

**Institute of Water Research
Annual Technical Report
FY 2008**

Introduction

The Institute of Water Research (IWR) at Michigan State University (MSU) continuously provides timely information for addressing contemporary land and water resource issues through coordinated multidisciplinary efforts using advanced information and networking systems. The IWR endeavors to strengthen MSU's efforts in nontraditional education, outreach, and interdisciplinary studies utilizing available advanced technology, and partnerships with local, state, regional, and federal organizations and individuals. Activities include coordinating education and training programs on surface and ground water protection, land use and watershed management, and many others. (An extended introduction can be found in our FY2001 Annual Technical Report.) We also encourage accessing our web site which offers a more comprehensive resource on IWR activities, goals, and accomplishments: <http://www.iwr.msu.edu>.

The Institute has increasingly recognized the acute need and effort for multi-disciplinary research to achieve better water management and improved water quality. This effort involves the integration of research data and knowledge with the application of models and geographic information systems (GIS) to produce spatial decision support systems (SDSS). These geospatial decision support systems provide an analytical framework and research data via the web to assist individuals and local and state government agencies make wise resource decisions. The Institute has also increasingly become a catalyst for region wide decision-making support in partnership with other states in EPA Region 5 using state-of-the-art decision support systems.

The Institute also works closely with the MSU Cooperative Extension Service to conduct outreach and education. USGS support of this Institute as well as others in the region enhances the Institute credibility and facilitates partnerships with other federal agencies, universities, and local and state government agencies. The Institute also provides important support to MSU-WATER, a major university initiative dealing with urban storm water issues with funding from the university Vice President for Finance. A member of the Institute's staff works half-time in facilitating MSU-WATER activities so the Institute enjoys a close linkage with this project. The following provides a more detailed explanation of the Institute's general philosophy and approach in defining its program areas and responsibilities.

General Statement

To deal successfully with the emergence of water resource issues unique to the 21st century, transformation of our knowledge and understanding of water for the protection, conservation, and management of water resources is imperative. Radically innovative approaches involving our best scientific knowledge, extensive spatial databases, and intelligent tools that visualize wise resource management and conservation in a single holistic system are likewise imperative. Finally, holistic system analysis and understanding requires a strong and integrated multi-disciplinary framework.

Research Program Introduction

The management of water resources, appropriate policies, and data acquisition and modeling continue to be at the forefront of the State Legislatures agenda and numerous environmental and agricultural organizations. Our contribution to informing the debate involved numerous meetings, personal discussions, and most importantly, the enhancement of web-based information to aid in the informed decision-making process.

Unique Capabilities: Decision Support Systems as the Nexus

IWR, with its extended research family, is exceptionally well-positioned to integrate research conducted within each of the three principal water research domains: hydrologic sciences, water resources, and aquatic ecosystems. Integrated decision support both reflects and forms the nexus of these three research domains. Expanding web accessibility to the decision support system nexus (formed by the intersection of the three research domains) will facilitate broad distribution of science-based research produced in these domains. A special emphasis is being placed on facilitation of science-based natural resource state and national policy evolution.

The Institute's extensive experience in regional and national networking provides exceptional opportunities for assembling multi-agency funding to support interdisciplinary water research projects and multi-university partnerships.

Using a Multi-Disciplinary Framework

Using a multi-disciplinary framework facilitates dynamic applications of information to create geospatial, place-based strategies, including watershed management tools, to optimize economic benefits and assure long-term sustainability of valuable water resources. New information technologies including GIS and computational analysis, enhanced human/machine interfaces that drive better information distribution, and access to extensive real-time environmental datasets make a new intelligent reality possible.

Effective watershed management requires integration of theory, data, simulation models, and expert judgment to solve practical problems. Geospatial decision support systems meet these requirements with the capacity to assess and present information geographically, or spatially, through an interface with a geographic information system (GIS). Through the integration of databases, simulation models, and user interfaces, these systems are designed to assist decision makers in evaluating the economic and environmental impacts of various watershed management alternatives.

The ultimate goal of these new imperatives is to secure and protect the future of water quality and supplies in the Great Lakes Basin and across the country and the world with management strategies based on an understanding of the uniqueness of each watershed.

Grant No. 05HQGR0172 Strategic Conceptual Plan for Submittal to the Army Corps of Engineers for the 516(e) Great Lakes Tributary Modeling Program

Basic Information

Title:	Grant No. 05HQGR0172 Strategic Conceptual Plan for Submittal to the Army Corps of Engineers for the 516(e) Great Lakes Tributary Modeling Program
Project Number:	2005MI97S
Start Date:	9/1/2005
End Date:	8/31/2009
Funding Source:	Supplemental
Congressional District:	8th
Research Category:	Water Quality
Focus Category:	Water Quality, Sediments, Models
Descriptors:	Spatial Decision Support System
Principal Investigators:	Jon Bartholic, Jeremiah A Asher, Ouyang Da, Da Ouyang, Saichon Seedang, Yi Shi

Publication

1. Zhai, Tong, Yi Shi, Rick Farnsworth, Bernard A. Engel, Jon Bartholic, Larry Theller, and David F. Bucaro. 2007. An interoperable, multi-host WEB-GIS based hydrologic and erosion modeling system

Title: Strategic Conceptual Plan for Submittal to the Army Corps of Engineers for the 516(e) Great Lakes Tributary Modeling Program Soil Erosion and Sedimentation Reduction Web Tool System Project (SESRTS)

Project Number: 2005MI97S

Start: 09/01/05(actual)

End: 08/31/09 (actual)

Funding Source: USGS ("104B") Supplemental

Congressional District: eighth

Research Category: Water Quality

Focus Categories: SED, WQL, MOD

Descriptors: Spatial Decision Support System

Primary PI: Jon F. Bartholic, Institute of Water Research, Michigan State University

Yi Shi, Research Associate and GIS Specialist, Institute of Water Research,
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Saichon Seedang, Visiting Research Associate, Institute of Water Research,
Michigan State University

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University

Jeremiah Asher, GIS Specialist, Institute of Water Research, Michigan State
University

Project Class: Research

Introduction

Background/Purpose

The goal of this effort is to create a more detailed soil erosion and sedimentation reduction web tool system using new web-based information technology capabilities that utilize spatial data and models, and economic and policy perspectives for more effective support of state and local efforts in order to reduce sediment and pollutant loadings to tributaries within the Great Lakes Basin.

General Statement

Problem/Demand

Sediment and nutrient loadings from nonpoint sources are major contributors to water pollution in the Great Lakes region and throughout the world. Sediment loadings cause two highly adverse economic impacts on our ecosystem: 1) lost productivity from unnecessary erosion, and 2) the costs of dredging for navigational and environmental purposes. The U.S. Army Corps of Engineers (ACOE) expends over \$15 million annually in the Great Lake's Basin for dredging sediment from Great Lakes waterways. To control and reduce these loadings to our rivers, lakes, and streams, public agencies and private land owners need effective tools for targeting practices that reduce the volume of sediment leaving the land.

ACOE Program

The ACOE Great Lakes Tributary Modeling Program, under Section 516(e) of the Water Resources Development Act of 1996, is an important initiative which complements other



programs designed to reduce sediment delivery to rivers and streams. This Program has funded numerous modeling efforts intended to encourage watershed planning and other local actions to control sediment movement and impacts. However, to achieve optimal reduction of pollutant loadings in water quality-impaired watersheds and to maintain water quality in others, there is an increasing demand for tools that provide accurate assessment of best conservation practices to apply and prioritize risk prone sites in these watersheds.

With progress on this SESRTS project over the past few years, development, evaluation, and feedback from initial user's efforts can now be focused on expanding the availability and adoption of SESRTS across the Great Lake's Basin. Following are Tasks/Deliverables for the next year to facilitate this basin-wide expansion.

Methodology

Research Program

Expansion of the HIT (High Impact Targeting) tool across the Great Lakes Basin

In 2007-2008, IWR made significant improvements to the processing time required by SEDMOD (Spatially Explicit Delivery Model), one of HIT's key inputs. Previously, a single SEDMOD run for an 8-digit watershed could take anywhere from a few days to two weeks. IWR effectively reduced this time to several hours by optimizing the underlying modeling algorithms of SEDMOD. This advancement (with some further enhancements) will allow IWR to attempt a basin-wide HIT analysis. IWR will conduct this analysis at a 30-meter resolution, and attempt to provide 10-meter analyses where higher resolution DEMs (Digital Elevation Models) exist. All of the data required for the basin-wide analyses are currently available, except for certified 12-digit watershed boundaries for Minnesota and New York. Indications are that these will be available by the end of 2008. The results of these analyses will be available for query and display through the on-line HIT tool and Digital Watershed. Users will be able to view surface erosion and sedimentation data at multiple scales (8, 10, and 12-digit watersheds and at the field level), perform comparative analyses between sub-watersheds, and evaluate the impacts of selected BMPs for any location within the Great Lakes Basin. The SEDMOD modeling improvement work will be continued to further enhance its capabilities such as handling very large data sets.

Prioritization of Great Lakes Basin HUC 8's

In 2007-2008, IWR utilized previous year's sediment estimates, additional nutrient models, and supplementary environmental, social, and economic variables to rank the Great Lakes Basin's 100+ 8-digit watersheds. The goal of this task was to assist the Corps in its selection of watersheds for future detailed sediment modeling. For the 2008-2009 year IWR will continue this effort to further refine the rankings by incorporating Corps data on harbor and dam locations into the rankings. These results will be presented to the ACOE so they can make a final selection of 10 watersheds across the basin that will receive greater attention.



Develop a Strategy Scope for Additional Web Tool Integration into SESRTS

Web-based tools are being developed by diverse drivers, including TMDL, 319, RAP, Ag Programs, and 516. There is an opportunity and need to have diverse "tools" that assist in sediment reduction and assessment of impacts that are being developed by various groups and integrated to the extent possible into one system, such as SESRTS, for optimizing end user's easy use of a suite of tools via a friendly interface. Implementation of the plans early phases will occur during this next year: identify "tools," assess their relative value via feedback from user assessments, develop a scope strategy for inclusion, and demo a prototype integrated system.

Strategic Plan and Initial Expansion through the Great Lakes Basin

Develop a strategic plan to include awareness, transference, adoption, and utilization of the SESRTS across the Basin by natural resource/watershed/government personnel, and units. We will work with the Great Lakes Commission on developing a strategic plan and will initiate implementation of the strategic plan (technology transfer) across the Basin.

Exploring the Feasibility of Establishing the Great Lakes Adaptive Watershed Governance

Problem and Research Objectives

Current institutional arrangements across the Great Lakes Basin fail, for the most part, to provide a coherent system of clearly-delineated accountability, or a common framework to coordinate watershed performance objectives among numerous local, state, regional, and federal agencies. These frequently dysfunctional institutional relationships preclude the effective implementation of a full suite of coordinated and targeted watershed management practices to improve water quality and protect ecosystem services in any given watershed.

