



ANNUAL REPORT

July 1, 2013 – June 30, 2014

Submitted by:

The Center for Water and Society Advisory Committee

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2 CWS Mission Statement

Statement of Purpose. The purpose of the Michigan Technological University Center for Water and Society (CWS) is to enhance the ability and the visibility of MTU personnel to solve water-related problems of local, regional, and international interest.

Mission Statement. The mission of the CWS is to promote research, education, and outreach in all disciplines at Michigan Tech related to water issues. The objectives of the CWS are

- to serve as a focal point for instructional and research activities in water-related fields and water-related outreach activities across the Michigan Tech campus;
- to provide an organizational structure that supports continuing growth in water-related fields and outreach activities and encourages interdisciplinary projects;
- to support interdisciplinary graduate and undergraduate education and research in water related fields;
- to pursue external funding opportunities to support these objectives and to facilitate CWS participating faculty to obtain external support; and
- to enhance the visibility of MTU and CWS as centers of expertise and cutting-edge research in water-related fields.

CWS has 59 faculty/staff participants and 56 current graduate student and 16 undergraduate student participants in 11 units across the Michigan Tech campus (see Appendices 1 and 2). CWS is governed by a director and advisory committee (see Appendix 3).

The most recent renewal proposal (renewed through December 31, 2015) which includes a five year plan can be viewed at:

http://www.mtcws.mtu.edu/pdf/CWS_Renewal_through_Dec2015.pdf

3 CWS Year in Review

3.1 Seminars & Symposia Subcommittee Activities

(Members: Rod Chimner, Emma Norman, Joan Chadde, Noel Urban)

The primary activity of the Seminars & Symposia Subcommittee was the planning and organization of CWS seminars. The largest CWS event takes place on or near World Water Day, March 22 of each year. The World Water Day events include a student poster competition, a guest lecturer, and a CWS social.

This year's World Water Day events included a "Let's Talk About Water" event sponsored by the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) through a grant from the Johnson Family Foundation. The 2014 World Water Day theme was the 'Nexus of Water and Energy'. To incorporate this theme with Michigan Tech's World Water Day events, the topic of hydraulic fracturing was the focus for the film presentation of Gasland, invited lecturers and panel participants, Dr. Wayne Pennington (Michigan Tech), Dr. Robert Howarth (Cornell), Frank Ettawageshik (United Tribes of Michigan). The following events were all part of Michigan Tech's World Water Day activities:

3.1.1 World Water Day Poster Competition – March 26, 2014

The World Water Day Poster Competition was held in the Dow lobby area. Posters were judged individually by CWS faculty in the early afternoon, and posters were on display for the rest of the day and evening.

The World Water Day Poster competition included Original Research and Coursework/Informational award categories. The posters are presented in PDF format on the CWS web page at:

http://www.mtcws.mtu.edu/2014CWS_Posters.html

The awards for the Poster competitions are as follows.

Original Research Posters

1st Place Award (\$250)

Jennifer Fuller

["Developing a Sustainable Treatment Solution to an Urgent Problem: Synthetic Hormones in the Water Cycle"](#)

2nd Place Award (\$150)

Marcel Dijkstra

["Ecosystem function in Lake Superior: Impacts of an episodic climate anomaly"](#)

3rd Place Award (\$100 - tie)

Alex Collins

[“Inter-annual Differences in the Water Use of Mature Sugar Maple in Response to Experimental Warming and Irrigation”](#)

3rd Place Award (\$100 - tie)

Ashley Coble

[“Nutrient Limitation and Temporal Variability of Dissolved Organic Carbon Mineralization in a Lake Superior Tributary”](#)

Coursework/Informational Posters

1st Place Award (\$250)

Mary Moritz

[“The Barro Blanco Dam: 30 years of engineering and politics”](#)

2nd Place Award (\$150)

Jennifer Fuller

[“Performance Evaluations on the Removal of Synthetic Hormones by Advanced Oxidation Processes in Drinking Water Treatment”](#)

3rd Place Award (\$100)

Laura Gallagher

[“Pseudo-steady State Evaluations on the Removal of n-propylbenzene from Water by Aqueous Phase Advanced Oxidation Processes”](#)

3.1.2 World Water Day Lectures and Events

Green Film Series – Gasland, March 20, 2014

Dr. Wayne Pennington, March 24, 2014

Interim Dean of the College of Engineering, Michigan Tech

Professor of Geophysical Engineering

Geological & Mining Engineering & Sciences

“Nuts and Bolts of Unconventional Oil and Gas Development: including all you might like to know about the technology and practice of hydraulic fracturing”

Environmental Engineering Seminar

Dr. Robert Howarth, March 26, 2014

David R. Atkinson Professor of Ecology & Environmental Biology, Cornell University

“Gas from shale hydrofracturing: Environmental consequences of this new and rapidly developing phenomenon”

Evening lecture with reception following where attendees could also view the student posters

Panel Discussion on hydraulic fracturing, March 27, 2014

Moderator: Dr. Emma Norman, Social Sciences, Michigan Tech

Panelists:

Mr. Frank Ettawageshik, Executive Director, United Tribes of Michigan

Dr. Robert Howarth, Cornell University
Dr. Wayne Pennington, Michigan Tech
The panel discussion was followed by a social

Mr. Frank Ettawageshik, March 27, 2014
Executive Director, United Tribes of Michigan
“When can we drink the water? Reflections on Indigenous water rights and sovereignty”
Guest lecture in Emma Norman’s World Resources Development class

Water's Edge Art Exhibit, March 20 – April 23, 2014
Great Lakes Research Center (1st, 2nd, and 3rd floors)
Featured Artists: Amy Arntson, Joyce Koskenmaki, Bonnie Peterson

3.1.3 Other CWS Seminars and Lectures

Jonathan Cole, October 17, 2013
Cary Institute of Ecosystem Studies, Millbrook, New York
“Terrestrial support of aquatic consumers in a large river, the Hudson”

Norman Yan, September 4, 2013
Fellow of the Royal Society of Canada
Department of Biology, York University, Toronto, Canada
“The widespread threat of calcium decline for Canadian Shield lakes”

Tom Powers, November 5, 2013
University of Montana
“The Economic Anomaly of Mining: Treasure and Tears”

Erik Brown, March 4, 2014
Professor of Geoscience at the Large Lakes Observatory, University of Minnesota Duluth
“The sedimentary record of Lake Malawi, East Africa: Stories of interactions between humans and their environment”

Approved funding to support visits by Celia Chen (*The fate and effects of metal contaminants in aquatic food webs*) and Peter McIntyre (*Ecology and conservation in rivers and lakes around the world*). These visits will occur in Fall 2014.

3.1.4 GLRC/CWS Water Brown-bag Lunch Series

GLRC and CWS jointly hosted a Water Brown-bag Lunch Series from Jan 15 through April 2, 2014, meeting on every other Wednesday.

The intent of the series was to promote broad, interdisciplinary conversation and collegial friendships among faculty, staff, and grad students at Michigan Tech who share an interest in water. Each meeting was launched by a speaker with a short (15-20 minutes), accessible

presentation to spark a lively discussion. Presentation topics were selected from the presenter's current research or potential interdisciplinary research ideas.

One of our most important goals is to build a true community of colleagues in a number of different disciplines who all share a special interest in water. The success of the series is bringing researchers of different disciplines together as colleagues and friends.

Series Organizers: Nancy Langston, Guy Meadows, Noel Urban, and Emma Norma

Presenter Schedule:

Jan 15: Nancy Langston (SS)

Jan 29: Noel Urban (CEE/CWS Director)

Feb 12: Emma Norman (SS) "Water and hydraulic fracturing"

Feb 26: Nancy Auer (BIO)

Mar 19: Evan Kane (SFRES)

Apr 2: Ali Mirchi (CEE) "Water resources management in a homogenizing world"

3.2 Degree and Education Subcommittee Activities

(**Members:** Jason Gulley, Daisuke Minakata, Noel Urban)

The primary activities of the Degree Subcommittee included the development of the CWS graduate level colloquium course, the development of the CWS Graduate Certificate in Sustainable Water Resources Systems, and the review of the Graduate Student Research and Travel grants awarded by CWS.

3.2.1 Colloquium Course

A new colloquium course was established in Spring 2009. The purpose of the colloquium is to review and discuss current interdisciplinary advances in a water topic of interest to CWS participants. The one-credit course is temporarily listed under UN5100 – Center for Water & Society.

Each week, participants read a journal paper or scientific report in preparation of discussion sessions on Fridays. Students not registered for the course and faculty are encouraged to participate. Discussion sessions are led by a group of students and faculty. This group prepares questions or comments the week preceding the discussion and sends these to the class. The group begins the discussion session with a 10-minute summary of the major issues covered the preceding week's reading and repeat the discussion questions. After the "formal" one-hour discussion session, course participants are invited to stay and continue the discussion. Students are expected to (a) produce and present a poster on a relevant topic for the Center for Water & Society's World Water Day poster session and/or (b) write and submit a 5-page reflection paper due at the end of the term.

The 2013-14 course was led by Judith Perlinger as a component of the NSF-funded CNH research project, “Managing Impacts of Global Transport of Atmosphere-surface Exchangeable Pollutants (ASEPs) in the Context of Global Change.” The course brought together students, faculty and additional experts from various fields and institutions (University of Stockholm, Massachusetts Institute of Technology, University of Massachusetts – Boston, University of Nevada – Reno) to explore the wicked problem of management of ASEPs in the context of global change. Course components included the creation of a web-based education module geared toward K-12 students or the public as a member of a team, and discussions of readings.

Colloquium Topics:

Spring 2014: *“Communicating Wicked Environmental Problems”*

Spring 2013: *“Interactions between water and people”*

Spring 2012: *“Humans and Aquatic Ecosystems: A Fluid Situation”*

Spring 2011: *“The Value of Water”*

Spring 2010: *“Impacts of Climate Change on the Great Lakes Ecosystem”*

Spring 2009: *“Climate Change and the Sustainability of Water Resources”*

3.2.2 Graduate Certificate in Sustainable Water Resources Systems

The Graduate Certificate in Sustainable Water Resources Systems formally recognizes students who have a set of core competencies in understanding current water resource issues and develop an advanced understanding of the problems and new technology development in their field of expertise. This certificate is useful to students in such fields as natural resource management, business and policy, environmental and civil engineering, geology and geological engineering, and environmental policy. Students holding this certificate understand water resource management from an interdisciplinary perspective that includes policy, natural and applied sciences. Seven certificates have been earned since Fall 2009.

