assessment of Pesticides in Wisconsin's Streams and Rivers

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With strong support from the EPA, I conducted a statewide probabilistic survey of pesticide concentrations in Wisconsin streams and rivers using EPA's National Aquatic Resources Survey's (NARS) survey design tools. Intersects of all perennial streams and rivers, and all public roadways in the state, provided a sample frame of 47,000 candidate sampling sites. These sites were then stratified by Strahler stream order and upstream watershed land uses dominated by either vegetable cropping, corn and soybean production, urban green space, or a stratum excluding the previous land use classes. Single water column grab samples collected from each of 100 survey sites were analyzed using both gas and liquid chromatography to test for 378 different pesticides and transformation compounds. A total of 140 different compounds were identified. The number of different compounds detected at individual sites ranged from 9 to 92 ($\mu = 28$). Results of Random Forests modeling suggest watershed land use more strongly influenced the number of pesticide compounds found within streams than stream order. Given growing concerns about the toxic effects of neonicotinoid (neonic) insecticides on aquatic invertebrates, I used NARS data interpretation tools and toxicity benchmarks established by Morrissey et al. (2015) and estimated that 10% (4,200 mi.) of Wisconsin's perennial streams and rivers had neonic concentrations chronically toxic, and an additional 7% (2,940 mi.) acutely toxic to invertebrate life.

Addressing Groundwater Contamination Through Use of Biochar and Zero Valent Iron (ZVI)

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One major pathway for groundwater contamination by synthetic chemicals is through leaching from contaminated surface soil. 2,4-Dinitrotoluene (DNT), a widely used nitroaromatic compound in the manufacturing of munitions and polyurethane foams, presents a high risk for groundwater contamination due to its persistence and high mobility in soil. Mitigation of DNT in soil is integral to maintaining clean groundwater, given that approximately 25% of Wisconsin population relies on drinking water from private wells. To address this, we utilized biochar for immobilization of DNT, followed by abiotic degradation with zero valent iron (ZVI). The capacity to immobilize DNT was evaluated in four biochar from different feedstocks using batch experiments. The data obtained were correlated with the chemical composition of each biochar. The efficacy of ZVI for reductive degradation of DNT was evaluated using three grain sizes of ZVI at different ZVI:water ratios. Concentrations of DNT and its primary degradation product 2,4-Diaminotoluene (DAM) were monitored using liquid chromatography with ultraviolet detection. The proposed strategy utilizing biochar and ZVI demonstrated significant efficacy in preventing the leaching of DNT from soil. This approach presents a promising remediation pathway for soils contaminated with DNT. By treating the soil as the source, we can address both existing contamination and prevent future movement into groundwater.

Determining Sediment and Porewater Concentrations for Per- and Polyfluoroalkyl Substances (PFAS) from a Diversity of Sites in WI

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Although PFAS has been widely measured across WI in surface water, sediment concentrations are lacking for many sites, and porewater (PW) concentrations are often not taken. PW samples are important for the understanding of the partitioning, fate, and transport of PFAS in sediments and lakes, but also for dredging operations, where the PW from dewatered sediments is returned to surface water. PFAS concentrations in dewatered sediments should meet newly established WI PFAS surface water standards. In this study, we developed a sample centrifugation method at the WI State Laboratory of Hygiene to separate porewater samples from sediments. We sampled PFAS in surface water, sediment, and PW across a variety of waterbodies; Devils Lake, Lake Wisconsin, Lake Monona, Starkweather Creek, Fifth Lake and Snowden Lake. These sites represent a range of know PFAS surface water concentrations and diversity of PFAS sources. PFAS was measured in surface water, sediment, and PW, and relative partitioning coefficients were determined. The PFAS results was also interpreted in relation to the sites' various sediment characteristic such at Total Organic Carbon, percent volatile solids, and percent sand/silt/clay. In general, PFAS was higher in surface water relative to PW at each site and PFAS had higher partitioning to sediments with higher percent volatile solids.

* Student presentation.

Session 3C: Climate Change

Simulations of Past and Future Water Budget Components for Building Community Resiliency to Climate Change in Minnesota

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Climate change is predicted to bring many hydrologic changes to the Upper Midwest over the next 75 years. Minnesota communities need information about potential future changes in water budget components to make informed decisions and build resiliency. The U.S. Geological Survey is partnering with the University of Minnesota Climate Adaptation Partnership to apply the USGS Soil-Water-Balance (SWB) model to simulate potential groundwater recharge, evapotranspiration, crop water demand, and surface runoff statewide for a historical period (2000 to 2022) and two future periods (2040-2059 and 2080-2099). We are conducting parameter estimation and history matching of the model using runoff, base flow, and evapotranspiration data from 71 watersheds across the study area for the period 2000 to 2022. We will estimate water budget components for two Shared Socioeconomic Pathways scenarios (SSP245 and SSP585) using drivers from six CMIP6 downscaled climate models for the two future time periods. The statewide water budget simulations will be served out by the University of Minnesota to provide communities with accessible, localized information. Minnesota has a strong regional gradient in climate and the impacts of climate change are likely to vary considerably from the southern and western to the northern and eastern parts of the state.