Adaptive Watershed Governance

Adaptive Watershed Governance (AWG) is the process of correlating and integrating the independent and often overlapping efforts of various government agencies, private environmental organizations, local communities, and local stakeholders to achieve common goals for improving water quality and ecosystems in the most economically efficient manner. Ideally, the process identifies existing financial support and/or economic incentives available to local stakeholders to provide input and support, and participate in efforts to achieve these goals. Existing governmental programs such as the EPA-319 and TMDL, USAEC-516 (e), and NRCS conservation programs, as well as the efforts of nonprofit organizations such as the Joyce Foundation and the Nature Conservancy, have similar goals that are well suited for collaboration and integration in such a way that resources could be more efficiently used to create the greatest environmental benefit, and gain local stakeholders support.

Strategy

Several steps need to be taken in order to determine the feasibility of establishing the AWG. These include analyzing existing social networks and their roles, identifying and developing a policy framework, and selecting a pilot site to explore the model of AWG at a watershed level. Initially, AWG can utilize the upcoming Great Lakes basin-wide education and outreach



initiatives of the Great Lakes Commission to assist in exploring the social network of Conservation Districts that play a crucial role in implementing AWG efforts across the Great Lakes basin. In addition, the strategy includes web-based modeling tools that are in development through Corps funding and already being utilized by some conservation districts. The modeling tools can identify problem areas and assist agencies in priority site selection to concentrate their efforts for a pilot study.

Principle Findings and Significance

Task 1.

- a. An enhanced algorithm and computational system for executing the generation of sediment risk areas over the basin (and other similar types of analyses) will be available.
- b. SEDMOD/RUSLE will be run over the basin.
- c. Results will be incorporated into HIT and Digital Watershed.

Task 2.

- a. New data from the ACOE on sediment removal in harbors and dam locations will be added/incorporated to the analysis and mapping system.
- b. Further refined rankings and analysis will be provided.

Task 3.

- a. Possible additional "tools" from other organizations will be appraised and ranked for consideration of inclusion into SESRTS.
- b. Some initial inclusion into SESRTS will be demonstrated.

Task 4.

- a. A strategy, action item sequence, and timeline for implementation will be documented in cooperation with the GLC.
- b. Numerous early action items in the strategy will be implemented including the engagement of at least three (3) states.
- c. Some additional contact with all states in the basin will take place with initial technology transfer occurring.

Task 5.

- a. Analysis of AWG will occur.
- b. A pilot study site will be selected.
- c. A mock implementation AWG at the watershed level will occur.
- d. A report will include lessons learned, and application to the basin will be assessed.

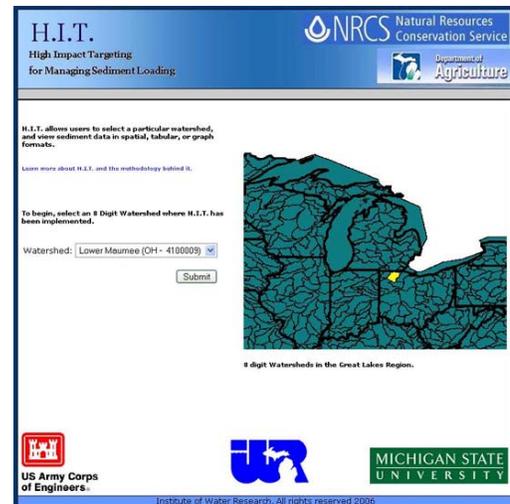


Figure 1. Conservation Innovation Grant (CIG).
<http://www.iwr.msu.edu/CIG-MDA/>

"The HIT program (Figure 2) will help protect water quality in rural areas through the targeted application of appropriate conservation BMPs," said Jon Bartholic, director of the Institute of Water Research.

The Institute will work closely with MDA and soil conservation district staff to implement the HIT approach in three watersheds: the Maple River, Saginaw Bay, and the River Raisin. The HIT program complements the USDA-funded Conservation Reserve Enhancement Program and Conservation Security Program implemented by the MDA in those watersheds.

The HIT program targets installation of conservation BMPs on high-risk erosion areas with the greatest potential to contribute sedimentation and associated loadings to state waterways. The Institute has developed this new technology with Geographic Information Systems (GIS) capacity to increase the efficiency of federal and state conservation programs delivery

Notable Achievements

n/a

Publications

n/a



Grant No. 07HQGR0003 Developing the Water Withdrawal Assessment Tool

Basic Information

Title:	Grant No. 07HQGR0003 Developing the Water Withdrawal Assessment Tool
Project Number:	2006MI114S
Start Date:	10/1/2006
End Date:	6/30/2008
Funding Source:	Supplemental
Congressional District:	8
Research Category:	Water Quality
Focus Category:	Models, Water Quantity, Water Quality
Descriptors:	Spatial Decision Support System
Principal Investigators:	Jeremiah A Asher

Publication

1. Reeves, Howard W., David A. Hamilton, Paul W. Seelbach and A. Jeremiah Asher. 2009. Groundwater-Water-Withdrawal Component of the Michigan Water-Withdrawal Screening Tool. U.S. Department of the Interior, U.S. Geological Survey, 46pgs.

Title: Developing the Water Withdrawal Assessment Tool

Project Number: 2006MI114S

Start: 10/01/06(actual)

End: 06/30/08 (actual)

Funding Source: USGS (“104B”) Supplemental

Congressional District: eighth

Research Category: Water Quality

Focus Categories: WQN, WQL, MOD

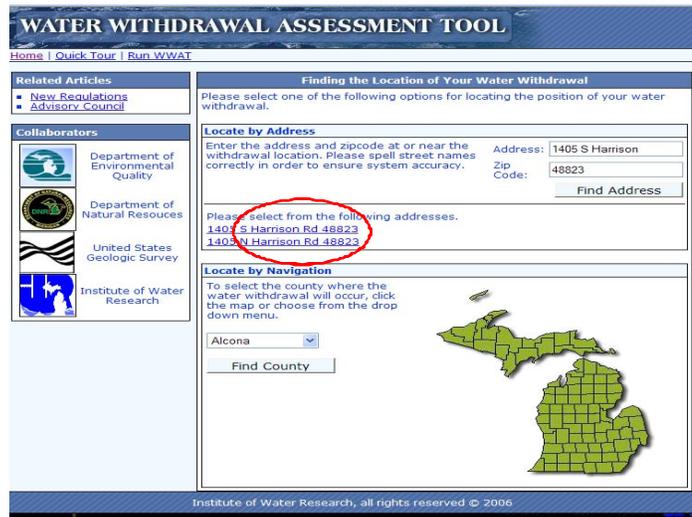
Descriptors: Spatial Decision Support System

Primary PI: Jeremiah Asher, GIS Specialist, Institute of Water Research, Michigan State University

Project Class: Research

Introduction

In 2006 and 2008, the Michigan legislature enacted new laws to manage large quantity water withdrawals in the state using science as the basis for policy development. Several of these laws required a water withdrawal assessment process and tool that could be used by the public to help protect and conserve the waters of the state. The Water Withdrawal Assessment Process was developed using several science-based models that include watershed characteristics, stream flow measurements, resident fish communities in streams throughout the state, and groundwater data. The stream flow model uses soils, geology, land use, and precipitation information to predict how much flow is available in each of 11 different stream types. The fish ecology model determines the impact of a reduction in stream flow on the fish species and abundance of fish that live there. Fish populations are an indicator of the health of the overall stream ecosystem. The groundwater model incorporates information about geology, well depth, pumping rate, and distance from nearby streams to estimate the reduction in stream flow due to pumping water from a well.



Methodology

A web-based water withdrawal assessment tool incorporating these models and associated data has been developed to assist individuals in determining if their proposed withdrawal is likely to cause an “adverse resource impact (ARI)” to a nearby river or stream. The tool considers the geographic variations in Michigan’s stream flows and fish community types when making the determination. All streams and rivers of the state are classified by size and water temperature, and each stream type has different characteristic fish populations that respond differently to the loss of water. The ARI has been defined as any withdrawal resulting in a specified percent decrease in the characteristic or thriving fish populations, as a result of a reduction in the index flow (the median flow of the lowest flow month of the year) as specified for each of the 11



stream types cited in the process. Irrespective of fish populations, an ARI also results from decreasing the index flow by more than 25%.

Users with new or increased capacity water withdrawals of 70 gallons per minute (gpm) or 100,000 gallons of water per day average in any consecutive 30-day period that supply a common distribution system will be required beginning July 2009 to use the web based tool to register their withdrawal. After using the tool, a user can request a site specific review from the Michigan Department of Environmental Quality (MDEQ).

Problem and Research Objectives

In order to assist in evaluating whether or not the withdrawal causes an ARI, the legislation calls for the use of a series of “zones” lettered from A to D. Zone A has little risk of causing an adverse resource impact, while Zone D means an adverse resource impact is likely to occur in the stream. Zones B and C lie between these extremes, indicating increasing risk. Withdrawals in Zone A get an immediate “pass” and the withdrawal can proceed after registration. Those in Zone B also get a pass unless the withdrawal affects a cold transitional stream. If this is the case, a site-specific review by the MDEQ will be needed in order to proceed. Those in Zone C may require some additional steps in the process before proceeding. A withdrawal in Zone D is likely to create an adverse resource impact, and a user cannot proceed. Instead, the user can either request a site-specific review from the MDEQ or rerun the tool and select an alternative option such as pumping less water, putting in a deeper well, or moving the well to a location further away from the stream.

Principle Findings and Significance

The use of the Assessment Tool is required beginning July 9, 2009. Under Michigan law, before a large quantity withdrawal (70 gpm or greater) can be initiated, a withdrawal must be registered with either the Michigan Department of Environmental Quality or with the Michigan Department of Agriculture if the withdrawal is for an agricultural purpose.

A registration, which can be done through the on-line tool, is valid for 18 months and the withdrawal capacity must be installed within that 18 months or the registration becomes void.

Notable Achievements

Title: Water Withdrawal Assessment Tool

Brief: **Senate Bill 212 (as enacted) PUBLIC ACT 190 of 2008**

- Provide for the implementation of the Great Lakes- St. Lawrence River Basin Water Resources Compact.

Senate Bill 723 (as enacted) PUBLIC ACT 189 of 2008

- Revise the membership and duties of the former Groundwater Conservation Advisory Council and change its name to the "Water Resources Conservation Advisory Council".

Senate Bill 860 (as enacted) PUBLIC ACT 185 of 2008

- Require the DEQ, on October 1, 2008, to make available for testing and evaluation an internet-based waterwithdrawal assessment tool.

House Bill 4343 (as enacted) PUBLIC ACT 184 of 2008

- Require the DEQ to notify certain local entities by e-mail if a proposed withdrawal falls into a particular category.



- Allow the notified entities to form a water resources assessment and education committee in order to assess trends in water use in the withdrawal's vicinity and educate water.

Funding Agency: Michigan Department of Environmental Quality

Publications

Reeves, Howard W., David A. Hamilton, Paul W. Seelbach and A. Jeremiah Asher. 2009. Groundwater-Water-Withdrawal Component of the Michigan Water-Withdrawal Screening Tool. U.S. Department of the Interior, U.S. Geological Survey, 46pgs.