3.2.3 Graduate travel awards

Approved funds processed in FY 2013-14

Brenda Bergman, August 4-9, 2013

Ecological Society of America
Minneapolis, MN

“Large mammals in subsidies’ dark side: contaminant ecology of mammal-mediated aquatic-terrestrial linkages”

Alex Collins, August 4-9, 2013

Ecological Society of America
Minneapolis, MN

“The interspecific differences in growth and water use efficiency between trembling aspen (Populus tremuloides) and red maple (Acer rubrum) as a result of interannual climate variation in Northern Minnesota”

Martin Hobmeier, August 4-9, 2013

Ecological Society of America
Minneapolis, MN

“Spiny water flea (Bythotrephes lungimanus) impacts on zooplankton communities in inter-connected lake system”

Valoree Gagnon, November 20-24, 2013

American Anthropological Association 112th Annual Meeting
Chicago, IL

“Contested Heritages and Risks: Industrial Wealth Production Impacts in Ojibwa Subsistence Landscapes”

Anna Lee Presley, November 20-24, 2013

American Anthropological Association 112th Annual Meeting
Chicago, IL

“Foodscape Archaeology on the Resource Frontier: Research in Progress in Michigan’s Copper Country”

Jade Ortiz, May 18-23, 2014

Joint Aquatic Science Meeting: Society for Freshwater Science, Phycological Society of America, Association for the Sciences of Limnology and Oceanography, Society of Wetland Scientists

Portland, OR

“Impact of Nutrient Loading and Eurasian Watermilfoil on Phytoplankton Communities among Channels of the Les Cheneaux Islands, Lake Huron”

Ashley Coble, May 18-23, 2014

Joint Aquatic Science Meeting: Society for Freshwater Science, Phycological Society of America, Association for the Sciences of Limnology and Oceanography, Society of Wetland Scientists

Portland, OR

“Spatial and temporal measurements of N, P, and C uptake in small Lake Superior tributaries”

Anika Kucynski, May 26-30, 2014

International Association for Great Lakes Research (IAGLR)
Hamilton, ONT, Canada

“Management Implications of Cladophora Resurgence in the Great Lakes”

Emily Sokol, May 26-30, 2014

International Association for Great Lakes Research (IAGLR)
Hamilton, ONT, Canada

“Polychlorinated biphenyl (PCB) Fish contamination: A Look at Michigan’s Upper Peninsula Inland Lakes”

Marcel Dijkstra, May 26-30, 2014

International Association for Great Lakes Research (IAGLR)
Hamilton, ONT, Canada

“Ecosystem function in Lake Superior: Impacts of an episodic climate anomaly”

Approved in FY 2013-14, but travel and/or funds were processed in FY 2014-15

Rasika Gawde, May 26-30, 2014

International Association for Great Lakes Research (IAGLR)
Hamilton, ONT, Canada

“Hydrodynamics and thermal regime in Lake Superior: Impacts of an episodic climatic anomaly”

James Olson, July 28-Aug 1, 2014

Society for Ecological Restoration
New Orleans, LA

“Assessing the Impact of Culvert Design on Three Ecosystem Functions in Northern Wisconsin Streams”

Travis Wakeham, November 20-24, 2013

American Anthropological Association 112th Annual Meeting
Chicago, IL

“A Model University-Community Collaboration: The Arts, Heritage, and Revitalization in Calumet, Michigan”

3.2.4 Research grants

Jennifer Fuller (Spring - \$750)

“Developing a Solution to an Urgent Problem: Pharmaceuticals in the Water Cycle”

Martin Hobmeier (Spring - \$750)

*“Enclosure Experiments Documenting consumptive and Non-consumptive Effects of an Invasive Species, *Bythotrephes lungimanus*”*

James Havu (Fall - \$715)

“Prospecting for caves and visualization of surface water flow into karst aquifers during spring reversals using Electrical Resistivity Tomography”

3.3 Ad Hoc Committee: Interdisciplinary Proposals

(Members: John Gierke, Carol MacLennan, Noel Urban, Amy Marcarelli)

This subcommittee was formed to explore ways that CWS could foster interdisciplinary proposals, and match proposal RFPs to specific CWS members or research areas. Suggestions from the committee included: 1) create social events that allow CWS members to know each other and develop networks; 2) sponsor one large proposal each year and assemble an appropriate team for it; 3) personally notify appropriate faculty of proposal opportunities in their field; 4) publicize to faculty both large grant opportunities and intra-university opportunities for assistance with large proposal preparation. These recommendations will be considered for implementation in the next fiscal year.

3.4 Outreach Activities

June 24- 28, 2013 **Great Lakes Watershed Investigations Teacher Institute** at Michigan Tech University

Explore the physical, chemical, and biological components of the Great Lakes ecosystem, using the Lake Superior watershed as the classroom: Agassiz research vessel, day at Gratiot Lake, visit streams, wetlands, stewardship projects. 2 credits. (22 Participants)

July 7, 2012 **Scientific Excursions Aboard MTU's Research Vessel: How Do Scientists Assess Great Lakes Health?**

162 participants went out on eight 30-minute scientific excursions led by Marcel Dykstra, a PhD student in CWS. Participants learned how scientists assess the health of the Great Lakes, how they collect data, what equipment they use, and what they think are the major threats to Great Lakes health.

2013-14 Green Film & Lecture Series (November 2013-May 2014)

Monthly showing of films on environmental topic to audiences of ~100 composed of MTU students and faculty and local community members. The Series is co-sponsored by CWS, the Keweenaw Land Trust, and the Keweenaw Universalist Unitarian Fellowship. Five films were shown in 2013 (listed below); each was followed by a discussion moderated by MTU faculty or community members.

November Lecture: **Thomas Power, University of Montana**
The Economic Anomaly of Mining: Treasure and Tears

December Lecture: **Chelsea Schelly, Social Sciences, Michigan Tech**
Technology, Nature & Society: Seeing the Social in the Material of Everyday Life

January – River Planet

February – Tiny: a movie about living small

March – Gasland

April – Thin Ice

May – GMO OMG (genetically modified organisms)

K-12 Students ~ 1st Annual Water Festival for Gr.4-8 Students

The first ever Lake Superior Water Festival enthralled **1,019 students** in grades 4-8 classes from Houghton (Grades. 6-8), Hancock (Gr. 8), Calumet (Grades 4, 5, 8), Lake Linden-Hubbell (Grades 4, 8), Dollar Bay (Grades 4-6, 8), Jeffers (Gr. 7), Stanton Twp. (Gr. 4-8), and Ewen-Trout Creek (Gr. 4-6) schools, in addition to triggering excitement amongst their teachers and the parent chaperones who accompanied them, and the 101 presenters and guides.

There were a total of 67 presenters and volunteers who contributed their time throughout the day, in addition to 34 Michigan Tech students who served as guides leading the classes to their various sessions in and around the Great Lakes Research Center. A total of 30 different sessions on a wide range of topics related to Lake Superior and water resources were presented. 75% of the sessions were presented by MTU scientists, graduate and undergraduate students, and 25% were presented by a diverse array of specialists from the National Park Service, U.S. Forest Service, U.S. Fish & Wildlife Service, Copper Country Arts Center, Friends of the Land of Keweenaw, Keweenaw Land Trust, U.S. Coast Guard, Copper Country Trout Unlimited, LakeDance in Chicago, SOAR from Dollar Bay High School, and the Michigan Nature Association.

The Water Festival was a monumental task and you and your staff did a great job. Nearly 1100 kids in a first year event in a new building and it went very well. Thank You for all of your efforts.

Clay Cotey, Earth Science Teacher, Washington Middle School (Calumet)

Thank you for putting on a wonderful event today! Everything was topnotch and very much appreciated!

Jean Dunstan, Gr. 6-8 science & social studies teacher, Stanton Twp. School

Great job! Thanks for a wonderful learning experience.

Janet Larson, Gr. 4 teacher, Stanton Twp. School

Water Festival publicity:

TV 6: <http://www.uppermichiganssource.com/news/story.aspx?id=809687#.UHB6Hq6rTT0>

TV 10: <http://abc10up.com/2012/10/michigan-tech-water-festival/>

Six videos from the Festival posted on YouTube:

<http://www.youtube.com/watch?v=lsA6bTi37v8>

An article in Michigan Tech Lode (Oct. 9, 2012).

Photos of Festival posted on the Water Festival website:

http://www.wupcenter.mtu.edu/education/water_festival/water_festival/index.html

The Water Festival was supported by---Michigan Space Grant Consortium, Lake Superior Stewardship Initiative, MTU Center for Water & Society, and Upper Peninsula Environmental Coalition. The Water Festival was coordinated by the Western UP Center for Science, Math & Environmental Education at Michigan Tech.

3.5 Project Support

One of the goals of CWS is to provide equipment cost share funding for proposals that will benefit multiple faculty and students with their water-related research.

Proposal support

Carol Asiala assisted in the preparation of 2 proposals (MDEQ & NSF).

3.6 Awards and Recognition for CWS Participants

Auer, Nancy A.

2014 Michigan Notable Book, Library of Michigan, January 1, 2014.

National Academies Education Fellow In the Life Sciences, The National Academies, July 12, 2013.

Selected to serve on the IAGLR Chandler-Misener Award subcommittee, International Association of Great Lakes Research, May 20, 2013.

Barkdoll, Brian D.

Fellow of the Environmental Water Resources Institute, American Society of Civil Engineers, May 7, 2013.

Becker, Jennifer G.

Props for Profs Winner, Michigan Tech, Jackson Center for Teaching and Learning, March 17, 2014.

Halvorsen, Kathleen E.

Michigan Technological University Research Award, MTU, April 15, 2014.

Kerfoot, W. Charles

Recognition, Wikipedia The Free Encyclopedia 2006-20012, 2013.

Marcarelli, Amy M.

Top 10% of teachers, Michigan Technological University, April 2014.

Perlinger, Judith A.

Canvas Course Content Contest (C4) Winner, Center for Teaching, Learning, and Faculty Development, April 2014.

NSF CNH Panel Member, National Science Foundation, February 20, 2014.

Scarlett, Timothy J.

Outstanding Contribution Award, Utah State History, September 5, 2013.

Wagenbrenner, Joseph

Canvas Course Content Award, Jackson Center for Teaching and Learning, April 2014.

Watkins, David W.

Outstanding Achievement Award, Environmental and Water Resources Institute, American Society of Civil Engineers, May 21, 2013.

4 CWS Budget

CWS Institute O/H Incentive Account

Beginning Balance July 1, 2013	\$14,615.70
Research Incentive Transfer In	\$31,150.75
Expenditures	\$24,141.95
CWS Sponsored Seminars.....	\$1,153.91
Student Research & Travel Grants.....	\$5,757.92
Student Research Poster Competition Awards.....	\$850.00
Center Supplies.....	\$200.00
Administrative Assistant	\$8,896.37
Travel	\$476.80
Outreach	\$4,935.25
Center Functions.....	\$1,366.21
Project Support	\$505.49
Balance as of June 30, 2014.....	\$24,141.95

5 Research

5.1 *New Awards 2013-14*

New Research Funding 2013-14:

\$ 1,852,292

1. Experimental Frameworks for Evaluating the Net Effects of Hydrological Service Payments on Coupled Social-ecological Systems in Mexico
PI: Alex Mayer (CEE)
University of New Hampshire
1211077P1: \$151,846 (01/15/2014-12/31/2017); Award date: 2/14/2014
2. CNH: Managing Impacts of Global Transport of Atmosphere-Surface Exchangeable Pollutants in the Context of Global Change
PI: Perlinger, Judith (CEE)
National Science Foundation
1211086P1: \$1,450,000 (9/1/2013-2/28/2017); Award date: 7/31/2013
1211086P2: \$52,550 (9/1/2013-2/28/2017); Award date: 7/1/2014
3. Professional Development for Teachers to Incorporate Place-Based and Culturally Centered Earth System Investigations in Pre-College Curricula at Native American Community Schools
PI: John Gierke (GMES)
University of Michigan-Michigan Space Grant Consortium
1311041P1: \$7,500 (5/1/2014 – 4/30/2015); Award date: 4/25/2014
4. Integrated Seasonal Drought Forecast-Adaptive Management System for the Lower Colorado River Basin in Texas
PI: David Watkins (CEE)
National Oceanic & Atmospheric Administration
1211078P1: \$92,298 (9/1/2013-8/31/2014); Award date: 9/5/2013
1211078P2: \$88,873 (9/1/2014-8/31/2015); Award date: 4/22/2014
5. Integrated Assessment of Torch Lake AOC
PI: Urban, Noel (CEE)
UNIVERSITY OF MICHIGAN-MICH SEA GRANT
1104023P3: \$29,775 (2/1/2012-1/31/2014); Award date: 11/12/2013
6. CI-TEAM Demo: Environmental CyberCitizens: Engaging Citizen Scientists in Global Environmental Change through Crowdsensing and Visualization
PI: Mayer, Alex (CEE)
National Science Foundation
1103036P6: \$32,000 (9/1/2011-8/31/2014); Award date: 5/2/2014

5.2 *Active Research Projects Affiliated with CWS, 2013-14*

1. **Collaborative Research: Modeling and Analyzing the Use, Efficiency, Value and Governance of Water as a Material in the Great Lakes Region Through an Integrated Approach**
PI: Alex Mayer
co-PIs: James Mihelcic, David Watkins, Qiong (Jane) Zhang
Sponsor: NSF
070215P1: \$1,078,322 (9/1/2007-8/31/2013)

This multidisciplinary 5-year research project (funded by the National Science Foundation MUSES program) will determine, through integrated physical and economic models and under various scenarios of population growth,

climate change, land use, and emissions, the impact of direct and indirect drivers on water quality, quantity, and availability in the Great Lakes region.