Implications of Future Rainfall on Stormwater Infrastructure in Wisconsin

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Anthropogenic climate change is increasing temperatures and altering precipitation patterns leading to more frequent extreme precipitation events in Wisconsin. However, stormwater infrastructure relies on outdated NOAA Atlas 14 rainfall data, which does not account for future climate changes. As rainfall patterns intensify, current designs risk becoming inadequate. This study compares stormwater systems designed with NOAA Atlas 14 data to those using future rainfall projections from the Wisconsin Rainfall Project, an effort under the Wisconsin Initiative on Climate Change Impacts that provides updated rainfall data for infrastructure planning. Using a HydroCAD model, a hypothetical 10-acre urban drainage area was analyzed to evaluate pipe sizing, runoff, detention basin changes, and the green infrastructure interventions, such as depaving. Results show that end-of-century rainfall events will increase stormwater discharge rates and volumes, requiring larger pipe sizes and expanding detention storage. Existing detention basins may need retrofits to manage increased volumes and prevent downstream flooding. An evaluation of existing stormwater infrastructure projects at the University of Wisconsin–Madison reveals increased release rates under future rainfall that threatens current flood control measures. This research emphasizes the need for climate-resilient stormwater management to reduce flood risks and support sustainable development in Wisconsin.

* Student presentation.

Mapping, Modeling, and (Bio)Manipulation of Fish Lake's Groundwater Flooding Problem

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In flat areas with limited surface drainage, changes in recharge can have immense impacts on groundwater levels. In the Fish Lake Basin, a shift from historical oak savanna and tallgrass prairie to agricultural row crops paired with an increase in precipitation has led to a 5m increase in lake levels over the last 70 years. To further understand groundwater flooding we quantified historical extent of inundation, modeled 1-D plant-groundwater interactions to quantify deep drainage and partition the drivers of groundwater flooding, and investigated biomanipulation methods. Historical analysis showed surface water area increasing by 1.72 km2 between 1937 and 2021. Modeling Infiltration, root water uptake, and soil water dynamics showed that over double the amount of deep drainage (a proxy for GW recharge) occurs for agricultural row crops compared to forest ecosystems under the same climatic conditions. We used the relationship between recharge and lake level change to quantify groundwater outflow from the basin. The relationship between recharge and precipitation was applied to long-term precipitation records to partition the impacts of drivers on Fish Lake levels. Without historical land use change in the basin, lake levels may have seldomly increased prior to 1980, when precipitation significantly increased due to changing climate. Similarly, biomanipulation would slow current trends of increasing lake level, but would not lead to a significant decrease in lake levels.

Characterization of Oxythermal Habitat Across Upper Midwestern Glacial Lakes

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Cold-water fish species are important to Wisconsin and its residents culturally, economically, and ecologically. They are at immediate risk of a changing climate, given threats to their habitat conditions and availability as lake ecosystems become warmer and nutrient loading increases. Preferred oxythermal habitat conditions, cold water and high dissolved oxygen, are modulated by both year-to-year natural climate variability and long-term anthropogenic climate change conditions through in-lake and external forcings. In this project, oxythermal stress metrics were calculated leveraging a newly compiled dataset of temperature and dissolved oxygen profiles across Upper Midwestern glacial lakes. We then investigated how each metric has changed over time to understand if seasonality, severity, or duration of oxythermal habitat has shifted as a response to intensifying climate variability and/or climate change conditions.

* Student presentation.