Natural Resources Integrated Information System

Basic Information

Title:	Natural Resources Integrated Information System
Project Number:	2008MI116B
Start Date:	3/1/2008
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Water Quality
Focus Category:	Management and Planning, Water Quality, Water Use
Descriptors:	None
Principal Investigators:	Jon Bartholic

Publication

1. Bartholic, Jon. 2008. Higher Education's Role in Preserving Lakes, American Council on Education's Solutions for Our Future, July 17; prepared for Lou Ann Simon, President, Michigan State University
2. Shi, Y., J.D.Snyder, J. Asher, J. Bartholic, and G. O Neil. 2008. The Fundamental Role of Land Cover Data in a Web-based Decision Support System to Assist Local Natural Resource Managers and Decision Makers. Annals of the Association of American Geographers. Chapter 14, pgs 251-274.
3. Reeves, Howard W., David A. Hamilton, Paul W. Seelbach and A. Jeremiah Asher. 2009. Groundwater-Water-Withdrawal Component of the Michigan Water-Withdrawal Screening Tool. U.S. Department of the Interior, U.S. Geological Survey, 46pgs.

Title: Natural Resources Integrated Information System

Project Number: 2008MI116B

Start: 03/01/08(actual)

End: 02/28/09 (actual)

Funding Source: USGS (“104B”)

Congressional District: eighth

Research Category: Water Quality

Focus Categories: M & P, WQL, MOD

Descriptors: Data Analysis, Data Storage and Retrieval, Information Dissemination, System Analysis, Geographic Information Systems, Water Quality Management, Watershed Management

Primary PI: Jon F. Bartholic, Institute of Water Research, Michigan State University

Project Class: Research

Problem and Research Objectives

To protect and restore the nation’s waters, federal and state agencies are increasingly utilizing a watershed approach to examine and address water resources problems. The overall goal of this approach is the restoration, maintenance and protection of water resources across the country. The Institute of Water Research at Michigan State University is also looking at water resources on a watershed basis and is working to develop programs and partnerships within a watershed framework. Because of our Institute's long-term position relative to national and state water programs, we function as a coordinator to assist with linkages, support education, research, and outreach with and among agencies in the broad water arena. Accordingly, we are in a unique position to facilitate watershed policy, planning, and management using a multi-disciplinary perspective.

Methodology

Our proposed efforts include three major thrusts. The first is the enhancement of integrated watershed systems including both surface and groundwater that can be used for analysis of various management options. The second is extended education where the internet and advanced computer systems as well as traditional conferences and training workshops are used to extend new knowledge to agencies, organizations, and local level watershed and land use groups. The third involves developing a networking infrastructure to facilitate cooperation among partners such as the USDA, Natural Resource Conservation Service, USEPA, Army Corp of Engineers, the Great Lakes Commission, state Departments of Natural Resources, Environmental Quality, and Agriculture, township associations and county organizations.

Principle Findings and Significance

Extensive investigation and research is needed to achieve effective coupling of human management needs with geospatial databases and decision support systems to assist better decision-making. Multiple research funding opportunities exist to support linking understanding of various phases of the hydrologic cycle with impacts on water use, management, and conservation. As a result, outstanding opportunities to develop scientific water management skills and techniques for the 21st Century are clearly within reach.

Development of geospatial decision support systems complement and build on the extensive scientific knowledge of the role of the hydrologic balance in the functioning of dynamic ecosystems. Based on current development of geospatial databases and modeling systems, a model of the hydrologic balance for the state can be developed to assist water management and conservation. By incorporating extensive geospatial data with the analytical capacity of decision support systems, university researchers are providing decision-makers and managers with a more refined understanding of the hydrologic cycle and water balance functions at watershed and statewide scales.

Our USGS investments led to a two-year \$540,000 grant from the Great Lakes Protection Fund awarded to Michigan State University and the Institute of Water Research (IWR) for a project entitled "Restoring Great Lakes Basin Waters Through the Use of Conservation Credits and an Integrated Water Balance Analysis System." The IWR is responsible for coordinating and collaborating multidisciplinary teams from various organizations including the World Resources Institute, Institute for Fisheries Research of the Michigan Department of Natural Resources, Public Sector Consultants of Lansing, US Geological Survey District Office, and MSU Departments of Agricultural Economics, Biosystems and Agricultural Engineering; Geography, Civil and Environmental Engineering; and the Community, Agriculture, Recreation and Resource Studies (CARRS). The website for this just completed grant is: <http://www.iwr.msu.edu/research/projects.html>

The bottom line shows a unique convergence of our NIWR/USGS and the Great Lakes Protection Fund project with the implementation of recently-enacted state legislation and with the next phase of state policy making. As prescribed in recent legislation, a set of policy recommendations addressing the sustainability of groundwater will be submitted by the Groundwater Conservation Advisory Council (GCAC) July 1, 2007 and the GCAC process needs to be informed by hard science and knowledge of state water resources and watershed management. In addition, the Groundwater Conservation Advisory Council is responsible for guiding the overall implementation of the legislative mandates for related water policy development as well designing the water withdrawal assessment tool. As some members of our project Advisory Committee serve on the Groundwater Conservation Advisory Council, a robust linkage provides an important mechanism for the Institute's role in developing the assessment tool and assisting in conflict resolution processes.

The Developing the Water Withdrawal Assessment Tool (www.miwwat.org) is a web-based water withdrawal assessment tool incorporating models and associated data that has been developed to assist individuals in determining if their proposed withdrawal is likely to cause an "adverse resource impact (ARI)" to a nearby river or stream. The tool considers the geographic variations in Michigan's stream flows and fish community types when making the determination. All streams and rivers of the state are classified by size and water temperature, and each stream type has different characteristic fish populations that respond differently to the loss of water. The ARI has been defined as any withdrawal resulting in a specified percent decrease in the characteristic or thriving fish populations, as a result of a reduction in the index flow (the median flow of the lowest flow month of the year) as specified for each of the 11 stream types cited in the process. Irrespective of fish populations, an ARI also results from decreasing the index flow by more than 25%.



Figure 1. Water Withdrawal Assessment Tool

Users with new or increased capacity water withdrawals of 70 gallons per minute (gpm) or 100,000 gallons of water per day average in any consecutive 30-day period that supply a common distribution system will be required beginning July 2009 to use the web based tool to register their withdrawal. After using the tool, a user can request a site specific review from the Michigan Department of Environmental Quality (MDEQ).

Web-based Offerings

Our web-based offerings continue to expand. A Nation-Wide Digital Watershed web site has been developed to allow individuals from across the United States locate themselves by using their address, watershed, or by regional areas established by the EPA. The illustration shows the software developed in the IWR that can be applied to a national situation. The data used in the system was acquired from EPA Basin data via the web. The site for Michigan allows users to zero-in on the eight-digit watersheds and then down to the 12-digit watershed system known as “Know Your Watershed.”

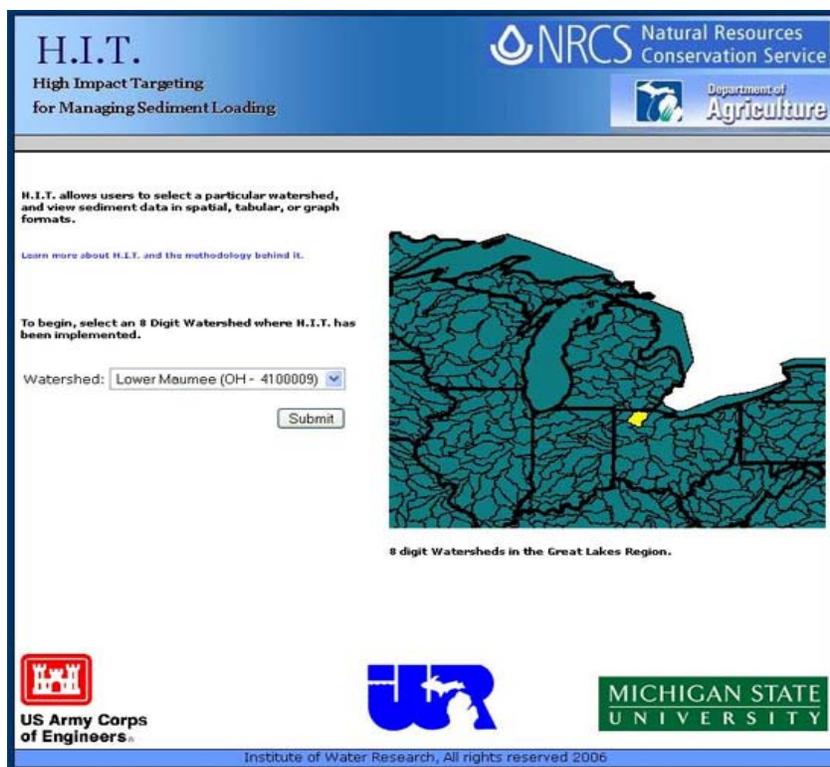


Figure 2. Conservation Innovation Grant (CIG). <http://www.iwr.msu.edu/CIG-MDA/>

USDA Awards \$600,000 Conservation Innovation Grant to Michigan Department of Agriculture for MSU Institute of Water Research Project (CIG-MDA) *continuation*

What Is the High-Impact Targeting (HIT) System?

The Web-accessible **High-Impact Targeting**—or **HIT**—system is a new tool that is designed to focus limited conservation resources on the most serious erosion and pollution problems. The **HIT** system can be used to identify—and target—the specific areas in agricultural fields that cause the greatest volumes of sediments deposited in waterways and adversely impact water quality and aquatic habitat. The intent is to get ‘the biggest bang for the buck’ by maximizing the beneficial impacts from the installation of new conservation practices on the highest-risk sediment yield areas.

HIT relies on advanced geographical information systems (GIS) technology and innovative applications of computer modeling. The HIT system provides data on sediment delivery and agricultural erosion presented in map formats, tables, and other graphic formats. HIT is an interactive system so users can choose the appropriate scale to visualize the GIS data on high-risk areas that are of the greatest interest to them. Users can either compare risk areas in their local watersheds or zoom down to field level and see specific farms with color-coded high risk areas.

Why Use HIT?

HIT can be used to target conservation assistance efforts like the Conservation Reserve Enhancement Program (CREP) and other NRCS programs. These efforts can be targeted on those areas with the greatest potential risk for erosion and resulting sediment loads to nearby waterways. Using HIT helps achieve the greatest impacts from those conservation efforts.



The use of HIT supports important NRCS, MDA, CREP, and other state agency conservation goals. These goals include the reduction of soil erosion and sedimentation, improvement of water quality, and enhancement of wildlife habitat. Conservation districts and farmers can use this targeted approach to realize the maximum impact of conservation programs to reduce wasteful soil erosion, improve valuable water quality, and restore wildlife habitat.

Conservation districts and watershed organizations can also use HIT to develop and coordinate strategic watershed management approaches to control erosion and reduce sedimentation in a watershed. Using HIT mapping of watersheds with color-coded data layers for high-risk sediment yields, the volumes of erosion and sediment may be compared among and within subwatersheds. High-risk sediment yield areas can be ranked and prioritized for targeting conservation efforts.