Though it is well known that nearly every product in global commerce is dependent on water, water has not traditionally been considered a material characterized by integrated analyses to quantify flows and stocks, opportunity costs, and full valuation (i.e., social, environmental, and service costs) through its myriad of uses. This has led to an undervaluing of water as a finite resource.

The Great Lakes region is chosen due to its large volume of available freshwater (but low rate of replacement), high economic impact, complex governance issues including an international border, and increasing competition for water allocation among industrial, agricultural, municipal, recreational, and ecosystem needs, as well as existing and future threats of water quality deterioration.

2. **SustR: Sustainable Development for Rural Communities: Social, Health, Economic, and Environmental Advances**

Investigator: Alex Mayer (GMES), Carol MacLennan (SS), and Blair Orr (SFRES)

Sponsor: U.S. Dept of Education, Fund for the Improvement of Post-Secondary Education

080423P1-P4: \$180,000 (9/1/2008-8/31/2013)

A consortium of six research-based universities and colleges in Mexico, Canada and U.S. has been formed to tackle the most critical issues in rural sustainability by educating a new generation of students and creating collaborative ties among researchers at these institutions. The consortium universities will exchange students and faculty in several engineering and science disciplines (anthropology, sociology, political science, biology, health sciences, environmental engineering and sciences, forestry) involved in finding social, political, economic and technical solutions to the problems of rural communities.

These universities offer a broad range of expertise in the area of rural sustainability, from social sciences, including an understanding of the social dynamics and economics in rural communities; public and community health, including an understanding of determinants of community and individuals' health in rural and remote communities; natural sciences, including an understanding of the capacity of the natural environment to sustain development in rural communities; and engineering, including knowledge of how to design, build and manage technical solutions.

Faculty activities will focus on the development of a general web-based course in water resources and intensive courses in urban water issues, and on the compilation of a collection of web-based case studies in water resources systems in North America. Faculty at the institutions will benefit immensely from exchange and discussion with each other as they compare the differences and similarities in their home territories. This exchange will enable students to learn in an "integrated" manner that not only combines diverse disciplines, but also the histories and experiences of the different regions. In effect this will be a laboratory for student learning and preparation for resolving a central problem that faces rural communities: linking reduction in poverty and increasing sustainability.

3. **New GK12 Global Watershed: Integrating Rural and Global Perspectives with Research and Technological Advances**

PI: Alex Mayer (GMES)

Co-PIs: Nancy Auer (BIO), Linda Nagel (SFRES)

Sponsor: NSF

080701P1: \$2,499,352 (9/1/2009-8/31/2015)

Project Description/Intellectual Merit. In project **GlobalWatershed**, graduate Fellows will conduct research in watershed science topics, at a range of scales and cultural contexts, while working with middle/high school teachers to create lesson plans that transfer this knowledge to their students. The goals of **GlobalWatershed** are to (a) expand traditional STEM graduate student training to allow graduate students to acquire improved teaching and communication skills and to gain a greater appreciation of the scientific context of their research, and make this expanded training a permanent fixture at MTU and to enrich STEM learning and instruction in local K12 schools serving low-income and high Native American populations and a Sonora, Mexico K12 school system, specifically by translating state-of-the-art watershed research to the K12 level, and make this enrichment sustainable at these schools. Fellows will receive training in effective teaching techniques, learning styles, lesson planning, classroom management, ways of assessing science proficiency, inquiry-based approaches for teaching science, teaching concepts of scientific research, and indigenous perspectives and awareness and sensitivity to

other ways of learning. Teachers will attend professional development workshops to learn about watershed science research and methodologies. Lesson plans and units will be developed by Fellows and teachers on a range of watershed topics, to be incorporated into secondary school curricula, including science, mathematics, and social studies. These materials will be aligned with appropriate Michigan and Sonora educational standards.

Broader Impacts. **GlobalWatershed** will integrate and strengthen global perspectives and technological advances in University research and rural secondary education. Fellows will gain research experience while also learning effective educational techniques and pedagogies from secondary school teachers. Together, the Fellow/teacher teams will impart knowledge of the many components of watersheds to secondary students. Teachers will become proficient in the use of new technologies in their classrooms, increase their research experience, and learn to address watershed research questions into their lessons. Our focus on Native American students will help us develop appropriate educational materials for a group that is traditionally under-represented in science and engineering. The collaboration with schools in Sonora will allow for exchanges in teaching strategies and will enrich the outlooks of all participants by exposure to a region where water scarcity is a day-to-day reality. Dissemination will occur via the **GlobalWatershed** web site and presentations at professional conferences and publications in peer-reviewed journals.

4. **IDR: Collaborative Research: Sustainable Water Resources for Communities Under Climate Change: Can State-of-the-Art Forecasting Inform Decision-Making in Data Sparse Regions?**

PI: Mayer, Alex (CEE)

co-PIs: Halvorsen, Kathleen (SS/SFRES)

National Science Foundation

091213P2: \$317,389 (9/15/2010-8/31/2015)

Intellectual Merit: Arid and semiarid regions may shoulder disproportional impacts of climate change due to the low resiliency and robustness inherent in both the natural and human infrastructure systems. One of the critical engineering systems threatened by climate change in these areas is water supply and its associated infrastructure. Imposing a warmer climate in a region of water scarcity may lead to unsustainable alternative future scenarios and further increase the complexity of water resources management. In this proposal, we intend to study decision-making for water resources management in anticipation of climate change in northern Mexico as a case study for the broader arid and semiarid southwestern North America. The goal of the proposed project is to determine whether water resources systems modeling, developed within a participatory framework, can contribute to the building of management strategies in a context of water scarcity, conflicting water uses and highly variable and changing climate conditions. Local stakeholders will be involved in guiding the design of supply- and demand-side management strategies and selection of climate change scenarios using state-of-the-art engineering tools. These tools include a water resources systems framework, a spatially-explicit hydrologic model, the use of forecasted climate scenarios under 21st century climate change, and observations obtained from field and satellite sensors. The participatory modeling approach will be conducted through a series of interactive workshops, carefully designed to encourage substantive participation from a broad range of stakeholders, including representatives from federal and local government agencies, water use sectors, non-governmental organizations, and academics. We will utilize the theory of planned behavior, which explains planned decisions, such as those made by water resource decision makers, as grounded in a suite of factors, including beliefs regarding risks, problems, and solutions. Through the theory of planned behavior, the participatory modeling process will be evaluated to understand if, and to what extent, the engineering tools are useful in the uncertain and politically-complex setting. Furthermore, the work will evaluate the sustainable outcomes emerging from the climate change scenarios and the potential adaptations that can be implemented in the decision-making process.

Broader Impacts: The proposed work combines engineering research with social and behavioral sciences for the purpose of evaluating sustainable water management outcomes in a semiarid region in a developing country. This approach undoubtedly challenges participants to carry out transformative, interdisciplinary research. We will engage three doctoral level students at MTU and ASU as well as undergraduate students for short-term research experiences. A focus on recruiting Hispanic students (with language skills) will facilitate interactions with local decision makers, regional stakeholders and the general public. Our team will build on prior work at ASU and MTU in water research within Mexico and other developing countries. In particular, we will bring the expertise and experience of the ASU School of Sustainable Engineering and the Built Environment and the MTU Center for Water and Society to bear on the problems of water supply under climate change threats. We will also work with several local universities in Sonora to develop an effective participatory modeling program. We expect that the results of this project will have an impact on water decision-making under climate change in the study area and provide a case study for replication in other data-sparse, semiarid regions.

5. **Predicting Ecosystem Changes in Lake Superior**

PI: Auer, Nancy (BIO)
co-PI: Auer, Martin (CEE)
US Environmental Protection Agency
100181P1: \$306,014 (9/1/2010 - 4/30/2014)

A linked hydrodynamic - nutrient food chain model will be expanded to include a bioenergetics submodel and applied to predict ecosystem changes in associated with climate change, variations in nutrient dynamics and alteration of food web structure (invasive species). A capacity to simulate the interplay of changes in energy resources (e.g. primary production) and energy sinks (e.g. predation and competition for food resources) will be developed and tested for benthic (*Diporeia* - lake whitefish) and pelagic (*Mysis*-rainbow smelt) food web components characteristic of Lake Superior.

6. **Integrated Modeling and Experimental Evaluation of Hydrodynamic and Microbial Controls on DNAPL Dissolution and Detoxification**

PI: Becker, Jennifer
co-PI: Seagren, Eric
National Science Foundation
100318P1: \$376,192 (12/28/2009 - 8/31/2014)

Background. In situ bioremediation based on biological reductive dehalogenation is now an established remediation approach for sites contaminated with aqueous-phase chlorinated ethenes. However, the EPA estimates that chlorinated ethenes are present as dense non-aqueous phase liquids (DNAPLs) at 46,000 contaminated sites in the U.S. The presence of DNAPL forms of these contaminants, which are known or suspected carcinogens, is a major obstacle to remediation efforts that has widespread implications for human and ecological health. Importantly, abiotic dissolution of DNAPLs into groundwater is a slow process and may require several hundred years to deplete the DNAPL source of contamination. Several in situ DNAPL treatment methods use physicochemical processes to mobilize and subsequently capture and/or destroy contaminants and thus accelerate the clean-up process. These methods can be difficult and costly to implement and may preclude bioremediation of dissolved contaminants by making conditions inhospitable to microorganisms. Recently, interest has grown in the use dehalorespiring bacteria to treat DNAPLs through bioenhanced dissolution, i.e., enhanced mass removal from chlorinated ethene DNAPLs through reductive dechlorination of dissolved contaminants near the DNAPL-water interface. This approach is appealing because it does not rely on DNAPL mobilization and is compatible with the clean-up of dissolved contaminants using bioremediation. Although bioenhanced dissolution appears promising, the design of biological DNAPL source treatment measures using a "black box" approach may not promote and sustain the growth of the populations with the greatest potential to bioenhance dissolution rates. The proposed project focuses on understanding the interrelated roles that hydrodynamics and competition among different dehalorespiring populations, as well as other community members, play in determining the distribution of dehalorespiring populations in the DNAPL source zone and dissolved contaminant plume and the resulting impact on the magnitude of bioenhanced dissolution and the extent of detoxification.

Project Approach and Objectives. Evaluation of the hydrodynamic and microbial controls on bioenhanced dissolution and detoxification of chlorinated ethenes will be accomplished using an integrated modeling and experimental approach that includes the following key objectives: (1) Mathematical modeling will be used to theoretically predict the relationships between microbial competition, hydrodynamic conditions, and bioenhancement for three model scenarios and design a micromodel system for studying DNAPL dissolution and source-zone microbial ecology at the porescale. (2) The micromodels will be used to independently estimate key system parameters and test model predictions for the three scenarios by experimentally evaluating the effects of microbial competition and hydrodynamics on population distribution, dissolution bioenhancement and plume detoxification. An innovative fluorescent in situ hybridization approach will be used to directly visualize and quantify population distribution in the micromodel. (4) An intermediate-scale flow cell will be used to test whether the micromodel experiments and mathematical modeling can predict bioenhancement effects in a scaled up system. (5) Mathematical modeling will be refined based on the experimental results and used to predict the effects of microbial competition and hydrodynamics on DNAPL source zone longevities for four DNAPL configurations.

7. **Virtual Water Accounting: A New Paradigm for the Adaptive Management of Great Lakes Water**

PI: Mayer, Alex (CEE)
Co-PI: Huckins, Casey (BIO)
Great Lakes Protection Fund

100679P3: \$916,736, (2/3/2011-8/31/2014)

This is a synthetic project to achieve the outcomes of (1) developing and proving a new scientific methodology relating economic production, watershed flow depletion, and ecosystem services, (2) pilot the new methodology to quantify these relationships in select HUC-12 scale watersheds and downstream watersheds in the Great Lakes Basin, (3) work with an advisory board of policymakers, watershed advocates, and leaders of business and finance to determine the implications of these relationships for water and economic development policy, and (4) determine how this pilot project's findings could be further developed and implemented to inform Great Lakes Basin water policy, including future revisions to the Great Lakes Compact. Towards this end will implement a comprehensive communication plan, with the goal of gathering input from water policy stakeholder communities. The deliverable of this research will be a proof of concept and plan of implementation for a new approach to an integrated adaptive management of water resources in the Great Lakes Basin that accounts for the economic and environmental impacts of water uses. The project investigators include the primary personnel and an advisory committee consisting of technical and policy domain experts who will collaborate with the primary personnel.