Session 4A: Communication and Management

Are Scientists Engaging in Science the Public Cares About? Exploring Public and Scientific Discourse on Water Quality in a Water-Rich Landscape

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Community concerns about water availability vary depending on local economic, regulatory, environmental, and ecological considerations. In water-rich basins, water quality is often the focus of community concerns. As such, understanding community priorities in the context of water quality is crucial for informing scientists working in water-rich basins. We compiled over 6,500 local news articles (public discourse) and 190 scientific abstracts (scientific discourse) related to water-quality issues in the water-rich Illinois River Basin (ILRB) published between 2018-2022. We applied a Structural Topic Model (STM) to identify key water-quality topics in both datasets and explore the variability of newspaper topics geographically across the basin. Prevalent topics in both the public and scientific discourses were agriculture, drinking water quality, PFAS, and river ecosystem/fish. The scientific discourse focused more heavily on a wider range of agricultural issues, while the public discourse focused more so on water infrastructure, community development, and wastewater. Furthermore, the public discourse varied geographically across the basin, with agriculture being most prevalent in agricultural portions of the basin, and PFAS and surface-water quality being more prevalent in the Wisconsin region of the basin. These results indicate a localized focus on water quality within the public discourse that did not always align with scientific discourses.

Groundwater Governance Conversations in Wisconsin and EPA Region 5

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Freshwater convened 35 scientists, lawyers and government staff from local, state, Tribal, and federal institutions in Lac du Flambeau in Oct. 2024 to discuss groundwater governance and identify regional issues, current practices and strategies for the five-county area of Taylor, Lincoln, Price, Vilas and Oneida.Here, thin glacial sediment overlies fractured crystalline rock resulting in the lowest yields in the state. Participants included 5 Tribes, GLIFWC, WDNR, US Forest Service and Geol. Survey, WGNHS, WRWA, regional planning and county conservationist staff.

After dialog to build trust and respect, issues were brainstormed, categorized, and further discussed in breakout sessions. Data availability, communication strategies, legal structures and emerging issues formed high-level categories. Barriers to solutions were explored and although no issues were resolved by the end of day 2, many committed to taking next steps with new partners and wanted to meet again.

This is one of 4 conversations held in EPA Region 5 to elevate practices for equitable and sustainable groundwater use. Others were held Detroit regarding an aquifer shared across Michigan, Indiana and Ohio with the Nottawaseppi Huron Band of Potawatomi; in the SW Minneapolis suburbs where the

Shakopee Mdewakanton Sioux Community shares an aquifer with Scott and Dakota counties; and the NW Chicago suburbs, with the help of Chicago Metropolitan Area Planning. This work is funded by the Joyce Foundation.

From Secchi Depth to Swimmability: A Framework for Linking Metrics, Perceptions, and Valuation of Lake Water Quality

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In studies valuing improved water quality, recreation-based categories are commonly used to convey water quality conditions (e.g., suitable for swimming, fishing, and boating). These scales are typically linked to objective water quality metrics through expert assessments, allowing researchers to evaluate how changes in these metrics influence ecosystem service values. However, this approach is constrained by the limited translatability between objective scientific measures and subjective public perceptions. This study addresses this limitation by developing an ordered complementary log-log model to link objective water quality metrics with subjective perceptions of lake quality. Utilizing data from Wisconsin's Citizen Lake Monitoring Network, the analysis examines how metrics such as Secchi disk depth, total phosphorus, and chlorophyll-a affect the probability of a lake being perceived as: 1) unsuitable for swimming and boating, 2) suitable for boating but not swimming, or 3) suitable for both swimming and boating. By linking these perceptions to willingness-to-pay (WTP) estimates from ecosystem service valuation studies, this framework enables the translation of measurable changes in water quality into economic valuations based on public perceptions rather than expert judgments. This interdisciplinary approach integrates ecological data, public perceptions, and economic valuation, offering insights for enhancing freshwater management.

Incentivizing Household Water Testing in Farm Worker Housing

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Wisconsin is one of the top agriculture economies in the United States, especially in dairy production, which is heavily reliant on farm labor. Many Wisconsin dairy farms rely on foreign-born workers to make up the farm workforce and nearly half of Wisconsin farms provide housing to workers as an employee benefit. Drinking water sources near agricultural activity are susceptible to contamination from animal waste and farm chemicals, and these contaminants can pose health hazards to humans and livestock. Housing provided to farm workers can range from older stock to grouped housing (i.e. several mobile homes on a property) which may not be regularly tested for contaminants in the drinking water. This project sought to incentivize well water testing for farmers in six counties in Central and Western Wisconsin by providing no cost water testing for bacteria, nitrates, and water quality.

Incentivizing water testing for landowners, especially those with multiple properties by providing no cost well water testing encourages testing participation. Partnerships with county health and land conservation departments as well as agencies that provide bilingual health outreach and education improve outcomes for both access to testing and follow up education.