As a result, farmers, conservation districts, and watershed organizations can base their decisions about the deployment of conservation resources on a clear picture of specific watershed conditions and the potential impacts of individual actions on water quality in their watersheds.

How Does HIT Work?

HIT integrates the calculations of two geo-spatial models to quantify and map sediment yields. There are three steps. First, an estimate of the percentage of eroded soil that ends up in nearby streams is obtained from the Spatially-Explicit Delivery Model (SEDMOD). Second, the annual volume in tons/acre/year of eroded soil is obtained from the NRCS' Revised Universal Soil Loss Equation (RUSLE). Third, the annual volume of sediment transported to nearby streams from specific areas is obtained by combining the results of SEDMOD and RUSLE.

The SEDMOD and RUSLE models are time-tested and widely accepted by the USDA NRCS and other national experts and researchers. MSU has integrated these models to take them to the next level and maximize their impact in controlling erosion and protecting water from sediment loadings.



Figure 3. Comprehensive Assessment Tool (Watershed CAT)

Watershed Comprehensive Assessment Tool (Watershed CAT)

The need for accurate geospatial data to develop effective watershed management plans has been well known to watershed managers, environmental government agencies and non-governmental organizations (NGOs) that specialize in restoring or maintaining the quality of water resources. Many online data sources offer web-services that freely distribute these data. However, it is difficult for a user to access, view and analyze watershed-scale, geospatial data without extensive GIS capabilities, even though it is a vital step to identify critical areas or pollution sources in a watershed. The Watershed Comprehensive Assessment Tool (Watershed CAT) Figure 3 fills this gap in watershed management by assembling a variety of data layers into one data viewer and coupling the viewer with a number of web-based tools. This allows users to analyze watershed data more efficiently and with more detail, and ultimately leads to developing highly effective management plans.

The primary objective of this project is to develop an online system to house a data viewer, data analysis tools and decision support tools. Using the primary data viewer (Digital Watershed), data layers from a variety of sources can be assimilated together to observe physical and hydrological spatial trends within the watershed. Using the numerous analytical tools, such as Analytical Tools Interface for Landscape Assessment (ATtILA), Regional Vulnerability Assessment (ReVA), Online access to Long-Term Hydrologic Impact Assessment (L-THIA) and the High Impact Targeting (HIT) system contained in the Watershed CAT, users will be able to identify landscape stressors, calculate the amount of impervious surfaces, identify areas of high erosion, etc. Finally, using decision support tools provided by the Watershed CAT, users will be able to compare and the cost effectiveness of numerous sediment erosion management practices.

The U.S. Environmental Protection Agency (EPA) has developed an extensive manual documenting the watershed management plan process, and is commonly referred to as the EPA Watershed Handbook. This guide highlights every step in the process of developing a watershed management plan, and many of those steps require substantial data collection and analysis.



Figure 4. Nation-Wide Digital Watershed <http://www.iwr.msu.edu/dw>

Many of these data-intensive steps are also necessary to be completed in order for the plan to be considered for funding under section 319 of the Clean Water Act. These requirements include creating a watershed data inventory, identifying causes of impairment and pollutant sources, and descriptions of the non-point source management measures to be taken to reduce pollutant loadings. The Watershed CAT system will provide a large majority of data necessary for the inventory, as well as several modeling options that can facilitate the completion of these funding requirements by watershed organizations.

Local watershed management forms the basis for continued economic development and environmental improvement in the United States. Success depends on an integrated approach that brings together scientific, education and training advances made across many individual disciplines and modified to fit the needs of the individuals and groups, who must write, implement, evaluate, and adjust their watershed management plans.

New and Future Development for Digital Watershed

Under the funding through EPA region 5, EPA's ATtILA and ReVa EDT have been integrated into the Digital Watershed system. These tools allow users to get various information on ecological conditions for 8-digit watersheds. Other small enhancements were also added for a project through EPA headquarters. They include impaired waters layers, map image function, improved Google Mapping and Microsoft Live Mapping (Figure 4).

Another major development under way is to add reporting and EPA STORET water quality information access via web services functions. This is supported by EPA NEIEN (National Environmental Information Exchange Network) grant through Wisconsin DNR. The reporting function has been integrated into the system and is operational. End users can get a variety of information on an 8-digit watershed using this function.

The STORET water quality information access function is still under development and will be released in summer 2009.



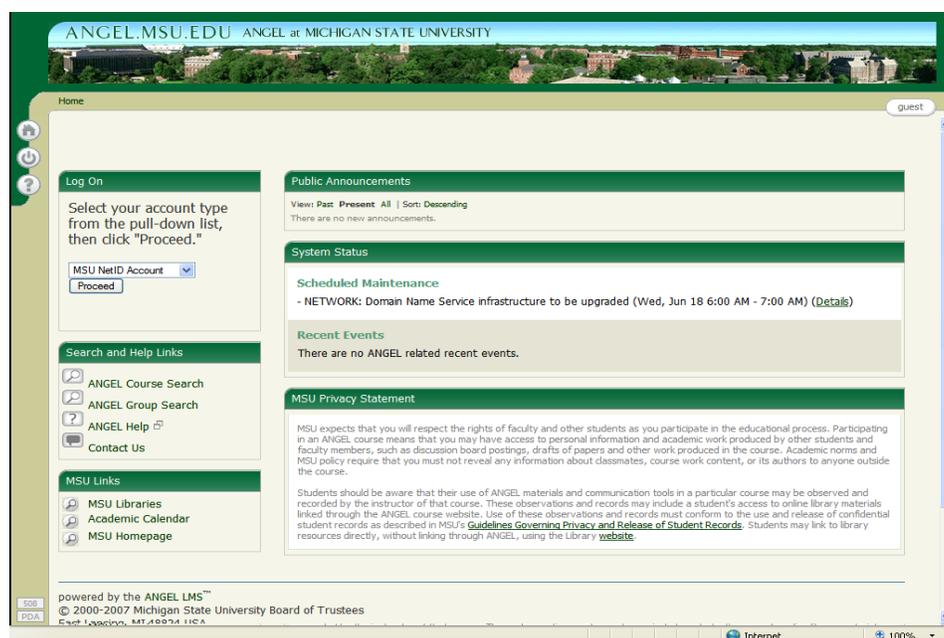


Figure 5. Virtual Watershed Management Courses

Virtual Watershed Management Courses

The web-available Mapping is used extensively in IWRs Virtual Watershed Management courses (Figure 5). This past year we offered all four 3-credit modules of Watershed Management each semester in the series for Certification. There are now over 120 students registered per year in these courses.

Related Research

We continue to obtain synergistic impacts by closely aligning our efforts with support from such organizations as the Corps of Engineers, USDA, US Forest Service and numerous other agencies and NGO's. This past year we received a grant from the Corps of Engineers for \$75,000 which involves estimating sediment delivery from each of the eight-digit watersheds within the entire U.S. side of the Great Lakes Basin. This database is not only of value to the Corps in prioritizing their efforts but also provides us with a broad set of additional information that we can use in other programs, and for assisting with the prioritization of high risk areas for erosion throughout the region. USDA funds involve a coordinating effort of outreach and research among all states within the EPA Region V. IWR personnel are partially funded through this regional project which coordinates and facilitates the communication of research methodologies, approaches, and results from our research and aides with region-wide outreach programming.

Training Potential

New graduates and graduate training continue to be a high priority of IWR. Unfortunately, graduate stipends have increased to the extent that a 1/2 time graduate student with fringe benefits, requires from \$35,000-\$45,000 (per year). We will make every effort to continue incorporating graduate students but with the high cost, it is increasingly difficult to employ more than a few students at any given time. As part of our partnership philosophy, we have jointly supported numerous graduate students with other departments and units on campus.



The returns on investments in the establishment of riparian buffers for water quality remediation in Michigan's inland lakes

Basic Information

Title:	The returns on investments in the establishment of riparian buffers for water quality remediation in Michigan's inland lakes
Project Number:	2008MI117B
Start Date:	3/1/2008
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Social Sciences
Focus Category:	Economics, Models, Water Quality
Descriptors:	water quality, economic, hedonic valuation, property values, cost, riparian buffers, property values
Principal Investigators:	Kendra Spence Cheruvellil, Daniel Boyd Kramer

Publication

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Start: 03/01/08(actual)
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Funding Source: USGS ("104B")
Congressional District: eighth
Research Category: Social Sciences
Focus Categories: ECO, MOD, WQL
Descriptors: water quality, economic, hedonic valuation, property values, cost, riparian buffers, property values
Primary PI: Kendra Spence Cheruvellil, Lyman Briggs College/ Department of Fisheries and Wildlife, Michigan State University
Daniel Boyd Kramer, James Madison College/ Department of Fisheries and Wildlife, Michigan State University
Project Class: Research

Introduction

Currently, the Michigan Department of Environmental Quality (MI-DEQ) is drafting new rules that will implement scientifically defensible nutrient standards for all of Michigan inland lakes (11,000 lakes, ponds, and reservoirs with an area of at least 5 acres) and streams (over 36,000 miles of rivers and streams). These standards will serve as a framework within which the MI-DEQ can assess the state of Michigan's waterbodies, protect those with excellent water quality, and better manage those with poor water quality. As part of the process of getting these new rules passed into law, the MI-DEQ must provide evidence of the economic, social, and environmental benefits associated with the implementation of these nutrient standards. Although most people agree with the idea that Michigan's inland lakes and streams are important, it is often more difficult to achieve consensus about the magnitude of their importance. The PIs have just completed a state-wide economic hedonic valuation study of Michigan's inland lakes. In the current project, we are integrating the results of this valuation study with a predictive water quality model and a cost model of implementing riparian buffers to improve lake water quality. Together, these coupled models will provide more complete information on the returns on investments in the establishment of riparian buffers to improve water quality. This study will allow for better public understanding of the importance of Michigan's inland lakes and will provide a common currency for communication between scientists, policy-makers, and managers.

General Statement

Problem/Demand

Michigan, long recognized as an important Great Lake State, has a tremendous asset in its inland lakes (11,000 that are 5 acres or larger, 6,300 that are 10 acres in size or larger, and 730 public access lakes). In addition to providing year-round water front property owners with many benefits (e.g., beauty, recreation), Michigan's inland lakes are the destination of millions of tourists and second home owners.



While inland lakes are popular, some management experts believe the stewardship effort is declining. Water quality monitoring is lagging behind the need to inform legislative and local policy makers. Development pressures are increasing, with little support or incentive for joint planning to manage development impacts on lakes. To make matters worse, there is little institutional knowledge of the value of inland water bodies, of the costs of remediation, of the struggle to provide adequate management, or of the impacts of existing policy and proposed policy changes. Because Michigan has a high proportion of waters deemed “high quality,” protective management of relatively un-impacted systems has to be balanced with remedial management of highly impacted lakes and streams.