8. **CI-TEAM Demo: Environmental CyberCitizens: Engaging Citizen Scientists in Global Environmental Change through Crowdsensing and Visualization**

PI: Mayer, Alex (CEE)

National Science Foundation

1103036P1: \$249,840 (9/1/2011-8/31/2015)

This demonstration project will create and evaluate a set of activities aimed at preparing a diverse science and engineering workforce with cyberinfrastructure knowledge and skills. A multidisciplinary team of faculty and undergraduate students will collaborate with citizen scientist end users to develop and deploy data collection and visualization tools, to monitor the critical ecosystems of Lightfoot Bay in the Upper Peninsula of Michigan. The proposed program will build upon existing educational programs at Michigan Technological University, Keweenaw Bay Ojibwa Community College, several local high schools, and a local land conservancy. Research scientists at International Business Machines who are actively engaged in the development of crowdsensing applications will collaborate with the co-PIs and students.

9. **Integrated Assessment of Torch Lake AOC**

PI: Urban, Noel (CEE)

co-PIs: MacLennan, Carol (SS), Perlinger, Judith (CEE)

UNIVERSITY OF MICHIGAN-MICH SEA GRANT

1104023P1: \$ 119,339 (2/1/2012-1/31/2015)

Torch Lake was impacted by copper mining and listed as an Area of Concern (AOC) in 1987. Beneficial Use Impairments (BUis) included fish tumors, degraded benthos, and fishconsumption advisories. The U.S.EPA conducted remediation and removed the site from the National Priority List. The Public Advisory Council petitioned the state to delist the site as an AOC. The state determined that two BUis still exist, and the site is not ready for delisting as an AOC. This site was not included in the 2010 Great Lakes Restoration Initiative projects because EPA deemed that inadequate information was available to accomplish rapid remediation. This site provides a contrast to many AOCs that are being successfully delisted. We propose a two-phase Integrated Assessment: Phase I will consist of gathering available data, and in Phase II the information will be presented to stakeholders. We will gather data not previously reviewed by state or federal agencies. Data will be summarized in multiple forms (fact sheets, presentations, maps, etc.) and presented to a variety of stakeholder groups that will be solicited for input on potential remedies. Results from both phases will be reported to the Michigan Dept. of Environmental Quality (MDEQ).

10. **Inventory of Mining Impacted Streams in the Coastal Zone of the Keweenaw**

PI: Urban, Noel (CEE)

co-PI: Kerfoot, W Charles (BIO)

Michigan Dept of Environmental Quality

1105024P1: \$55,560 (1/1/2012-8/31/2013)

The mouths of all perennial streams tributary to Lake Superior and located on the Keweenaw Peninsula will be surveyed for physical habitat quality and biological health in order to identify degraded habitat, particularly habitats impacted by historical mining activities. Benthic macroinvertebrate surveys will be conducted in spring and fall, and copper concentrations in water and sediments will be measured. This study will identify the most impacted sites and will help local non-profit organizations and government agencies to plan subsequent

remediation. In addition, community outreach and public education efforts will inform the public of results of this study and of the health and threats to the coastal wildlife habitat and water quality.

11. Changes in Ecosystem Function Associated with Sand Accumulation in a Lake Superior Tributary

PI: Marcarelli, Amy (BIO)

US Dept of Agriculture

1106039P2: \$35,633 (8/29/2011-8/31/2016)

Watershed land-use such as the construction and maintenance of roads (e.g., grading and plowing unpaved roads) can enhance erosion of fine sediments, which can be deposited into river channels. These inputs can shift the equilibrium between erosion and sedimentation within the stream, favoring deposition of fine sediments. This is especially problematic in relative low gradient channels such as those in the lower reaches of the Salmon Trout River in Marquette County, Michigan. The accumulation of sand in stream channels can embed larger substrates such as cobble and gravel, and resultant loss of substrate heterogeneity in streams can have wide-ranging impacts on stream ecosystem structure and function, as well as reduce quality and quantity of fish habitat. Long-term surveys of juvenile salmonid abundances reveal notably low densities in the Salmon Trout River relative to those detected in neighboring tributaries of Lake Superior. We predict this variation may in part be the result of variation in productivities across the systems, which may relate to the fine sediment dynamics and accumulation in the Salmon Trout River. We are conducting a comparative survey of functional attributes (i.e. nutrient retention, microbial, algal, and animal biomass and production, and organic matter decomposition) and structural attributes (i.e., stream habitat and the biological communities it hosts) of river reaches that are more or less impacted by accumulation of fine sediments. This research will lead to increased understanding of the Salmon Trout River ecosystem, its ecosystem properties, and the ecosystem effects of sand accumulation. This will enhance prediction of the effects of sand on stream ecosystem and in the long-term this knowledge should enhance preservation and restoration of the Salmon Trout River watershed, and the native fish, including the population of coaster brook trout it hosts.

12. WSC-Category 2 Collaborative: Robust Decision-making for South Florida Water Resources by Ecosystem Service Valuation, Hydro-economic Optimization and Conflict Resolution Modeling

PI: David Watkins (CEE)

National Science Foundation

1110089P1: \$430,497 (1/1/2013-12/31/2017)

Intellectual Merit

We propose a cross-disciplinary approach utilizing the expertise of multiple institutions to investigate the behavioral dimensions of decision-making for water management and land use plans under various climate change, economic, population, and sea level rise (SLR) scenarios. Our study site is south Florida, a region with many competing water allocation targets, which is subject to extreme climate variability and threatened by SLR. We employ new optimization modeling approaches based on robust-decision making to develop management strategies that enhance the resilience and sustainability of water supplies for the built and natural systems, while also accounting for the broad-sector value of water use. Optimization criteria in the model will incorporate the results of new research linking water management, ecological functioning, and the economic value of ecosystem services in collaboration with the NSF-funded Florida Coastal Everglades Long-Term Ecological Research (FCE-LTER) program. New experimental approaches will be implemented to better understand the impacts of information type and uncertainty in the processes of both selecting decision criteria and evaluating model outcomes among individuals and groups of local stakeholders. These experiments are designed to improve our understanding of the roles of cognitive and perceptual biases in risk assessment and decision-making when hydro-economic optimizations are coupled with scenario forecasts. Finally, with agency and stakeholder involvement we will collaboratively develop recommendations for adaptive water management plans that foster long-term support.

Broader Impacts

Low-lying coastal regions, such as south Florida, which are subject to SLR, climate change, and growing populations will benefit from the development of this innovative, pragmatic approach to optimizing the social-ecological benefits of water resources allocated between the built and natural environments. Our work will include novel approaches for dynamically incorporating economic assessments into stakeholder evaluations of adaptive land use and water management strategies. Participating local, state, and federal agencies responsible for managing the region's water resources will benefit from these broad-sector analyses of adaptive schemes that explicitly incorporate uncertainty estimates of potential outcomes. Comparative behavioral analysis of stakeholder evaluations and institutional decision-making will provide unique insights into how information type, information content and cognitive biases combine to influence risk perception under different hydro-economic

scenarios, and how the perceived risks to specific indicators of individual and collective well-being influence scenario selection. Societies such as those in south Florida, whose options for managing public water resources are limited by climatic, physical or legal constraints, require this type of integrated assessment to promote cooperative decision-making while preparing for uncertain hydro-climatic conditions and socioeconomic future.

Under-represented minorities and women will be recruited for all graduate and post-doctoral positions. We will train a total of 4 undergraduate and 11 graduate students in economics (2), behavioral sciences (2), ecosystem sciences (3), environmental policy (2), climatology (1), and hydrologic modeling (1), as well as 4 post-doctoral level researchers. Junior investigators will be expected to present findings at the annual meetings planned as part of this project. Outcomes from the project will be broadly disseminated through publication in peer-reviewed journals and presentations to be made at various venues, including scientific meetings, civic and environmental organizations, and government agencies. The project will engage a diverse array of people via surveys and via stakeholder meetings, specifically incorporating the lower income and Hispanic American communities in south Florida.

13. REF-IE: Building Infrastructure for Great Lakes Research

PI: Noel Urban (CEE)

co-PIs: Auer, Martin (CEE), Green, Sarah (CH), Kerfoot, W. Charles (BIO)

Michigan Technological University

1205011P1: \$26,955 (7/1/2012–8/31/2013)

Equipment grant to purchase a Carbon Analyzer for use in the labs of the Great Lakes Research Center.

14. Experimental Frameworks for Evaluating the Net Effects of Hydrological Service Payments on Coupled Social-ecological Systems in Mexico

PI: Alex Mayer (CEE)

co-PI: Kathleen Halvorsen (SS/SFRES)

University of New Hampshire

1211077P1: \$151,846 (1/15/2014 – 12/31/2017)

Scope of Work for Subcontract for Michigan Technological University to University of New Hampshire's NSF project:

Dr. Alex Mayer will coordinate water quality sampling and analysis work in Veracruz, Mexico, during the first two years of the project. This effort will include sample site selection, determination of sample frequency, development of sampling and analysis protocols, purchase of sampling supplies, supervision of sampling and analysis activities, and coordination with community monitoring programs. He will supervise a PhD student in this capacity in the first two years of the project. Dr. Mayer will contribute to interdisciplinary evaluation of payment for hydrologic services programs in Veracruz. Dr. Mayer will oversee the subcontract budget and coordinate submissions of MTU portions of reporting to NSF.

Dr. Kathleen Halvorsen will assist with the household surveys and qualitative interviews. Dr. Halvorsen will supervise a PhD student in the first two years of the project who will assist with survey and interview data collection and analysis. She will coordinate the community meetings that present the results of the socioecological modeling including developing, administering, and analyzing a pre- postsurvey to meeting participants in the last year of the project.

15. Integrated Seasonal Drought Forecast-Adaptive Management System for the Lower Colorado River Basin in Texas

PI: David Watkins (CEE)

co-PIs: Laura Bourgeau-Chavez (MTRI), Colin Brooks(MTRI)

US Dept of Commerce, NOAA

12110787P1:\$92,298 (9/1/2013 – 8/31/2014)

12110787P2:\$88,879 (9/1/2013 – 8/31/2015)

The Lower Colorado River Authority (LCRA) in Austin, Texas, manages the Highland Lakes reservoir system in

Central Texas, a series of six lakes on the Lower Colorado River. This system provides water to approximately 1.1 million people in Central Texas, supplies hydropower to a 55-county area, supports rice farming along the Texas Gulf Coast, and sustains in-stream flows in the Lower Colorado River and freshwater inflows to Matagorda Bay. The current, prolonged drought conditions are severely taxing the LCRA's system, making allocation and management decisions exceptionally challenging, and affecting the ability of constituents to conduct proper planning.

This *CSI-SARP: Coping with Drought* project will develop an integrated seasonal drought forecast-adaptive management system to mitigate drought impacts for the Lower Colorado River in Central Texas. To address rapidly growing demands and risks associated with drought, hydroclimatic (precipitation, streamflow) forecasts with seasonal lead times are proposed to provide advance information toward improved allocation decisions. Historically, such forecasts have not been objectively integrated into decision making; however, the LCRA is considering approaches to formally include the use of seasonal forecasts in their next Water Management Plan, making this project timely.

In collaboration with the LCRA, the methodology will involve the following steps:

- 1) Apply climate and hydrologic data to generate skillful hydroclimatic forecasts at relevant time scales;
- 2) Assess the potential value of using the forecasts in conjunction with risk-sharing policies and financial instruments, and identify residual risk; and
- 3) Incorporate forecasts into LCRA's operational water resource management models.