Session 4B: Groundwater Quality

An Evaluation of Multi-decade Groundwater Data from Atrazine Prohibition Areas in Wisconsin

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Atrazine is an herbicide commonly applied on crops such as corn and soybeans. A prolonged consumption of water containing high levels of atrazine is linked to liver, kidney, and heart damage, as well as increased risk of birth defects. Since the mid-1980's groundwater sampling programs in Wisconsin have detected atrazine in drinking water samples from private wells. The Wisconsin Department of Natural Resources established a groundwater quality standard of 3.0 ppb of atrazine and the sum three of its metabolites (collectively referred as Atrazine Total Chlorinated Residue, or TCR) in the early 1990's, and the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) began implementing a management strategy of creating prohibition areas – areas where the use of atrazine is not allowed – to address the problem. Today, more than 30 years since the first prohibition areas were created, there are 101 atrazine prohibition areas in Wisconsin, encompassing 1.2 million acres. Here, we present findings from three decades-worth of atrazine TCR concentration data collected from Wisconsin groundwater and associated trend analysis over time. We also present insights gained from more recent groundwater quality data collected from private potable wells located within atrazine prohibition areas. The goal of these analyses is to evaluate the effectiveness of atrazine prohibition areas as a regulatory tool for protecting Wisconsin's groundwater resources.

Groundwater Quality Monitoring at CAFOs: How DNR Makes Decisions

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The Wisconsin DNR is delegated WPDES permit authority from the federal government under the Clean Water Act. Wisconsin statute and administrative code dictates that all WPDES permittees, including CAFOs, must meet groundwater quality standards. Groundwater quality monitoring is the best tool for ensuring compliance with these standards, but must also meet the legal standard for reasonableness. I will explain how DNR makes determinations for monitoring requirements at CAFOs using available geologic, hydrogeologic, soils and groundwater quality.

Developing Safe-Drinking Water Supplies from Wisconsin's Aquifers

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2024 was a landmark year for ensuring safe drinking water with the establishment of standards for several PFAS compounds. As a result, many of Wisconsin's water utilities are exploring alternative water supplies because existing wells do not meet these standards.

The City of Prairie du Chien has long relied on the sand and gravel aquifer to meet their daily water demand of 1 million gallons, but two of their wells are not in use due to PFAS contamination. Underlying, confined bedrock aquifers provide an alternative supply and are protected from anthropogenic contaminants. However, trace minerals mobile under reducing geochemical conditions are often encountered along deep groundwater flow paths. Borehole geophysical logs collected in a 982-ft historic artesian well in Prairie du Chien identify the glauconitic Tunnel City Formation and shale facies in the Eau Claire Formation. Although total dissolved solids, iron, and radium were elevated in a water sample from this well, a well cased and grouted through the upper bedrock strata may produce good water quality from the Mt Simon sandstone. Another alternative is to blend waters from shallow and deep aquifers, but this approach requires significant changes to the City's distribution system. This example from southwest Wisconsin demonstrates that as water quality standards become ever more protective of human health, the quantity of potable groundwater available to Wisconsin's communities necessarily decreases.

Mineralogical Indicators of Groundwater Arsenic Contamination: Linking the Glacial Aquifers of the Upper Midwest United States to the Deltaic Aquifers of Southeast Asia

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Contamination of groundwater by geogenic arsenic (As) poses a significant public health threat worldwide. Understanding the factors responsible for the mobilization of As into groundwater is often limited by a lack of solid-phase redox characterization of the iron minerals to which As is sorbed. While iron minerals govern the solid-solution partitioning of As and can undergo redox transformations to release As, it has been challenging to compare processes responsible for As release in geologically distinct environments across the world. Furthermore, sampling locations have been biased toward contaminated environments or a few field areas, e.g. primarily in South and Southeast Asia. Here, we address two critical gaps in understanding of As solid-solution partitioning: (i) the paucity of solid-phase aquifer redox compositions related to measured aqueous concentrations of groundwater and (ii) the limited and qualitative links between geogenic As contamination in the deltaic aquifers and the glacial aquifers. In this synthesis of X-ray absorption spectroscopy data, we integrate iron and As spectroscopy spectra from the deltaic aquifers of the Red River Delta in Vietnam with those from glacial aquifers from the upper Midwest United States. We find that the redox status of sediments is similar across these geographically distinct As-contaminated aquifers, with implications for understanding biogeochemical mechanisms affecting water quality across these diverse aquifer systems.

Session 4C: Modeling

Watershed Response to Climate Forcing: Insights from the Trout Lake Watershed

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There is widespread agreement that future climates will tend toward warming; how such change affects aquatic systems such as cold-water fisheries is not well understood. In response, new capabilities for simulating heat transport simulation have allowed for some initial watershed-scale insights using synthetic watersheds.