Currently, the MI Department of Environmental Quality (DEQ), with support from the U.S. Environmental Protection Agency, is drafting new rules that will implement nutrient standards for all of Michigan inland lakes and streams. These scientifically defensible standards have been developed with the help of Michigan State University researchers (Soranno et al. 2008), and will serve as a framework within which the MI-DEQ can assess the state of Michigan’s waterbodies, protect those with excellent water quality, and better manage those with poor water quality. As part of the process of getting these new rules passed by the Michigan legislature, the MI-DEQ must provide evidence of the environmental, social, and economic benefits associated with the implementation of these nutrient standards (Cheruvilil 2006). To support this end, we are integrating a valuation and cost model to determine the returns on investment from establishing riparian buffers along streams feeding into Michigan’s inland lakes.

Methodology

We have just finished a project using a hedonic valuation model to estimate the value of changes in water quality of Michigan’s inland lakes. Hedonic models assume that one can estimate economic values for non-market goods when “demand may be reflected in the prices people will pay for associated goods” (Farber et al. 2002). For example, the value of lakefront homes or properties is a reflection of not only housing and property attributes but of the water quality of an associated lake or stream. The assumption made by the hedonic model is that “market goods have values influenced, in part, by characteristics of neighboring ecosystems” (Wilson and Carpenter 1999). Below is a simple representation of a hedonic model.

$$Y = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 WQ + \varepsilon$$

In this equation, Y is a vector of sales prices on lakeshore properties based on Multiple Listing Service (MLS; real estate sales records) data. X is a vector of variables pertaining to characteristics of the lakeshore property (e.g., number of bedrooms and bathrooms, square footage, frontage) and Z is a vector of variables pertaining to contextual factors (e.g., soil type, distance to major roads, distance to major urban centers). Finally, WQ is the water quality variable (i.e. water transparency as measured by Secchi disk depth). The goal in this recently-completed project was to estimate the coefficient for the water quality variable (β_3). In the current project, we are now acquiring the data in order to couple those hedonic valuation results with a predictive water quality model and remediation cost model.

In previous work, Dr. Cheruvilil has built multilevel models to predict lake chemistry and quality using natural lake and landscape features and land use/cover. In this study, we will



build multilevel predictive models, which is a multivariate approach specifically used to analyze hierarchical data such as lakes within ecoregions (Singer 1998, Bryk and Raudenbush 2002). It separates variance into variance components at each spatial scale (local and regional) (Wagner et al. 2006, Cheruvilil et al. 2008), allowing for a more thorough understanding of what predicts lake water chemistry and quality. The result of these model building exercises is a set of hierarchical models (one for each lake response variable) that (1) demonstrate which natural and anthropogenic lake and landscape features at two spatial scales are most important for predicting lake water quality, chemistry and biology and (2) quantifies the amount of total, within-ecoregion and among-ecoregion variation these features can account for.

Using the coefficients from the predictive, multilevel water quality model, we can estimate the water quality effects and economic costs of converting riparian areas from agriculture to grass and woody buffers. Although Dr. Kramer has done such work previously for a small sample of 25 lakes (Kramer et al. 2006), the scope of this proposed project is much larger. Riparian buffers are a recommended best management practice (BMP) and have been shown to reduce nutrient inputs to streams (Lowrance and others 1997). In the proposed project, we assume that the riparian buffers temper the phosphorus load to lakes according to the following function:

$$E_{Buffer} = E_{AG} \left(\frac{1 - MAX * B^X}{Y^X B^X} \right)$$

where E_{BUFFER} is the coefficient for the buffered agricultural land in the watershed, E_{AG} is the original export coefficient for the agricultural land, MAX is a parameter that sets the maximum buffering capacity regardless of buffer width, B is the buffer width, Y is the buffer width at which the export coefficient is reduced by half, and X is a parameter governing the steepness of the mitigation function at the inflection point. The use of this function assumes that as the width of the riparian buffer increases from zero, phosphorus attenuation changes nonlinearly. At small widths, buffering capacity is small. At intermediate widths, however, the effectiveness of the buffer increases rapidly. Finally, at greater riparian buffer widths, little attenuation capacity is added by increasing the buffer width. The above function will be parameterized and calibrated using the predictive water quality model.

Finally, we can estimate the opportunity cost of setting aside land for riparian buffers by determining the annual returns for land in agriculture. Data on agricultural productivity, production costs, and crop prices allow the estimation of the average value of 1 acre of farmland used for a variety of crops grown in Michigan (source: USDA/FSA/EPAS current enrollment). In addition to this opportunity cost, we will estimate costs for installing riparian buffers (e.g., site preparation, planting, etc.) and annual maintenance costs (source: EPA).

Problem and Research Objectives

We will estimate the costs of water quality remediation using riparian buffers for lakes and streams leading to inland lakes in Southwest Michigan based on the opportunity cost of setting aside land for riparian buffers using the annual returns for land in agriculture. We will then estimate the capitalized economic benefit of changes in water clarity based on real estate



sale prices of lakeshore properties. To do so, we are in the process of completing the following tasks.

1. Create a spatial database of land use in riparian areas of streams feeding into our study lakes (and for the lakes themselves).
 - a. Create lakeshed designations (i.e. local watersheds) for approximately 600 lakes in Southwest Michigan. Note that these lakes overlap with the lakes that we used in our previous hedonic valuation study.
 - b. Within each lakeshed, quantify natural and anthropogenic landscape features (e.g., land use/ cover, roads, run off, base flow, precipitation).
 - c. Identify incoming streams to lakes and create GIS buffers to simulate riparian buffers around these streams and the study lakes.
2. Estimate costs of conversion, foregone annual returns for riparian areas in agriculture, and annual maintenance costs.
3. Integrate hedonic valuation model (previous work) with cost model.
4. Write scientific paper for publication in a peer-reviewed journal and present findings at scientific conference as well as to inland lake and land use managers and policy makers (e.g., at the MI-DEQ).

Principle Findings and Significance

To date, we have made significant progress assembling the GIS database which will be used for the “returns on investment” analysis. Once the database is complete (estimated Summer 2009), we anticipate that the analysis will move quite quickly.

In our previous hedonic valuation study, we used both traditional, single-level, and multilevel hedonic models to quantify the effect of water clarity on property values. Using single-level hedonic models, we found that lake water clarity had a positive effect on property values in three of the four identified markets (Lake, Urban, and Chicago) and when all markets were combined. These results matched closely what previous, smaller-scale studies in different states have found. In our Rural market, however, water clarity had no negative effect on property values. Our results of the multilevel hedonic model were generally similar in nature to those found with the single-level traditional hedonic models. Many of the statistically significant predictors that were included in the best multiple regression models were also included in the multilevel models, and they had similar regression coefficients. However, lake water clarity had a positive effect on property values in just two of the four markets. This result demonstrates the importance of taking the hierarchical nature of the data (i.e. properties nested on lakes) into account when conducting such analyses.

In those models that included water clarity, the effects of water clarity on lakefront properties was quite large. Our analysis suggests that the change in property values due to a one meter increase in lake water clarity ranges from \$1,022 to \$122,338. Mean increases per property due to a one meter increase in water clarity ranged from \$6,716 to \$22,191 in three of the four markets. The payoffs, therefore, are potentially substantial. By estimating costs to associate with remedial actions, we will have a much more complete assessment of the value of such investments.



Notable Achievements

We have secured funding from the Center for Water Sciences (MSU) to fund a postdoc for two years. An overview of the project is below. As you can see, this project builds on the current project.

We propose to develop a highly functioning team of researchers to effectively couple human and natural systems in a spatially-explicit way that is guided by our landscape limnology framework for lakes. We build upon an approach to lake classification that we have developed and integrate it with recent advances in economics, human decision modeling, and policy. We use lakes as model socio-ecological systems that when studied from a spatial perspective, are highly heterogeneous, yet also have spatial patterns associated with them. We propose to first quantify functional relationships between human activities and ecological responses of lakes, using a classification approach that groups lakes that are similar in key hydrogeomorphic variables. Building on these functional relationships, we will then quantify the costs of rehabilitation (for degraded lakes) and the costs of protection (for lakes currently experiencing low human impact), also using a classification approach. Quantifying costs allows us to develop prioritized lists of lakes to target for cost-effective rehabilitation or protection, which is a unique attribute of our research approach and is one of the components that is broadly applicable to the management of populations of ecosystems in general. Then, coupling our ecological and economic approaches with agent-based modeling of human behavior will allow us to directly model multilevel interactions among drivers and couple spatially-explicit ecological and economic models with social dimensions to identify and begin to explain important spatial patterns in these coupled human and natural systems.

Publications

We will submit the manuscript regarding water quality valuation to the journal *Ecological Economics* during the next two weeks. Results of this study have been presented to the North American Lake Management Society (NALMS) (presenter: Emily Norton, FW grad student, 11/08), the Department of Fisheries and Wildlife (presenter: Emily Norton, FW grad student, 2/09), the MI chapter of NALMS (presenter: Emily Norton, FW grad student, 4/09), and the MI-DEQ (presenter: Dr. Kramer, 5/09).



Water Use and Water Demand by Self-supplied Residential Water Users in Michigan

Basic Information

Title:	Water Use and Water Demand by Self-supplied Residential Water Users in Michigan
Project Number:	2008MI118B
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Congressional District:	Eighth
Research Category:	Social Sciences
Focus Category:	Economics, Groundwater, Water Use
Descriptors:	Groundwater use, water demand, self-supplied water use
Principal Investigators:	Patricia Norris, Saichon Seedang, Mary Thompson

Publication

Title: Water Use and Water Demand by Self-supplied Residential Water Users in Michigan

Project Number: 2008MI118B

Start: 03/01/08(actual)

End: 02/28/09 (actual)

Funding Source: USGS (“104B”)

Congressional District: eighth

Research Category: Social Sciences

Focus Categories: ECO, GW, WU

Descriptors: Groundwater use, water demand, self-supplied water use

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Mary Thompson, Outreach-Specialist, Guyer-Seevers Program in Natural Resource Conservation, Department of Community, Agriculture, Recreation and Resource Studies (CARRS), Michigan State University

Project Class: Research

Introduction

Across the Great Lakes region, groundwater is the principal source for self-supplied domestic water use and many community public water supplies, and it is a significant source for agricultural and golf course irrigation as well as numerous industrial and commercial enterprises. In Michigan, groundwater is considered the primary water supply source for residential use. Nearly half of Michigan’s population relies on groundwater sources for drinking water (Michigan Department of Environmental Quality-MDEQ, 2003). According to a National Groundwater Association report¹, almost 63 percent of total groundwater withdrawn in Michigan is used for residential use, either through community supplied wells or private self-supplied individual wells. There is increasing local and statewide concern about a growing demand for groundwater withdrawal leading to supply shortages. In addition, the depleted groundwater limits availability of water to sustain stream base flows during summer droughts and adversely affects aquatic ecosystems dependent upon groundwater flows (e.g., wetlands, rivers). Currently Michigan does not have precise information on water withdrawal and use for the residential water use sector, especially those that rely upon private residential wells. The proposed research focuses on an estimation of per capita self-supplied residential water use at selected sites in Michigan. The research also seeks to understand trends and behaviors as well as factors that influence self-supplied water use. The results of this research can be useful for developing water conservation policies and better estimating self-supplied residential withdrawal and use to integrate into water management and planning at the local watershed scale. The objective of this technical report is to report the progress of survey planning and development efforts during 2008-2009.