The forecast model will utilize predictors from multiple sources, including seasonal climate forecasts from NOAA's CFS model and National Multi-model Ensemble Forecast program, as well as satellite remote sensing estimates of relative soil moisture and land cover. We hypothesize that seasonal forecasts developed for the LCRA will allow water supply allocation decisions to be delivered more confidently and at longer lead times (e.g., 3-6 months), ultimately translating into increased benefits for the LCRA and its constituents through improved planning, particularly for drought conditions.

The proposed work to integrate climate risk management strategies into decision-making is highly aligned with NOAA's NGSP long-term goals, the Coping with Drought Competition objectives, and NIDIS priorities. The NGSP supports a number of core capabilities, including *predictions and projections* and *integrated service development and decision support*, all key components of this work addressing the societal challenge of *climate impacts on water resources*. The proposal specifically addresses the Competition objective of *identifying how non-structural approaches to water resource management could increase adaptive capacity for managing climate risks* to advance NOAA's ability to provide sustained, reliable, and timely climate services. The choice of working with the Highland Lakes system in central Texas supports an identified NIDIS pilot area. We expect primary outcomes to include integration of forecast products into the NIDIS web platform, specifically supporting the Southern Plains Regional Drought Early Warning System, including seasonal drought forecasts, reservoir level projections, and impact assessments.

16. **CNH: Managing Impacts of Global Transport of Atmosphere-Surface Exchangeable Pollutants in the Context of Global Change**

PI: Judith Perlinger (CEE)

co-PI: Emma Norman (SS), Shiliang Wu (CEE/GMES)

National Science Foundation

1211086P1: \$1,450,000 (9/1/2013-8/31/2016)

1211086P2: \$52,550 (9/1/2013-2/28/2017)

Toxic pollutants that pass readily in both directions between the atmosphere and environmental surfaces exhibit three characteristic tendencies when they are emitted to the environment: resistance to rapid degradation, accumulation in organic-rich surface reservoirs, and semivolatility causing re-emission to the atmosphere. These pollutants, which we term "Atmosphere-Surface Exchangeable Pollutants" or ASEPs, are emitted to the environment through human activities, are transported and "processed" in the environment, and are then deposited where they may harm humans and wildlife, often in locations distant from their original use or release. Incomplete understanding of the dynamic behavior of these pollutants in the environment has resulted in efforts to regulate them that do not fully protect human and ecosystem health from risks. The human system, including sociopolitical activities, cultural perspectives, and socioeconomic activity resulting in emission of the pollutants into the environment and other environmental stressors, the biogeochemical cycling of the pollutants in the global environment, and the impairment of ecosystem services that result from this cycling comprise the coupled human-natural system of study. Our objective is to probe the complex dynamics and feedbacks within the system and to identify critical social adaptations and governance advancements required to address the challenges to

sustainability posed by these chemicals. Because emissions of these pollutants occur throughout the world and they tend to move northward in cycles of re-volatilization and deposition, resource managers face a particularly difficult challenge in addressing concerns related to this form of contamination. To identify ways in which the regulation of these chemicals can be improved we will simulate their global transport under differing future climate and land cover/land use scenarios to estimate amounts sequestered in and re-emitted from ecosystems. We will quantify the economic costs in the United States caused by exposure to these chemicals. We will analyze efforts to adaptively manage these chemicals at scales ranging from local to global. The Laurentian Great Lakes will provide the geographical focus for nested analysis of social adaption and governance.

The project focuses on pollutants that travel long distances in the atmosphere and cause harm to humans and ecosystems far from the locations where they were emitted. The characteristics of atmosphere-surface exchangeable pollutants lead to a separation in space and time of use and harmful impacts. These pollutants are released into the environment through human activities that yield economic benefits, but the economic costs of damage to human health and environmental impacts are often borne by other segments of society. Because the chemicals cross political boundaries, efforts to address any concerns are complex. The project will examine details about the environmental cycling of these pollutants (how, where and when they cycle between the air and the Earth surface) that currently impede our ability to model their global transport and fate and thus inform policy decision-making. The project will also assess the economic damages caused by these pollutants in the United States. By studying the coupled human-natural system involving these chemicals, this project will improve our understanding of sustainable means of production, use and governance of a class of pollutants. Public outreach and distributed K-college education activities, and partnering between researchers, educators, stakeholders, and decision makers, will promote incorporation of research results into learning, education, and governance. This project brings together a diverse group of natural and social scientists from four academic institutions to study the problem of these pollutants in a more holistic fashion than has ever been attempted to date, and may serve as a model for studying other classes of substances in the future.

17. Professional Development for Teachers to Incorporate Place-Based and Culturally Centered Earth System Investigations in Pre-College Curricula at Native American Community Schools

PI: John Gierke (GMES)

co-PI: Emily Gochis (GMES)

University of Michigan- Michigan Space Grant Consortium

1311041P1: \$7,500 (5/1/2014 – 4/30/2015)

This project will engage teachers in professional development activities to promote place-based and culturally centered Earth Systems investigations in diverse K-12 classrooms. School culture and curricula have a strong influence on students' decisions for the future. Integrating Earth Science into STEM curricula through inquiry based investigations of examples relevant to their community has potential for engaging Native American students and increasing underrepresented populations' participation in geosciences. However, many teachers have little formal background in Earth Science, are unaware of the presence of local geoheritage examples and are inexperienced in pedagogical practices needed to integrate these places into their standards based curriculum. Teacher participants will investigate several local and regional examples during a summer teacher institute aimed at improving Earth Science literacy and modeling effective pedagogical practices. During the school year teachers will further develop teaching methods through pedagogical mini-workshops and ultimately implementation of a field-based, culturally grounded investigation with students.

5.3 Proposals Submitted under CWS, 2013-14

1. CI-TEAM Demo: Environmental CyberCitizens: Engaging Citizen Scientists in Global Environmental Change through Crowdsensing and Visualization
PI: Mayer, Alex (CEE)
National Science Foundation
1103036P6 \$32,000
2. Integrated Plan to Lower Toxics Exposure from Eating Torch Lake Fish
PI: Noel R. Urban
US Environmental Protection Agency
1308012P1: \$546,650
3. WSC-Category 2: Collaborative Research: Dynamic Links Between Island Water Resources Climate Change Sea Level Rise Tourism Economic Development and Demographics
PI: Jason D. Gulley
National Science Foundation
1309021P1 \$3,085,148
4. WSC-Category 2 Collaborative Research: The Adaptive Capacity of the Great Lakes Socio-Aquatic System in the Face of Global Change
PI: Alex S. Mayer
National Science Foundation
1309023P1 \$1,713,453
5. Huron Creek Watershed Improvements Phase 1: Reducing Copper Loads from Stamp Sand Deposits in the Keweenaw Peninsula with Permeable Reactive Barriers
PI: Alex S. Mayer
Michigan Dept of Environmental Quality
1310032P1 \$144,710
6. Professional Development for Teachers to Incorporate Place-Based and Culturally Centered Earth System Investigations in Pre-College Curricula at Native American Community Schools
PI: John S. Gierke
UNIVERSITY OF MICHIGAN-MICHIGAN SPACE GRANT CONSORTIUM
1311041P1 \$10,000
7. Collaborative Research: Discriminating between Local and Non-local Controls on Water Pressure and Ice Velocity of the Greenland Ice Sheet
PI: Jason D. Gulley
National Science Foundation
1312012P1 \$496,471
8. Wildfire Ash Effects on Water Quality
PI: Joseph W. Wagenbrenner
US Dept of the Interior
1312030P1 \$398,079
9. Understanding Links between Critical Zone Processes and Karst Features in Coastal Carbonate Aquifers
PI: Jason D. Gulley
National Science Foundation

- 1401035P1 \$235,187
10. NRI: GUARDIAN (Generic Underwater Autonomous Robot for Diver-Integrated Assistance and Navigation)
PI: Jason D. Gulley
Bishop Museum
1401046P1 \$212,138
11. Coastal SEES Collaborative Research: Improving Restoration Strategies for Great Lakes Coastal Ecosystems by Unifying Landscape and Hydrodynamic Perspectives
PI: Colleen Mouw
National Science Foundation
1401051P1 \$129,450
12. Spatial Variation of Surface Melt Patterns on Debris-covered Glaciers with Respect to Landform Evolution
PI: Jason D. Gulley
National Aeronautics Space Administration
1402028P1 \$30,000
13. Coupling Experimental and Theoretical Molecular-Level Investigations to Visualize the Fate of Degradation of Organic Compounds in Aqueous Phase Advanced Oxidation Systems
PI: Daisuke Minakata
National Science Foundation
1402053P1 \$330,000
14. Toward AOC De-listing: Lessons from Priority AOCs for Persistent AOCs
PI: Noel R. Urban
Great Lakes Commission
1403055P1 \$36,100
15. Toward Sustainable Consumption and Healthy Cities
PI: Alex S. Mayer
Arizona State University
1404014P1 \$155,685
16. Collaborative Research: Understanding Freshwater Lens Depletion on Carbonate Islands Due to Sea Level Rise Formation of and Evaporation from New Lakes and Climate Change
PI: Jason D. Gulley
National Science Foundation
1406003P1 \$397,571
17. Collection and Identification of Larval Fishes
PI: Nancy A. Auer
SENES Consultants Limited
1406060P1 \$61,203

6 Publications by CWS Participants, 2013-14

This listing includes publications by CWS members that are relevant to water-related issues. Publications are ordered by first author and include journal articles, books, and chapters in books that are published, in press, or accepted. Items which are in press or accepted will be counted as published with complete references in the next CWS Annual Report.

Published/Accepted journal articles, books, chapters, proceedings, reviews	90
Accepted journal articles, books, chapters, proceedings, reviews	15
Other Publications	14
Proceedings	7
Reviews	7
Presentations	87
FY 2012-13 references which completed publication in 2013-14.....	23

6.1 Publications (Published or Accepted)

6.1.1 Book

1. "The Great Lake Sturgeon", 2013, editors: **Auer, N.**, Dempsey, D., MSU press, Lansing, MI, ISBN/ISSN ISBN-10: 1611860784, *Published*.
2. "Water without Borders? Canada, the United States, and Shared Waters", 2013, editors: **Norman, E.**, Cohen, A., Bakker, K., University of Toronto Press, Toronto, *Published*.
3. Attinti R., Sarkar, D., **Datta, Rupali**, 2013, "Effect of Ethylene Diamine Disuccinic Acid (EDDS) application on lead geochemical forms in paint-contaminated residential soils", Geological Society of America Abstract with Program, 5th International Conference on Medical Geology, *Published*.
4. Attinti, R., Sarkar, D., **Datta, Rupali**, 2013, "Effect of EDTA on leaching of lead from paint contaminated residential soils during Hurricane Sandy", Agronomy Abstracts, *Published*.
5. Caporale, A., Sarkar, D., Punamiya, P., Violante, A., **Datta, Rupali**, 2013, "Effect of arbuscular mycorrhizal fungi on growth of vetiver grass (*Chrysopogon zizanioides* L.) and its arsenic uptake from soil and water systems", Geological Society of America Abstract with Program, 5th International Conference on Medical Geology, *Published*.
6. Pidatala, V. R., Sarkar, D., **Datta, Rupali**, 2013, "Metabolomic and Proteomic Profiling of Vetiver Grass (*Chrysopogon Zizanioides*) Under Lead stress", Proceedings of the 10th International Phytotechnologies Conference, Oct, 1-4, *Published*.
7. Punamiya, P., Sarkar, D., **Datta, Rupali**, 2013, "Al-based Drinking Water Treatments Residuals as a Novel Green Sorbent for Tetracycline and Oxytetracycline: Results from Greenhouse Study", HDSETAC Conference Proceedings, *Published*.
8. Punamiya, P., Sarkar, D., **Datta, Rupali**, 2013, "Effect of Solution Properties on Tetracycline Removal by Iron-Based Drinking Water Treatment Residuals", Geological Society of America Abstract with Program, 5th International Conference on Medical Geology, *Published*.
9. Sidhu, V., Sarkar, D., Rakshit, S., **Datta, Rupali**, 2013, "Effects of biosolids addition on geochemical forms of copper and phosphorus in contaminated stamp sands of Torch Lake", MI, *Published*.