Here we use a previously calibrated groundwater flow model for the Trout Lake Watershed and heat transport forcings and parameters from a published synthetic model to successfully approximate the lag of heat arrival to the water table. The amplitude of seasonal heat variation and amount of heat added to cold-water streams, on the other hand, was appreciably undersimulated. The amplitude can be more closely simulated by adjusting heat transport parameters; the lack of heat present in the streams cannot, however, suggesting the importance of non-groundwater related processes (e.g., solar radiation). There is general agreement between the overall watershed response to warming and the residence time distribution in the aquifer, but the location of sources and sinks within the watershed affect the local response – scales important for cold-water refugia. These simulations suggest that the effect of changing climate will not be expressed homogeneously in the watershed over space and time. Given the Trout Lake watershed is hydrostratigraphically relatively simple, such heterogeneity is expected to be exacerbated by more complex hydrogeologic settings.

Balancing Environment and Economy in an Agricultural Basin in Oregon: Moving Beyond Scenarios with Multi-Objective Optimization

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With rising temperatures and increasing frequency and severity of drought, water management in over-allocated agricultural basins is becoming ever more critical and complex. There has been growing interest in using hydro-economic models to forecast future conditions of farmer livelihoods and environmental flows in response to management scenarios. Scenario-based approaches allow for input from diverse stakeholders and subject matter experts, but often miss opportunities for more efficient or optimal solutions. This is because the solution space is limited by a few model runs of hand-picked management interventions, whereas combinations of considerations in optimization can point to counterintuitive but efficient configurations.

This study linked an evolutionary algorithm for constrained multi-objective optimization to an existing hydro-economic model of an agricultural basin in Oregon to explore the potential for efficiency gains from exploring more of the solution space. Overall, the optimization algorithm was able to find optimal solutions that balanced the competing objectives, leading to less profit loss and less spring flow loss when compared to the scenario-based approach, even when subject to water rights constraints. These results demonstrate the enormous potential for using evolutionary multi-optimization algorithms to increase efficiency in complex water management settings, for a nominal increase in effort when the hydrologic and/or economic models already exist.

Insights from a MODPATH vs MT3D-USGS Comparison of Groundwater Travel Time Distributions in the Wisconsin Central Sands

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Groundwater quality changes in wells and streams are lagged behind changes to land use due to groundwater travel times. Two contaminant transport methods were compared to assess differences in their simulated transit time distributions (TTDs) to streams and wells in the Wisconsin Central Sands. MODPATH was used to simulate advective groundwater flow with particle tracking, while age-mass was simulated with MT3D using a finite difference solution without dispersion to allow for direct comparison of the two methods. MODPATH appropriately simulates groundwater TTDs from the water table to surface discharge but is subject to inaccuracies at weak-sink well cells due to the grid discretization. MT3D better represents these weak-sink well cells since it removes mass in proportion to the prescribed pumping rate. However, MT3D treatment of weak-sink stream cells is not as accurate because mass should be removed from the cell top rather than the full cell volume. MT3D simulations of TTDs can also be confounded by the instantaneous vertical distribution of mass throughout recharge cells instead of at the water table surface. Both methods have strengths/weaknesses, with MT3D better representing weak-sink well cell behavior, and MODPATH better representing surficial recharge and discharge. Ideas for ameliorating weaknesses include grid refinement or analytical particle tracking within weak-sink well cells for MODPATH and the introduction of a thin water table layer for models using MT3D.

Adding MODPATH to the Groundwater Nitrate Decision Support Tool for Wisconsin Wells and Streams

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A nitrate decision support tool (GW-NDST) was developed to address nitrate transport from land to groundwater wells in Wisconsin. The published tool was designed to estimate the magnitude of nitrate leaching reductions needed to achieve concentration goals and the associated time lag to a well of interest, with groundwater time lags estimated from a machine learning (ML) model. The GW-NDST has been updated to allow users to choose between the original ML model or, where available, vetted numerical models for simulating groundwater transport and time lags. Use of numerical models

(MODFLOW & MODPATH) allows for more complex hydrogeologic settings and simulating the source of water to wells and streams, thus helping to answer the question of where contaminated water came from. Users can now evaluate how spatially different nitrate leaching rate reductions among “young-” and “old-water” contributing areas would influence simulated nitrate concentrations in wells. The introduction of numerical models also facilitates application of the tool for simulating groundwater nitrate loading into stream segments. Finally, the tool can aid in estimating source areas and advective lag times for general susceptibility assessments, such as potential PFAS contamination from an unknown source. Expanding the capabilities of the GW-NDST while maintaining a relatively simple user interface can enhance public knowledge of groundwater movement and time lags in areas of interest to Wisconsinites.

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