¹ Internet access at http://www.michigan.gov/documents/deq/deq-wd-dwehs-gwroleinmieconomicvitality_270434_7.pdf



General Statement

Problem/Demand

Reliable information on water use and availability is fundamental to state, regional and national efforts to improve water science and water management. Understanding and accounting for human water use is critically important as growing demands for water combine with the hydrologic implications of large-scale climate change to raise concerns about how human water needs will be balanced with the needs of water-dependent ecosystems. Yet, our knowledge of how much water is being withdrawn, by whom, and where is constrained by limited reporting of water use by many types of users in many locations. A 2002 National Research Council report described the limitations of, and needed improvements to, current water use information, focusing especially on data collection efforts and water use estimation methods (NRC 2002). Improved information on water use is especially vital in the Great Lakes region, where relative wealth in water has meant relatively less attention by states to groundwater withdrawals.

Inventories of water use are compiled and published periodically by states, USGS and, in the Great Lakes region, the Great Lakes Commission. In some cases, methods used to estimate water use vary across states and agencies and as a result, reported water use varies. The quantity of water withdrawn by entities that are required to report withdrawals (with some notable exceptions) is relatively well known, but estimates of groundwater withdrawn by self-supplied domestic (private well) users are more problematic. Generally, self-supplied domestic water use is approximated using estimates of self-supplied domestic population and per capita use coefficients adapted from water use reports for public water supplies. For the Great Lakes states, per capita use coefficients used to estimate self-supplied domestic water use for the 2000 USGS water use report (Hutson et al. 2004) ranged from 55 gallons per capita per day (gpcd) to 90 gpcd, and neither of these numbers was based on actual withdrawals by self-supplied domestic users.

This method raises questions about the accuracy of water use estimates for the domestic self-supplied population. Do water users relying upon private wells use water for the same purposes and at the same rates as publicly-supplied users, so that similar per capita use rates can be accurately applied to both groups? Do self-supplied domestic well users moderate their water use in response to factors like well capacity, aquifer characteristics or wastewater management system? Is outdoor water use a bigger factor for self-supplied domestic users? Does rural versus suburban residence location affect how well-owners use water? Answers to these questions and others will improve the estimation of self-supplied domestic water use. Without more careful attention to these kinds of questions, inaccurate estimates of self-supplied domestic water withdrawals may undermine the ability to account for these water withdrawals in larger state and regional water planning and management activities.

Methods

This project proposed to collect primary data at three selected areas within Michigan. A household survey will be carried out using mail survey forms. The research will follow the process shown in Figure 1.

Problem and Research Objectives

To have a precise estimation of per-capita self-supplied water use and other water use information (i.e. pattern and behavior of use), it is necessary to conduct a survey gathering water use information at the household level. Specific objectives are: 1) To conduct a survey of



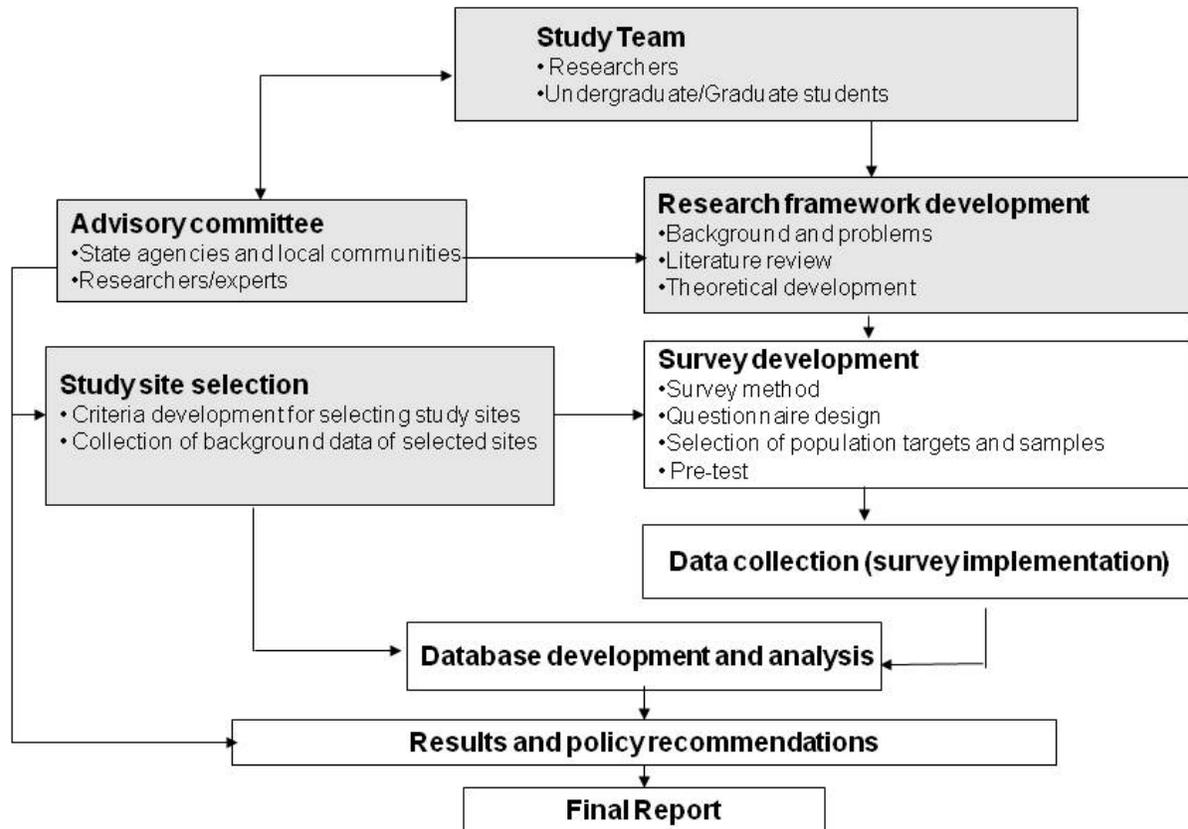


Fig 1. Research plan and process; work progress described in this report is shown in gray

residential self-supplied water users to collect information about their water use, water withdrawal, patterns and behavior of use, and factors influencing their use of groundwater; 2) To estimate per capita self-supplied residential water use and project changes in use; and 3) To provide recommendations for groundwater conservation and management, specifically demand side management.

Principle Findings and Significance

During the fiscal year 2008-2009, the following research activities were accomplished (indicated by gray shaded areas in Figure 1): 1) building a study team, 2) selecting the study sites, 3) establishing an Advisory Committee, and 4) developing a research framework.

1) *Building a study team*

We have expanded our study team beyond our extensive experience in economic and social survey research to include water resource experts who have a better understanding of issues related to physical groundwater hydrology in Michigan and methods for on-site water use measurement. Dr. David Lusch is a senior scientist with MSU’s Institute for Water Research and Remote Sensing and Geographic Information Sciences Research and Outreach Services and will make their data management and geographic information system resources available to the research. Dr. Ben Dziegielewski, at Southern Illinois University, has conducted extensive field surveys of water withdrawals and water use research methods for many cities of the U.S. and has amassed analytical capabilities



especially suited to the proposed research. These two individuals also serve as Co-PIs for a newly proposed research project that expands the framework of surveys to include on-site water withdrawal monitoring, and mail surveys of publicly-supplied domestic water use (see more detailed discussion of this proposed project in “Notable Achievements”).

2) Selecting study site

Two study areas have been selected and another is in process. Several criteria were used during the site selection process, including potential water use problems and conflicts (e.g. agricultural irrigation and residential wells), demographic distribution (e.g., high, medium, and low population densities and rates of growth), ecological importance (sensitivity of stream flow and resource concerns), availability of supporting data (e.g., GIS-based demographic and hydro-geological data) and local support and collaboration. Figure 2 shows the locations of the two selected sites (Kalamazoo and Oakland Counties) and a potential third county (Newaygo County) on a map depicting estimated recharge to glacial deposits (MDEQ, 2005). A summary of the study areas’ characteristics is shown in Table 1. Most household wells within the three counties rely on recharge from glacial deposits. The estimated recharge in the Oakland County area is between less than 6 inches/year and 11 inches/year, while Kalamazoo and Newaygo Counties have recharge ranges between 7 and 22 inches/year. Oakland County, a suburb of Detroit, is the most urbanized of the three areas, and during 2000-2006 had the most household well activities (replacement and new wells installed), while Newaygo County is the most rural area. U.S. Census survey data from 1990 show an average of 23 percent of households in Kalamazoo and Oakland Counties had private wells, while all Newaygo County households relied on private wells (and no communities have installed public systems since 1990), which is similar to most rural counties in Michigan.

3) Establishing an Advisory Committee

We are working closely with representatives of the Michigan Department of Environmental Quality (MDEQ), city and local county health officials (Kalamazoo and Oakland Counties), Michigan USGS Water Sciences, and local well suppliers and contractors. In addition, we have had several communications with individual water resource professional and research organizations for their suggestions and input on site selection and survey framework and method, primarily to understand how the data from the project can be useful for their work. The USGS Water Sciences and MDEQ have been working with us and provided advice for developing the research framework and shared data for survey use. A USGS researcher in New Hampshire has been contacted and has shared her experience with residential water use surveys and results. We established new collaboration with a research team at Michigan Technological Institute that is working on NSF collaborative research on water use, modeling, policy and institutions. Our project team has attended workshops and conferences to network with state and local water resource professionals.

We anticipate forming a formal Advisory Committee that will consist of state and local agency representatives, academic researchers and professionals in water resources. We anticipate the major role of the committee will be to help guide us through the survey process by providing input and recommendations in the processes of survey sample selection, survey development, data sharing and collaboration, and results and outcomes that will become available for their use.