6.1.2 Book, Chapter in

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6.1.5 Proceedings

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6.2 Published Papers Not Listed Above

1. **Auer, Nancy A., Auer, Martin T.**, 2013, "Semi-Annual report EPA - GLRI", Predicting Ecosystem Change Lake Superior, *Accepted*.
2. **Auer, Nancy A., Auer, Martin T.**, 2014, "Semi-Annual report EPA - GLRI", Predicting Ecosystem Change Lake Superior, *Accepted*.
3. Das, P., Sarkar, D., Panja, S., **Datta, Rupali**, 2013, "Stimulative phytoremediation of 2, 4, 6-Trinitrotoluene (TNT) from Soil using Vetiver Grass (*Chrysopogon zizanioides* L.): A Greenhouse Study", Geological Society of America Abstract with Program, 5th International Conference on Medical Geology, *Published*.
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12. Task Committee on Environmental and Water Resources System Education, 2013, "Water Resources Systems Analysis through Case Studies: Data and Models for Decision Making", editor: **Watkins, D.**, American Society of Civil Engineers, Reston, VA, 170, ISBN/ISSN 978-0-7844-1287-9, *Published*.
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6.3 Presentations

1. Antonio C., Sarkar, Dibyendu, Punamiya, Pravin, Violante, Antonio, **Datta, Rupali**, 2013, Effect of arbuscular mycorrhizal fungi on growth of vetiver grass (*Chrysopogon zizanioides* L.) and its arsenic uptake from soil and water systems., MED-GEO 2013, Geology and Health Div. of Geological Soc. of America, Arlington, VA, August 25, 2013 - August 29, 2013.
2. Attinti, Ramesh, Sarkar, Dibyendu, **Datta, Rupali**, 2013, Effect of EDTA on Leaching of Lead from Paint Contaminated Residential Soils during Hurricane Sandy., Joint Annual Meeting of the American Society of Agronomy, Soil Science Society of America and Crop Science Society of America, ASA-CSSA-SSSA, Tampa, FL, November 3, 2013 - November 6, 2013.
3. **Auer, Nancy A.**, 2013, 10th Annual Nme Release, Little River Band of Ottawa Indians, Manistee River, Michigan.

4. **Auer, Nancy A.**, 2013, A 25 year journey working toward lake sturgeon restoration in the Great Lakes., Cornell Biological Field Station, Cornell University, Biological Field Station.
5. **Auer, Nancy A.**, 2013, Talk on Lake Sturgeon in Lake Superior and Climate Change, Lake Superior Fisheries, Institutes for Journalism and Natural Resources, Sand Point, Baraga.
6. **Auer, Nancy A.**, 2014, Hydropower and Fisheries: Lake Superior lake sturgeon, SWE Region H Conference, MTU, Houghton.
7. Barnett, Audrey, **Mouw, Colleen**, McKinley, Galen, 2014, The role of satellite estimated phytoplankton community size structure in export flux, Ocean Sciences, Association for the Science of Limnology and Oceanography; The Oceanography Society; American Geophysical Union, Honolulu, HI, February 24, 2014 - February 27, 2014.
8. **Cavaleri, Molly A.**, 2013, How does 'big science' happen? Adventures in the development of a large-scale climate manipulation experiment in the tropics, 2013 School of Forest Resources and Environmental Science Faculty Forum, Michigan Tech, SFRES, Michigan Tech, Houghton, MI, November 2013.
9. **Cavaleri, Molly A.**, 2013, Native trees are more conservative in their water use than invasive tree species in a lowland wet forest in Hawaii, 2013 98th Annual Meeting of the Ecological Society of America, Minneapolis, MN, Ecological Society of America, Minneapolis, MN, August 2013.
10. **Cavaleri, Molly A.**, 2013, Urgent need for large-scale warming manipulation experiments in tropical forests, 2013 American Geophysical Union Annual Meeting, American Geophysical Union, San Francisco, CA, December 2013.
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12. Chen, Haidi A., McKinley, Galen A., **Mouw, Colleen**, 2013, Observed dominance of submesoscale fronts to subtropical chlorophyll, Ocean Carbon and Biogeochemistry Workshop, NASA, NSF, Woods Hole Oceanographic Institution, July 22, 2013 - July 25, 2013.
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15. **Chimner, Rodney A.**, 2014, Northern white cedar restoration, Northeast White Cedar Plant Community Restoration Project Technical Advisory Meeting, Grand Rapids, MN.
16. **Chimner, Rodney A.**, 2014, Restoring Northern White Cedar in the Great Lakes Region, Challenges in Forest Regeneration, MISAF, Escanaba, MI.
17. **Coble, Adam P., Cavaleri, Molly A.**, 2013, Comparison of sugar maple leaf morphology in a closed-canopy and canopy gap, 2013 98th Annual Meeting of the Ecological Society of America, Minneapolis, MN, Ecological Society of America, Minneapolis, MN, August 2013.
18. **Coble, Adam P., Cavaleri, Molly A.**, 2014, MAESTRA: A three-dimensional canopy process model, 2014 USGS John Wesley Powell Center for Analysis and Synthesis Working Group: Integrating modeling and empirical approaches to improve predictions of tropical forest responses to global warming. Fort Collins, CO, 2014 USGS John Wesley Powell Center for Analysis and Synthesis, Fort Collins, CO, April 2014.
19. **Coble, Adam P., Cavaleri, Molly A.**, 2014, Team MAESTRA: Adventures in canopy function modeling, 2014 USGS John Wesley Powell Center for Analysis and Synthesis Working Group: Integrating modeling and empirical approaches to improve predictions of tropical forest responses to

global warming. Fort Collins, CO, USGS John Wesley Powell Center for Analysis and Synthesis, Fort Collins, CO, April 2014.

20. **Coble, Ashley A., Marcarelli, Amy M., Huckins, Casey J.**, 2013, Nitrogen and phosphorus, but not carbon, are quickly taken up in streams: assessing variability in nutrient uptake across six Lake Superior tributaries, Annual meeting, Ecological Society of America, Minneapolis, MN, August 2013.
21. **Coble, Ashley A., Marcarelli, Amy M., Kane, Evan S.**, 2014, Nutrient Limitation and Temporal Variability of Dissolved Organic Carbon Mineralization in a Lake Superior Tributary, World Water Day Poster Competition, Center for Water and Society, Houghton, MI.
22. **Coble, Ashley A., Marcarelli, Amy M., Kane, Evan S.**, 2014, Nutrient Limitation and Temporal Variability of Dissolved Organic Carbon Mineralization in a Lake Superior Tributary, ESC/BRC Student Research Forum, Ecosystem Science Center/Biotechnology Research Center, Houghton, MI.
23. **Collins, Alex R., Cavaleri, Molly A.**, 2013, The interspecific differences in growth and water use efficiency between trembling aspen (*Populus tremuloides*) and red maple (*Acer rubrum*) as a result of interannual climate variation in northern Minnesota, 2013 98th Annual Meeting of the Ecological Society of America, Minneapolis, MN, Ecological Society of America, Minneapolis, MN, August 2013.
24. Collins, Scott F., Baxter, Colden V., Felicetti, Laura, Florin, Scott, **Marcarelli, Amy M.**, Wipfli, Mark S., Servheen, Gregg, 2014, Direct and Indirect Responses of Stream and Riparian Organisms to Artificial Additions of Salmon Carcasses and Salmon Analog Pellets are Mediated by Subsidy Form and Duration, Annual meeting, Idaho Chapter of the American Fisheries Society, Idaho Falls, Idaho, February 10, 2014 - February 13, 2014.
25. Das, Padmini, **Datta, Rupali**, V R Reddy, Pidatala, Sarkar, Dibyendu, 2013, Proteomic profiling of Vetiver grass (*Chrysopogon zizanioides*) under 2,4,6-Trinitrotoluene (TNT) stress, International Phytotechnology Society Annual Meeting, International Phytotechnology Society, Syracuse, NY, October 1, 2013 - October 4, 2013.
26. Das, Padmini, Sarkar, Dibyendu, Panja, Saumik, **Datta, Rupali**, 2013, Stimulative phytoremediation of 2,4,6-Trinitrotoluene (TNT) from Soil using Vetiver Grass (*Chrysopogon zizanioides* L.), MED-GEO 2013, Geology and Health Div. of Geological Soc. of America, Arlington, VA, August 25, 2013 - August 29, 2013.
27. Das, Padmini, **Sengupta, Aparupa**, Nelson, Diane, Sarkar, Dibyendu, **Datta, Rupali**, 2013, Phytoextraction of RDX-contaminated aqueous media by Vetiver Grass (*Chrysopogon zizanioides*), Joint Annual Meeting of the American Society of Agronomy, Soil Science Society of America and Crop Science Society of America, ASA-CSSA-SSSA, Tampa, FL, November 3, 2013 - November 6, 2013.
28. D'Sa, Eurico, Goes, Joaquim, Naik, Puneeta, **Mouw, Colleen**, Gomes, Helga, 2013, Summer bio-optical properties in the southeastern Bering Sea, International Ocean Color Meeting, International Ocean Colour Coordinating Group, Darmstadt, Germany, May 2013.
29. Eggert, Sue, Timm, Anne, King, Nicole, **Olson, James, Marcarelli, Amy M.**, Kolka, Randy, Higgins, Dale, Reinecke, Sue, 2014, Improved stream food web function associated with stream simulation design culverts in northern Great Lakes streams, Minnesota Lake Superior Watershed Stream Science Symposium, Duluth, MN, January 2014.
30. **Flaspohler, David J.**, 2013, Ecosystem response to intensive bioenergy plantings in South America, PIRE NSF Ecosystem Team Leader presentation, NSF, Buenos Aires, Argentina, May 26, 2013 - May 28, 2013.
31. **Froese, Robert E.**, Premer, Michael I., **Nagel, Linda M.**, 2013, Aspen site productivity - biomass harvesting project, NCASI Northern Regional Meeting 2013, National Council for Air and Stream Improvement, Inc, Wausau, WI, May 8, 2013 - May 9, 2013.
32. Goodman, Keli, Hall, Robert O., Baxter, Colden V., **Marcarelli, Amy M.**, Roberts, Brian J., Tank, Jennifer L., Lunch, Claire K., Berukoff, Steve, Powell, Heather, 2013, Challenges and opportunities of

long-term continuous metabolism, Annual meeting, Ecological Society of America, Minneapolis, MN, August 2013.