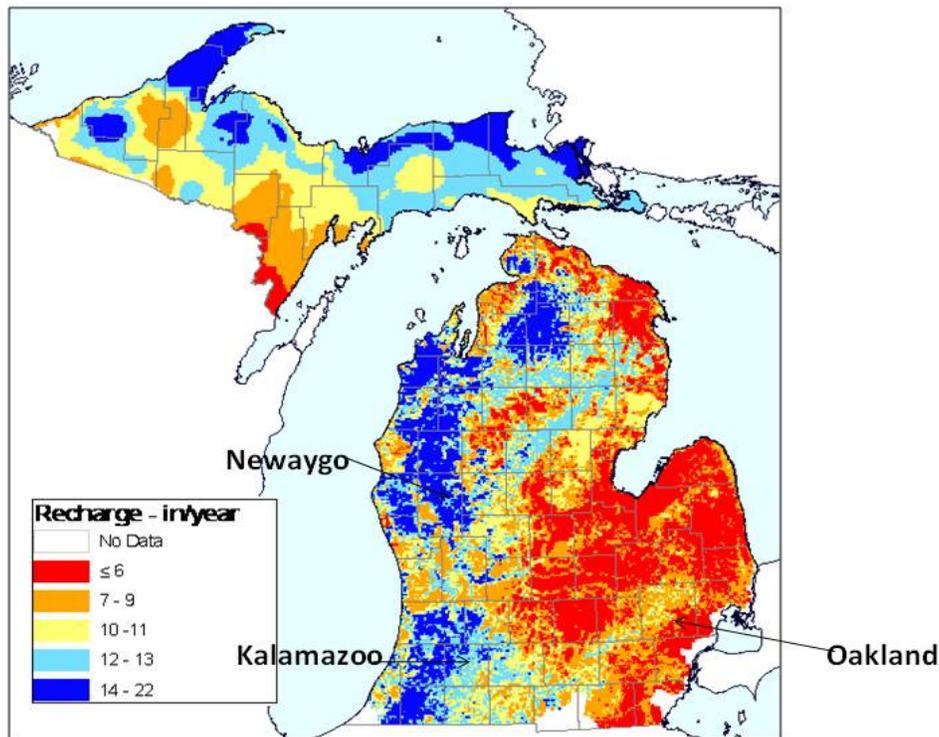


Table 1 Site Characteristics

Site Characteristics	Oakland County	Kalamazoo County	Newaygo County**
<u>Census data</u>			
Total population 2000	1,194,156	238,603	47,874
Total number of households 2000	471,115	93,479	17,599
Housing units density 2000 (per square mile)	563.9	176.6	27.5
Total number of households 1990	410,488	83,703	13,776
Total number of household wells 1990	73,423	22,850	16,853
<u>State data *</u>			
Number of household wells	11,894	4,298	3,363
Average pumping capacity (gpm)	37	42	27
Average well depth (feet)	110	101	95
Number of wells in bedrock aquifer	203	99	4
Number of wells in drift aquifer	4,701	3,325	2,646

*Michigan Wellogic data between 2000-2006 (MDEQ), and not all records have complete information

** Potential study area



Source: Groundwater Mapping Project (www.rsgis.msu.edu)

Fig 2 Study Area Locations and Estimated Recharge to Glacial Deposits

4) *Research framework development*

Numerous studies of publicly-supplied residential water demand have been conducted over the past 50 years in various locations of the US. These researchers have attempted to understand the factors that influence household water uses. The research has been especially useful for cities, municipalities, and private-public utilities for developing policies related to water demand and consumption. Many studies focus solely on price structure, though some incorporate household or economic characteristics into the analysis. Important variables that are often included in these studies are water price, income, weather, household characteristics, and indoor and outdoor uses. An extensive list of previous water demand studies can be found in Espey et al. (1997), Arbues, (2003), Dalhuisen et al. (2003), and Worthington and Hoffman (2008). These authors have also included discussions of model specification, data sets, estimation problems and results. To date we have not found any empirical surveys of self-supplied residential water demand, or any self-supplied residential water use surveys published in any journal articles in the U.S. This may be because self-supplied water use is not considered a public policy priority and groundwater use by a private household is generally viewed as private matter. Groundwater is not priced directly (the well owner pays for installation of well and energy for pumping); therefore estimating water demand for self-supplied residential water use is problematic. A proxy variable for water price (e.g., pumping cost) has been used in several areas for agricultural groundwater use; however water resource experts have expressed the view that energy costs for pumping domestic water are too low, given the amount of water commonly used, to truly factor into water use decisions of private households. Some questions relevant to self-supplied water use that may replace the price variable in demand studies can be incorporated into our survey questionnaire, such as “Do you worry about your well going dry? Do you limit water use in your household in any way? If yes, how and why?” We also anticipate including questions that address the opportunity cost of water use/overuse. We will continue to expand our literature review and our discussions with water experts to refine our research framework and survey method.

Most water use studies that attempt to estimate water use in a single-family home through combinations of household surveys and field measurement are published as technical and government reports. These studies have not focused on obtaining economic variables to construct a demand function, but rather incorporate some relevant water use explanatory variables to construct water use relationships. The following is a summary of the two surveys (Mayer et al., 1999 and Horn et al., 2007) most relevant to our study that will guide us in the survey process.

The most comprehensive study of residential water use was sponsored by the AWWA Research Foundation in partnership with an extensive group of public water suppliers (Mayer et al., 1999). Conducted between 1995 and 1998, the study combined billing records, mail survey results, and measurements of actual water use (using data loggers attached to water meters) for samples of households in 14 cities across the United States and Ontario, Canada. The results of the study have since been widely used by municipalities, states and the USGS to assist in water use reporting efforts. Of note, the average indoor per capita water use rates, ranging from 53.9 gpcd in Tampa, Florida to 75.3 gpcd in Walnut, California, are remarkably similar to the per capita coefficients



applied for the Great Lakes states. The AWWA study also provided direct measurement of water use by individual fixtures and appliances, and has since been used as the principle source for such information. Prior to the AWWA study, no reliable measurement of separate residential indoor and outdoor rates of water use existed. However, the AWWA study looked only at publicly-supplied water users and did not address self-supplied domestic uses.

Only one reported study has attempted to directly estimate per capita water use coefficients for self-supplied domestic water use. Working in Southeastern New Hampshire, USGS scientists and state partners conducted a survey of both publicly-supplied and self-supplied domestic water users (Horn et al., 2007). The survey was distributed through local schools' environmental curricula to middle school students and their families, who completed a water demand survey to document water use practices and kept a log of actual water use activities for a period of one to four weeks. Results of this study suggested no significant difference between publicly-supplied per capita use and self-supplied per capita use. However, the survey did not assess both indoor and outdoor water uses because it was conducted during early spring, and no on-site measurement of actual water use was conducted. Also, questions about sample selection bias are raised because the survey sample consisted of households with at least one child of middle school age. However, the report does not provide demographics of those who participated in the survey.

Notable Achievements

We have gained more knowledge about water use and demand estimation for self-supplied domestic water use (through literature review and communications with water resource experts, and state and local officials). We have a better understanding about research needed and information gaps, and we are able to define research questions and expand the study scope for better and more reliable results. We submitted a proposal in collaboration with USGS and state and local agencies to the USGS/NIWR Water Resources Research National Competitive Grants Program FY2009 (Title: Improving Self-supplied Domestic Water Use Estimation: Using Surveys and Water Use Monitoring to Compare Self-supplied and Publicly-supplied Water Use). The research proposes to conduct a mail survey of both self-supplied and publicly-supplied domestic water users. In addition, self-supplied domestic water withdrawal measurements are being proposed in order to validate estimated water use during different time periods. This research offers a cutting-edge opportunity to combine innovative technology for on-site water withdrawal measurement for private wells with behavioral science research that investigates how water use decisions by households affect total water use. Individual, community-level, statewide and national water management decisions will be improved by the results of this research.

Publications

N/A



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Prospectus for Developing an Innovation Clearinghouse for Next Generation Water and Wastewater Utilities

Basic Information

Title:	Prospectus for Developing an Innovation Clearinghouse for Next Generation Water and Wastewater Utilities
Project Number:	2008MI120B
Start Date:	3/1/2008
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Social Sciences
Focus Category:	Management and Planning, Law, Institutions, and Policy, Education
Descriptors:	Water and Wastewater Utilities
Principal Investigators:	Janice Beecher, Ruth Kline-Robach, Saichon Seedang

Publication

Title: Prospectus for Developing an Innovation Clearinghouse for Next Generation Water and Wastewater Utilities

Project Number: 2008MI120B

Start: 03/01/08(actual)

End: 02/28/09 (actual)

Funding Source: USGS (“104B”)

Congressional District: Eighth

Research Category: Social Sciences

Focus Categories: EDU, M&P, LIP

Descriptors: Groundwater use, water demand, self-supplied water use

Primary PI: Janice Beecher, Director, Public Utilities Institute, Michigan State Univ.

Ruth Kline-Robach, Outreach Specialist, Institute of Water Research, Michigan State Univ.

Saichon Seedang, Vis Ast. Professor, Institute of Water Research and Guyer-Seevers Program in Natural Resource Conservation, Department of Community, Agriculture, Recreation and Resource Studies (CARRS), Michigan State Univ.

Project Class: Research

Introduction

The purpose of this project is to explore needs and opportunities for developing an innovation clearinghouse for next generation water and wastewater utilities. Next generation utilities will require a new mix of financial, managerial, and technical capacities in order to perform effectively and efficiently. This purpose relates closely to the broader interest in helping water and wastewater utilities find their way along a path toward sustainability, defined in both ecological and environmental terms, particularly in the face of mounting infrastructure and cost pressures related to infrastructure needs, regulatory requirements, and changing economic conditions (including both growth and decline).

General Statement

Problem/Demand

Despite great strides, and a growing number of technical and resources, water and wastewater utilities continue to struggle. A possible barrier to capacity development is the lack of access to information resources. A clearinghouse function would consolidate resources and lower the cost of their use by water managers.

Methodology

For this project, we are exploring the needs of next generation water and wastewater utilities by examining key trends and policy developments. We are reviewing information resources, as well as existing and prospective curriculum available to utility managers and alternative delivery mechanisms. As outreach is also central to this project, we have also participated in several forums that include various stakeholders involved in these issues.



Problem and Research Objectives

The U.S. water and wastewater industries are highly fragmented and pluralistic. Many small systems are especially challenged to meet infrastructure, regulatory, and other demands. Economic pressures are making matters worse. Yet opportunities also exist to help systems evolve into next generation utilities that are more effective and efficient, and ultimately sustainable. Examples include modern techniques for watershed analysis, asset management, and water service pricing. The research objective is to identify and mobilize resources for next generation water management.

Principle Findings and Significance

Preliminary, we are finding that both the need and interest related to this project are great. That is, water and wastewater utilities would benefit from greater access to information that will guide them toward next-generation solutions. Increasingly, these solutions are defined in sustainability terms, which have both ecological and economic dimensions. Also, the state of the economy, the state of the water infrastructure, and trends in demand have combined to make progress even more imperative.

Notable Achievements

- Dr. Beecher participated in a panel on “Michigan's Critical Infrastructure: Water and Sewer System Concerns,” Michigan State University’s Institute for Public Policy and Social Research Policy Forum, March 25, 2009.
- Dr. Beecher and Prof. Bartholic organized and participated in a workshop Water Asset Management on Approximately 15 attendees participated in a special one-day workshop on asset management issues and methods for the water sector. (October 10, 2008 at MSU).
- Dr. Beecher Participated as technical advisor at the inaugural meeting of the International Exchange Program on Regulation of Water Services and Sustainability. (January 2009, Rome Italy).
- Dr. Beecher participated as an invited expert in the Aspen Institute Dialogue on Sustainable Water Infrastructure in the U.S. (2008-2009, Aspen, CO and Queenstown, MA).
- Dr. Beecher participated in a panel on “Utility Infrastructure,” Michigan State University’s Institute for Public Policy and Social Research Policy Forum, May 20, 2008.