33. Goodman, Keli, Lunch, Claire K., Baxter, Colden V., Hall, Robert O., Holtgrieve, Gordon W., Roberts, Brian J., **Marcarelli, Amy M.**, Tank, Jennifer L., 2013, Challenges and opportunities of long-term continuous metabolism at the National Ecological Observatory Network, Annual meeting, American Geophysical Union, San Francisco, CA, December 2013.
34. **Griffis, Veronica W.**, 2013, Assessment of Regional Variation in Watershed Flood Response and Delineation of Hydrologically Homogeneous Regions Using Spatially Distributed Data (invited), AGU Fall Meeting 2013, AGU, San Francisco, CA, December 11, 2013.
35. **Griffis, Veronica W.**, 2013, Long-term Flood Risk Forecasts Informed by Climate and Land Use Projections (invited), Developing Sustainable Networks of Women Scientists for Addressing Issues of Hydrologic Events and Hazards, COACH for Scientists, Buenos Aires, Argentina, November 5, 2013.
36. **Griffis, Veronica W.**, Salvadori, Neila, 2013, Evaluation of the Relative Influence of Climate Variability and Human Activities on Flood Risk in Moderately Impaired Watersheds, AGU Fall Meeting 2013, AGU, San Francisco, CA, December 13, 2013.
37. **Grunert, Brice**, Klump, Val, **Mouw, Colleen**, 2014, The role of meteorological forcing on the persistence and mixing of distinct water masses in Green Bay, Lake Michigan, Ocean Sciences, Association for the Science of Limnology and Oceanography; The Oceanography Society; American Geophysical Union, Honolulu, HI, February 24, 2014 - February 28, 2014.
38. **Gulley, Jason**, 2013, Role of conduits in melt of debris covered glaciers, Glacier Works, Initially Kathmandu, exhibit will travel, December 1, 2013 - 2015.
39. **Halvorsen, Kathleen E.**, 2013, Co-Author (with lead author **Andrew Kozich**, Advisee): "Great Lakes Perceptions of Water-related Resources" at International Symposium on Society and Resource Management Conference. Estes Park, CO. June., June 4, 2013 - June 8, 2013.
40. **Halvorsen, Kathleen E.**, 2013, Panel Author: "Socioecological Impacts from Bioenergy Development across the Americas" at International Symposium on Society and Resource Management Conference. Estes Park, CO. June., ISSRM, IASNR, Estes Park, CO, June 5, 2013 - June 7, 2013.
41. **Halvorsen, Kathleen E.**, 2013, Paper Presented: "Impacts of Bioenergy Development across the Americas" Halvorsen, Medeiros, Selfa at International Community Development and Sustainability Practice Conference at Columbia University, NYC. September., ICDSR, ICDSR, Columbia University, NYC New York, September 1, 2013 - September 3, 2013.
42. **Halvorsen, Kathleen E.**, 2014, Invited Keynote Presentation at University of Illinois Champaign-Urbana in the Energy from Biomass Institute (EBI) speaker series. "Impacts of Bioenergy Development across the Americas.", Keynote Presentation at University of Illinois Urbana Champaign, April 20, 2014 - April 21, 2014.
43. **Kerfoot, W. Charles**, 2013, Great Lakes Research Center: Welcome, Dedication of the Great Lakes Research Center, Michigan Tech, Michigan Tech, Houghton, August 2, 2013.
44. **Langston, Nancy E.**, 2013, Iron Mining in the Boreal North, Extractive Industries in the Arctic, Memorial University, Newfoundland, Memorial University, October 4, 2013 - October 6, 2013.
45. **Marcarelli, Amy M.**, 2014, Ecosystem approaches to understand stream restoration, Department of Biological Sciences, Idaho State University, Pocatello, ID, January 2014.
46. **Marcarelli, Amy M.**, 2014, Ecosystem approaches to understand stream restoration, Department of Watershed Sciences, Utah State University, Logan, UT, January 2014.
47. **Marcarelli, Amy M.**, 2014, Ecosystem responses to restoration activities in Lake Superior tributaries, Lake Superior Research Presentations, Lake Superior Technical Committee - Great Lakes Fisheries Commission, Great Lakes Research Center, Houghton MI.

48. **Marcarelli, Amy M.**, Baxter, Colden V., Benjamin, Joseph R., Murakami, Masashi, 2013, Does quality trump quantity? Ecosystem-level consequences of subsidies in a forested stream, Annual meeting, Ecological Society of America, Minneapolis, MN, August 2013.
49. **Marcarelli, Amy M.**, Collins, Scott F., Baxter, Colden V., **Huckins, Casey J.**, 2013, How can ecosystem ecology learn from and inform fisheries restoration?, Annual meeting, Ecological Society of America, Minneapolis, MN, August 2013.
50. **Matthys, Anthony D.**, **Huckins, Casey J.**, **Marcarelli, Amy M.**, 2013, Embeddedness: A context dependent driver of fish habitat preference, Annual meeting, Ecological Society of America, Minneapolis, MN, August 2013.
51. Mazzoleni, Lynn R., Dzepina, Katja, Mazzoleni, Claudio, China, Swarup, Fialho, Paulo, Kumar, Sumit, Zhang, Bo, Owen, Robert C., Wright, Kendra, Olsen, Seth, **Perlinger, Judith A.**, **Urban, Noel R.**, Kramer, Louisa J., Dziobak, Michael, Helmig, Detlev, Hueber, Jacques, 2013, Chemical and Molecular Characterization of Free Tropospheric Aerosol Sampled at the Pico Mountain Observatory, Azores, American Association of Aerosol Research, 2013, American Association of Aerosol Research, Portland, September 30, 2013 - October 4, 2013.
52. **Minakata, Daisuke**, 2013, Organic matter of hills and humans origin: Impacts on freshwater and oceanic ecosystems, International Symposium on the Connectivity of Hills, Humans and Oceans (CoHHO) Integrated ecosystem management from hill to ocean, Kyoto University, Kyoto, November 26, 2013 - November 28, 2013.
53. **Minakata, Daisuke**, Guo, Xin, Crittenden, John C., 2013, Mechanistic insights on intermediates and byproducts formation in aqueous phase advanced oxidation processes using computer-based first-principles and kinetic Monte Carlo Techniques, Advanced Oxidation Technology-19, San Diego CA, November 19, 2013 - November 23, 2013.
54. **Minakata, Daisuke**, Mezyk, Stephene, Crittenden, John C., Huang, Ching-Hua, 2014, Can we predict intermediate-radicals and stable-byproducts in the aqueous phase advanced oxidation processes using computational chemistry, Borchardt conference, American Water Works Association and University of Michigan, University of Michigan, February 25, 2014 - February 26, 2014.
55. Moore, Timothy, **Mouw, Colleen**, Twardowski, Michael, Sullivan, James, 2013, Ocean color observation in Lake Erie for HAB detection, IAGLR Conference, International Association of Great Lakes Research, West Lafayette, IN, June 3, 2013 - June 7, 2013.
56. **Mouw, Colleen**, 2013, Phytoplankton size variability in the global ocean, International Ocean Color Meeting, International Ocean Colour Coordinating Group, Darmstadt, Germany, May 2013.
57. **Mouw, Colleen**, 2014, New Approaches in Satellite Remote Sensing of Ecosystem Change in the Great Lakes, AAAS Annual Meeting, AAAS, Chicago, IL, February 13, 2014 - February 17, 2014.
58. **Mouw, Colleen**, 2014, Observed dominance of sub-mesoscale fronts to oligotrophic chlorophyll, Ocean Science, AGU, ASLO, TOS, Honolulu, HI, February 24, 2014 - February 28, 2014.
59. **Mouw, Colleen**, 2014, Optics and Remote Sensing of Lake Superior, Lake Superior Technical Committee, Great Lakes Fisheries Commission, Houghton, MI, January 7, 2014.
60. **Mouw, Colleen**, 2014, Phytoplankton Cells to Ecosystems: from the Global Ocean to the Great Lakes, Invited seminar, University of Minnesota-Duluth, Large Lakes Observatory, Duluth, MN, April 2014 - April 30, 2014.
61. **Mouw, Colleen**, Greb, Steven, 2013, Status and Recent Recommendations for Remote Sensing of Coastal and Inland Waters, IAGLR Conference, International Association of Great Lakes Research, West Lafayette, IN, June 3, 2013 - June 7, 2013.
62. Niehaus, Joseph, **Becker, Jennifer G.**, China, Swarup, Mazzoleni, Claudio, Kostinski, Alexander B., Cantrell, Will H., 2014, Laboratory measurements of contact freezing by dust and bacteria at temperatures of mixed phase clouds, European Geophysical Union, spring meeting, EGU, Vienna, Austria, April 29, 2014 - May 2, 2014.

63. **Olson, James C., Marcarelli, Amy M., Huckins, Casey J.**, 2014, Spatial Heterogeneity of Biofilm Biomass: Relationship to Substrate Size, Velocity and Depth, World Water Day Poster Competition, Center for Water and Society, Houghton, MI.
64. **Olson, James C., Marcarelli, Amy M., Huckins, Casey J.**, 2014, Spatial Heterogeneity of Biofilm Biomass: Relationship to Substrate Size, Velocity and Depth, ESC/BRC Student Research Forum, Ecosystem Science Center/Biotechnology Research Center, Houghton, MI.
65. **Olson, James C., Marcarelli, Amy M.**, Timm, Anne, Eggert, Sue L., Kolka, Randall K., 2013, Evaluating the impact of culvert designs on hydrologic connectivity and nutrient uptake in Northern Wisconsin streams, Annual meeting, Ecological Society of America, Minneapolis, MN, August 2013.
66. **Ortiz, Jade, Marcarelli, Amy M.**, Fahnenstiel, Gary L., Smith, Robert, 2014, Impact of Nutrient Loading and Eurasian Watermilfoil on Phytoplankton Communities among Channels of the Les Cheneaux Islands, Lake Huron, World Water Day Poster Competition, Center for Water and Society, Houghton, MI.
67. **Ortiz, Jade, Marcarelli, Amy M.**, Fahnenstiel, Gary L., Smith, Robert, 2014, Impact of Nutrient Loading and Eurasian Watermilfoil on Phytoplankton Communities among Channels of the Les Cheneaux Islands, Lake Huron, ESC/BRC Student Research Forum, Ecosystem Science Center/Biotechnology Research Center, Houghton, MI.
68. Punamiya, Pravin, Sarkar, Dibyendu, **Datta, Rupali**, 2013, Effect of Solution Properties on Tetracycline Removal by Iron-Based Drinking Water Treatment Residuals, MED-GEO 2013, Geology and Health Div. of Geological Soc. of America, Arlington, VA, August 25, 2013 - August 29, 2013.
69. Punamiya, Pravin, Sarkar, Dibyendu, **Datta, Rupali**, 2013, Remediation of Tetracyclines in Manure and Manure Amended Soils: A Long-Term Greenhouse Column Study, Joint Annual Meeting of the American Society of Agronomy, Soil Science Society of America and Crop Science Society of America, ASA-CSSA-SSSA, Tampa, FL, November 3, 2013 - November 6, 2013.
70. Rakshit, Sudipta, Sarkar, Dibyendu, **Datta, Rupali**, 2013, Molecular Mechanisms of Oxytetracycline Sorption on Goethite, Hematite, and Magnetite: In Situ ATR-FTIR Study, Joint Annual Meeting of the American Society of Agronomy, Soil Science Society of America and Crop Science Society of America, ASA-CSSA-SSSA, Tampa, FL, November 3, 2013 - November 6, 2013.
71. Rakshit, Sudipta, Sarkar, Dibyendu, **Datta, Rupali**, 2013, Surface complexation of antimony on kaolinite, MED-GEO 2013, Geology and Health Div. of Geological Soc. of America, Arlington, VA, August 25, 2013 - August 29, 2013.
72. Reddy, V. R., Pidatala, **Datta, Rupali**, Sarkar, Dibyendu, 2013, Comparative Metabolomic Profiling of Vetiver (*Chrysopogon zizanioides*) and Maize (*Zea mays*) under Lead Stress, Joint Annual Meeting of the American Society of Agronomy, Soil Science Society of America and Crop Science Society of America, ASA-CSSA-SSSA, Tampa, FL, November 3, 2013 - November 6, 2013.
73. Resh, Sigrid, **Kane, Evan S.**, Richter, Dana L., 2013, Interactive effects of climate change and decomposer communities on the stabilization of wood-derived carbon in soils: Catalyst for a new study, TES/SBR Joint Investigators Meeting, DOE, Washington D.C., May 14, 2013 - May 15, 2013.
74. Salvadori, Neila, **Griffis, Veronica W.**, 2013, Evaluation of the Influence of Climate Variability on Flood Risk in Moderately Impaired Watersheds, World Water & Environmental Resources Congress 2013, ASCE, Cincinnati, OH, May 2013.
75. Sarkar, Dibyendu, **Datta, Rupali**, 2013, Urban Sprawl and "Green" Remediation of Residential Soils: A Case Study with Arsenic, Joint Annual Meeting of the American Society of Agronomy, Soil Science Society of America and Crop Science Society of America, ASA-CSSA-SSSA, Tampa, FL, November 3, 2013 - November 6, 2013.
76. **Seagren, Eric A.**, 2013, Great Lakes Research Center at MTU, 59th Annual Upper Peninsula Wastewater Operators Conference, Michigan Water Environment Association (MWEA) Local Section 21, Harris, MI, May 14, 2013 - May 15, 2013.

77. **Seely, Bruce E.**, 2013, Ghosts of the Future: Histories of Technology in STS, Asia Pacific Science Technology and Society Network Biennial Meeting, National University of Singapore, Singapore, July 15, 2013.
78. **Seely, Bruce E.**, 2014, Historical Perspective on Demonstration Projects, Annual Meeting, Transportation Research Board, Transportation Research Board, Washington, DC, January 15, 2014.
79. **Sengupta, Aparupa, Sarkar, Dibyendu, Bagley, Susan, Datta, Rupali**, 2013, Using biological remediation system to address antibiotic contamination of water sources., MED-GEO 2013, Geology and Health Div. of Geological Soc. of America, Arlington, VA, August 25, 2013 - August 29, 2013.
80. Siddhu, Virinder, Rakshit, Sudipta, Sarkar, Dibyendu, **Datta, Rupali**, 2013, Effects of biosolids addition on the total and plant available copper in the contaminated stamp sands of Torch Lake: An incubation study., Joint Annual Meeting of the American Society of Agronomy, Soil Science Society of America and Crop Science Society of America, ASA-CSSA-SSSA, Tampa, FL, November 3, 2013 - November 6, 2013.
81. Siddhu, Virinder, Sarkar, Dibyendu, Punamiya, Pravin, **Datta, Rupali**, 2013, Geochemical forms of copper and phosphorus in copper mining impacted sediments of Upper Peninsula, Michigan, MED-GEO 2013, Geology and Health Div. of Geological Soc. of America, Arlington, VA, August 25, 2013 - August 29, 2013.
82. **Spellman, Patricia, Griffis, Veronica W.**, 2013, Stream Flow Across Hydrologic Boundaries: Implications for Flood Frequency Analysis in Karst Terrain, Geological Society of America Annual Meeting, Denver, CO, October 27, 2013.
83. **Spellman, Patricia, Griffis, Veronica W., LaFond, Kaye**, 2013, Impacts of Climate Change on Current Methodologies for Flood Risk Analysis: Watershed-Scale Analyses Using the Soil and Water Assessment Tool (SWAT), AGU Fall Meeting 2013, AGU, San Francisco, CA, December 12, 2013.
84. **Trochta, John, Mouw, Colleen**, 2014, OBSERVING INTERANNUAL VARIABILITY OF SATELLITE-DERIVED PROPERTIES IN LAKE SUPERIOR WITH THE USE OF FUZZY CLUSTERING, Ocean Sciences, Association for the Science of Limnology and Oceanography; The Oceanography Society; American Geophysical Union, Honolulu, HI, February 24, 2014 - February 28, 2014.
85. **Veverica, Timothy J., Kane, Evan S., Marcarelli, Amy M., Green, Sarah A.**, 2014, Fluorescence Spectroscopy Suggests Extracellular Electron Shuttling is a Dominant Metabolic Pathway in Temperate Peatlands, World Water Day Poster Competition, Center for Water and Society, Houghton, MI.
86. **Veverica, Timothy J., Kane, Evan S., Marcarelli, Amy M., Green, Sarah A.**, 2014, Fluorescence Spectroscopy Suggests Extracellular Electron Shuttling is a Dominant Metabolic Pathway in Temperate Peatlands, ESC/BRC Student Research Forum, Ecosystem Science Center/Biotechnology Research Center, Houghton, MI.
87. Zhang, Bo, Owen, Robert C., **Perlinger, Judith A.**, Val Martin, Maria, Kramer, Louisa J., Mazzoleni, Lynn R., 2013, Chemical climatology of air pollutants at Pico Mountain Observatory, American Geophysical Union Meeting, American Geophysical Union, San Francisco, CA, December 9, 2013 - December 13, 2013.

6.4 Editorial Activities

Bagley, Susan T.

Editor, MicrobeLibrary, American Society for mCrobiology, Papers, Appointed. July 1, 2012 - Present.
Editorial Board Member, Journal of Industrial Microbiology and Biotechnology, Society for Industrial Microbiology, Appointed. July 1, 2003 - June 30, 2013.

Barkdoll, Brian D.

Associate Editor, Journal of Hydraulic Engineering, ASCE.
Associate Editor, Journal of Water Resources Planning and Management, ASCE.

Campbell, Gary A.

Associate Editor, Resources Policy, Papers, Appointed. January 2011 - Present.
Editorial Board Member, African Journal of Business Management. 2007 - Present.

Datta, Rupali

Editor, Journal Editor, Current Pollution Reports,
Editor, Textbook, An Integrated Approach to Environmental Management, Wiley, Papers, Appointed. March 2013 - Present.
Associate Editor, International Journal of Environmental Science and Technology, Papers, Appointed. 2013 - Present.

Doskey, Paul V.

Editor, Journal of Great Lakes Research.

Gierke, John S.

Associate Editor, Journal of Contaminant Hydrology, Appointed. 2009 - Present.

Griffis, Veronica W.

Editor, Book, Applications of Statistical Distributions in Hydrologic Sciences and Engineering, American Society of Civil Engineers.
Associate Editor, ASCE Journal of Hydrologic Engineering, American Society of Civil Engineers, Papers. October 2012 - Present.

MacLennan, Carol A.

Editorial Board Member, He Kā Waiho Ho‘ohemahema, Hawaiian Journal of History, Papers, Appointed. January 2013 - Present.
Editorial Board Member, Justice on Kaua‘i, Hawaiian Journal of History, Papers. January 2013 - Present.
Editorial Board Member, The Royal Residences, Hawaiian Journal of History. January 2013 - Present.

Marcarelli, Amy M.

Associate Editor, Freshwater Science, Society for Freshwater Science, Papers, Appointed. March 1, 2013 - Present.

Merz, Thomas E.

Editorial Board Member, International Journal of Business Studies, Appointed. August 30, 2007 - Present.

Minakata, Daisuke

Associate Editor, Journal of Advanced Oxidation Technologies, Papers, Appointed. January 1, 2014 - Present.

Rose, William I.

Editor, Journal Editor, Journal of Volcanology and Geothermal Research.

Seagren, Eric A.

Editorial Board Member, Korean Society for Civil Engineering (KSCE) Journal of Civil Engineering, Papers, Appointed. July 2011 - Present.

Editorial Board Member, Visual Media Briefs, American Society for Microbiology, Papers, Appointed. July 1, 2012 - June 30, 2015.

Waddell, Craig

Editorial Board Member, Environmental Communication Yearbook, Papers, Appointed. January 2002 - Present.

Watkins, David W.

Editorial Board Member, Journal of Water Resources Planning & Mgmt. (ASCE), Papers, Appointed. December 2004 - Present.

Associate Editor, Journal of Water Resources Planning and Management, Appointed. December 2004 - Present.
Associate Editor, ASCE Journal of Water Resources Planning and Management Papers. 2004 - Present.

7 Appendix 1: CWS Faculty/Staff Participants

Biological Sciences

Nancy A. Auer
Susan T. Bagley
Rupali Datta
Casey J. Huckins
Charles W. Kerfoot
Amy M. Marcarelli

Chemistry

Sarah A. Green

Civil & Environmental Engineering

Martin T. Auer
Brian D. Barkdoll
Jennifer G. Becker
Paul Doskey
Veronica Griffis
David W. Hand
Neil J. Hutzler
Alex S. Mayer
Daisuke Minakata
Judith A. Perlinger
Eric A. Seagren
Noel R. Urban
David W. Watkins

Geological & Mining Eng. & Science

Suzanne Beske-Diehl
John S. Gierke
Jason D. Gulley
Alex S. Mayer
Colleen B. Mouw
Wayne D. Pennington
William I. Rose

Humanities

R. Craig Waddell

Michigan Tech Research Institute (MTRI)

Colin Brooks
Liza Jenkins
Nathaniel Jessee

School of Business & Economics

William S. Breffle
Gary Campbell
Thomas E. Merz

School of Forest Resources & Environmental Science

Molly A. Cavaleri
Rodney A. Chimner
David J. Flaspohler
Margaret R. Gale
Kathleen E. Halvorsen
Martin F. Jurgensen
Evan S. Kane
Blair D. Orr
James M. Schmierer
Amy J. Schrank
Kenneth J. Vrana
Joseph W. Wagenbrenner

Social Sciences

Melissa P. Baird
Mary Durfee
Hugh Gorman
Kathleen E. Halvorsen
Nancy E. Langston
Carol A. MacLennan
Patrick E. Martin
Susan R. Martin
Timothy Scarlett
Bruce E. Seely

Western UP Center for Science, Mathematics & Environmental Education

Joan F. Schumaker Chadde

Adjunct Faculty

Daya Muralidharan
Linda M. Nagel
Thomas G. Pypker
John Sutherland
Qiong Zhang

8 Appendix 2: CWS Student Participants

Biological Sciences

Emily Bouckaert
Ashley Coble
Brian Danhoff
Cameron Goble
Martin Hobmeier
John "Marty" Holtgren
Taylor Luginbill, undergrad
Jeff Kiiskila
Sara Klemm
Anthony Matthys
Barbara Michel
Stephanie Ogren
Jeremy Olach
James Olson
Jade Ortiz, undergrad
Schueller, Kyle, undergrad
Aparupa Sengupta
Alexandria Winters, undergrad
Jade Woiderski, undergrad
Foad Yousef, post-doc

Civil & Environmental Engineering

Helen Amiri
Nate Arnold
Megan Dalbec
Marcel Dijkstra
Ben Downer
Jennifer Fuller
Laura Gallagher
Meng Gao
Rasika Gawde
Andrew Grow
Rabi Gywali
Kaitlin Hannum
Meral Jackson
Erica Jones
Tanvir Khan
Anika Kuczynski
Aditya Kumar
Kaye LaFond
Taile Leswif
Ankita Mandelia
Christa Meingast
Leigh Miller
Ali Mirchi, post-doc
Renee Oats
Julie Padilla
Alicia Sherrin

Emily Sokol
Jennie Tyrell
Lindsey Watch
Nathan Zgnilec

Geological & Mining Engineering & Sciences

Paula Giryn
Emily Gochis
Brice Grunert
James Havu
Toni Larche
Rachel Pressley, undergrad
Josh Richardson, post-doc
John Trochta
Angela Yu

School of Forest Resources & Environmental Science (SFRES)

Brenda Bergman
Adam Coble
Alex Collins
Erin Collins, undergrad
Aleta Daniels
Joshua Davis
Eric Dipping, undergrad
Erin Grupido, undergrad
Scott Hillard
John Hribljan, post-doc
Rita Koch
Cassandra Ott
Melissa Patterson, undergrad
Matt Van Grinsven
Timothy Veverica

Social Sciences

Aparajita Banerjee
Valorie Gagnon
Naima Khan
Andrew Kozich
Amanda Krueze
Mariah Maggio
Margaret Morrison
Brian Pattullo
Anna Lee Presley
Emma Schwaiger
Travis Wakeham, undergrad
Melanie Yang

Appendix 3: CWS Advisory Committee

Director

Noel Urban
nurban@mtu.edu

Civil & Environmental Engineering

Administrative Assistant

Carol J. Asiala
cjasiala@mtu.edu

Geological & Mining Engineering & Science

Advisory Committee

Rupali Datta
rupdatta@mtu.edu

Biological Sciences

Sarah A. Green
sgreen@mtu.edu

Chemistry

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dminakat@mtu.edu

Civil & Environmental Engineering

Jason Gulley
jdgulley@mtu.edu

Geological & Mining Engineering & Science

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Humanities

Colin Brooks
colin.brooks@mtu.edu

Michigan Tech Research Institute

Thomas Merz
temerz@mtu.edu

School of Business & Economics

Rod Chimner
rchimner@mtu.edu

School of Forest Resources & Environmental Science
(SFRES)

Emma Norman
esnorman@mtu.edu

Social Sciences

Joan F. Schumaker Chadde
jchadde@mtu.edu

Western Upper Peninsula Center for Science, Mathematics &
Environmental Education

CWS Subcommittees

Research and Education: Jason Gulley, Daisuke Minakata, Noel Urban

Seminars and Symposia: Emma Norman, Joan Chadde, Rod Chimner, Noel Urban