Information Transfer Program Introduction

As information from any source becomes increasingly accessible over the internet, it is critical that science-based information be made apparent and available to the general public and specific user groups. With a reputation for dependable and accurate information, Universities must continue to provide current, reliable, nonbiased and readily transferable information to a wide audience in formats that are easily understood via the web but also in alternate formats. Thus, an effective information dissemination program is essential for transferring research-based information to a wide and often diverse audience and offering alternative solutions to problems being assessed. To address these needs, the Institute of Water Research (IWR) has developed and expanded upon its information dissemination and training program.

The objectives of the program are to develop and present educational programs designed to increase the public's awareness, knowledge and appreciation of the water quality and quantity problems in Michigan and to stress the environmental and economic trade-offs required to solve real world water related problems. These programs are offered in a variety of formats that suit the needs of individuals and user groups, including conferences, seminars, training workshops, computer models, web-based programs, and printed material. Audiences include agency personnel, watershed organizations, riparian owners, farmers, local governmental agencies, students, and University faculty. Evaluations of programs are included to assess the merit of the programs and help prioritize issue areas and programming/training needs.

Information Dissemination and Technology Transfer Training Programs

Basic Information

Title:	Information Dissemination and Technology Transfer Training Programs
Project Number:	2008MI115B
Start Date:	3/1/2008
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Water Quality
Focus Category:	Education, Groundwater, Surface Water
Descriptors:	None
Principal Investigators:	Lois G Wolfson

Publication

1. Martinell, M., L. Wolfson, J. Iles, B. Liukkonen, and K. Stepenuk. 2009. Building Volunteer Capacity to Monitor E. coli in Surface Water, University of Wisconsin, Madison, WI. 2 pp.
2. Reeves, H.W., Hamilton, D.A., Seelbach, P.W., and Asher, A.J. 2009. Ground-water-withdrawal component of the Michigan water withdrawal screening tool: US Geological Survey Scientific Investigations Report 2009-5003, 36 pp.
3. Wolfson, L. 2009. Surface Water Resources. Pages 206-220. In Schaetzl, R.J., Darden, J.T. and D. Brandt (eds). Michigan Geography and Geology. Pearson Custom Publishing, Boston, MA.
4. Wolfson, L. and M. Martinell. 2009. The Midwest Spatial Decision Support System (MSDSS) Partnership, University of Wisconsin, Madison, WI. 2pp.

Project Number: 2008MI58B

Start: 03/01/08(actual)

End: 02/28/09 (actual)

Title: Information Dissemination and Technology Transfer Training Programs

Investigators: Lois G. Wolfson, Institute of Water Research, Michigan State University

Focus Categories: EDU, GW, SW, WQL

Congressional District: Eighth

Descriptors: Water Quality; Water Quantity, Watershed Management; Macroinvertebrates; Wetlands; Interactive Web-based Systems; Water Withdrawals; Exotic Species

INFORMATION TRANSFER PROGRAM

Research Program

The following programs were coordinated, developed and delivered for fiscal year 2008-2009.

Training Workshops

The Institute took the lead and coordinated a series of 11 hands-on training and lecture workshops on the background and use of the new legislatively mandated Water Withdrawal Assessment Process and Tool. The workshop portion discussed key hydrologic and concepts; environmental criteria now used to assess “adverse resource impacts” in rivers and streams, and provided an overview of local groundwater and surface water resources within the community where the training occurred. The web based tool, developed by Institute personnel and designed for use by those preparing a new or increased water withdrawal (100,000 gal/d or more), was demonstrated. Participants were shown how to site a new or expanding withdrawal, and register their use. Overall, 325 people attended the workshops. The tool and related information is available at www.miwwat.org. The process and tool will help to manage and protect the waters of the state.

The Lake and Stream Leader’s Institute convened the Alumni Class of 2008 and began preparing for the new Class for 2009. IWR staff played a significant role in both the development and implementation of the program and worked with the coordinator in developing the session and leading advanced training sessions in lake and stream ecology. The overall goals of the program included developing local water/land resource leaders and educating participants on a variety of lake and stream issues ranging from ecology to local government to mediation. Meetings for the 2010 Class were held to discuss and evaluate the previous programs in order to improve upon previous offerings.

An IWR staff member led four sessions on lake and stream ecology during The *Conservation Stewards Program*, a comprehensive eight week program to assist local decision makers, agency personnel, and interested citizens with tools and information concerning land and water ecosystems. The 10-hour session, co-led by IWR staff and divided into two days, consisted of lectures, interactive sessions, and hands-on lake and stream ecology. Approximately 30 attendees took part in the class.

A 3-credit course aimed specifically for students is offered through the Department of Fisheries and Wildlife, but is held as an intensive 2-week session. The course, *Development of a Natural*



Resources Field Institute: Shaping Future Professionals through Experiential Learning and Teaching, provided opportunities for students to take part in hands-on field work, develop projects, and present their results. IWR staff lent support for this course by helping to teach the sessions on lake and stream ecology and management.

Conferences

The annual Great Lakes conference focuses on current and emerging issues related to Great Lakes water quality, ecology, fisheries, contaminants, exotic species, policy, and management. In 2008, the IWR co-sponsored the 18th year of this conference. Titled *The Great Lakes: An Ecosystem in Transition*, the conference focused on climate change and how it affects Great Lakes water levels, fisheries, waterfronts, and the ecosystem. Other talks discussed economic development, hypoxia, and impacts on Isle Royale, located in Lake Superior. The day's session attracted over 150 people, representing state and local agency personnel, researchers, educators, environmental organizations, and interested citizens. Co-sponsorship included several MSU departments as well as the Office of the Great Lakes, Michigan Department of Environmental Quality.

In coordination with MSU Extension's Water Area of Expertise Team, the Institute assisted with the development and implementation of a conference/workshop on *Collaborative Solutions for Reducing Phosphorus in Agricultural and Urban Watersheds*. Speakers focused on understanding phosphorus cycling and its impact on Michigan's water resources as well as current and future trends in urban and agricultural phosphorus fertilizer management. Institute staff helped to facilitate the workshop portion aimed at prioritizing priority recommendations from a state Phosphorus report. A key State Senator was invited by the Institute Director to the meeting. The Senator provided introductory remarks and a charge to the audience and helped set the positive tone for the day.

IWR staff members also co-coordinated a workshop with the Michigan Chapter, North American Lake Management Society. The meeting on *Exotic Species: Regional and Local Management* brought in a nationally recognized speaker along with state agency personnel to discuss current invasive species problems in inland waters in Michigan, and the need for a rapid response program for dealing with invading species. The program was also moderated by Institute staff. Approximately 50 people attended the meeting.

The Institute was a cosponsor for a series of six workshops around the state on *Planning for Water Quality and Land Use*. As part of the highly acclaimed Citizen Planner Series, these workshops were aimed at helping local government officials and other decision makers address key water issues through hands-on learning and classroom activities.

Events

A number of University wide events are annually held, and the Institute offers its expertise and knowledge by lending support to these events. In FY 2008-09, the following programs and/or exhibits were led and taught by IWR staff: Ag Expo, an agricultural exhibition aimed mainly at farmers and the agricultural community; Grandparent's University, held annually for grandparents and their grandchildren to learn about the University and its offerings; the State Finals for the Science Olympiad Groundwater Section, an event for high school students to compete with other students on science-related issues; Environmental Monitoring Competition,

for FFA high school students, and the Children's Water Festival, which attracts fourth and fifth graders to learn about water, natural resources, recycling, and other science related activities. In total, these events attract over 38,000 adults and children to the MSU campus.

Internet-Based Decision Support System

Computing technology and the development of decision support systems is one of the major focal points for the Institute. Staff members continually work to improve its programs, and link other models and systems into comprehensive systems. Digital Watershed, the flagship web site for the Institute (www.iwr.msu.edu/dw) has expanded nationally and has links to models and data bases at Purdue, Ohio State, and Wisconsin DNR. It also utilizes Google Earth for providing images nationwide. Users type in an address or county anywhere in the continental United States to obtain information for the surrounding area. The IWR also continues to publish its bi-monthly on-line newsletter, *The Watershed Post* to provide current information on Institute activities as well as general articles of interest. Contributions are generally made by IWR staff and grantees.

Lectures and Seminars

The Institute delivered papers, presentations, and posters on and off-campus. Audience participants in 2008-09 included legislators, community personnel, watershed managers, college students, K-12, and interested citizens.

Personnel and Facilities

The Institute of Water Research maintains a variety of computer workstations and servers for its growing web based decision support systems. In addition to computer-related supplies and equipment, the IWR also has video editing and photographic equipment, color printers, and field supplies for its Information Dissemination Program. The Institute's technology transfer program is under the direction of Principal Investigator Dr. Lois Wolfson, with several Institute personnel contributing to the project, including Dr. Jon Bartholic, Director, Ruth Kline-Robach, Outreach Specialist, and Jeremiah Asher and Yi Shi, Information Technology Specialists.

Notable Achievements

The Institute took the lead in the development of a legislatively mandated web based tool that will help determine if water withdrawals with a pumping capacity of at least 100,000 gallons of water per day will have an adverse resource impact on stream fisheries. In coordination with the US Geological Survey and Michigan Departments of Natural Resources and Environmental Quality, who developed the models behind the tool, the Institute also held a series of training sessions throughout the state on the new legislation and how the tool can and will be used.

USGS Summer Intern Program

None.

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	0	0	0	6	6
Masters	0	0	0	2	2
Ph.D.	0	0	0	5	5
Post-Doc.	0	0	0	0	0
Total	0	0	0	13	13

Notable Awards and Achievements

Project Title: The Water Withdrawal Assessment Tool

Funding Agency: Michigan Department of Environmental Quality:

In 2006 and 2008, the Michigan legislature enacted new laws to manage large quantity water withdrawals in the state using science as the basis for policy development. Several of these new laws required a water withdrawal assessment process and tool that could be used by the public to help protect and conserve the waters of the state. The water withdrawal assessment tool was designed to be used by a person proposing a new or increased large quantity water withdrawal to assist in determining whether the proposed withdrawal might cause an adverse impact to a nearby stream or river. The IWR developed the web based tool utilizing the interactive models developed by a team of scientists and was given the responsibility to provide training for user groups throughout the state.

Notable Achievement: Legislation requires that the tool will be required for use by the summer of 2009 for reporting and registering new or increased large water withdrawals unless a site specific review is requested. This project is a leading example of tying science and technology together and coupling it with legislation. As a result the following bills were enacted in Michigan:

Senate Bill 212 (as enacted) PUBLIC ACT 190 of 2008

Provide for the implementation of the Great Lakes- St. Lawrence River Basin Water Resources Compact.

Senate Bill 723 (as enacted) PUBLIC ACT 189 of 2008

Revise the membership and duties of the former Groundwater Conservation Advisory Council and change its name to the "Water Resources Conservation Advisory Council".

Senate Bill 860 (as enacted) PUBLIC ACT 185 of 2008

Require the DEQ, on October 1, 2008, to make available for testing and evaluation an internet-based waterwithdrawal assessment tool.

House Bill 4343 (as enacted) PUBLIC ACT 184 of 2008

Require the DEQ to notify certain local entities by e-mail if a proposed withdrawal falls into a particular category.