

Institute of Water Research

Annual Technical Report

FY 2003

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 MSUs 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; www.iwr.msu.edu.

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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 stormwater issues with funding from the university Vice President for Finance. A member of the Institutes 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 Institutes general philosophy and approach in defining its program areas and responsibilities.

Research Program

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.

Natural Resources Integrated Information System

Basic Information

Title:	Natural Resources Integrated Information System
Project Number:	2002MI1B
Start Date:	3/1/2002
End Date:	2/28/2003
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Not Applicable
Focus Category:	Management and Planning, Water Quality, Models
Descriptors:	
Principal Investigators:	Jon Bartholic, Jon Bartholic

Publication

1. Bartholic, J. 2003. Presented Models of Weather Patterns: Where Does Irrigation Water Go? Consumptive Use at the Michigan Irrigation Association Irrigation Workshop. December 4, Shipshewana, IN.
2. Bartholic, Jon. 2003. 45th Annual Regulatory Studies Program (Presentation).
3. Bartholic, Jon. 2003. Digital Watershed: A Nationwide Web Application Tool for Effective Watershed Management presentation in Muskegon, Michigan at the Michigan State of the Lakes Conference, October 2003
4. Ouyang, D., J. Bartholic, and J. Selegan. 2003. Assessing Soil Erosion and Sediment Load from Agricultural Croplands in the Great Lakes Basin, The Journal of Great Lakes Research. (In review).
5. Bartholic, J., 2003. Presented Water Supply and Resource Management at the 45th Annual NARUC Regulatory Studies Program sponsored by the Institute of Public Utilities of Michigan State University. August 10, East Lansing, MI.
6. Bartholic, J. 2003. Presented Pesticides: Its not just about bugs at the Agricultures Conference on the Environment. March 24, Lansing, MI.
7. Bartholic, J. 2003. Presented About Digital Watershed at the Lake Michigan State of the Lake 03 Conference. October 21-22, Muskegon, MI
8. Bartholic, J. 2004. Presented at Michigan Land Use Summit sponsored by the Land Policy Program of Michigan State University. February 2-3, East Lansing, MI.
9. Bartholic, J. 2004. Presented MSU 2003 Research Results on Drip Irrigation at the Southwest Michigan Irrigation Workshop. January 27-28, Benton Harbor, MI.

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Introduction

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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

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.

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 decisionmakers 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.

Natural Resources Integrated Information System

Basic Information

Title: Natural Resources Integrated Information System

Project Number: 2002MI1B

Start Date: 3/1/2003

End Date: 2/28/2004

Funding Source: 104B

Congressional District: Eighth

Research Category: None

Focus Category: Management and Planning, Water Quality, Models

Descriptors: None

Principal Investigators: Jon Bartholic

Publication

1. Bartholic, Jon. 2003. Midwest Groundwater Conference Lecture.
2. Bartholic, Jon. 2003. 45th Annual Regulatory Studies Program (Presentation).
3. Bartholic, Jon. 2003. Digital Watershed: A Nationwide Web Application Tool for Effective Watershed Management presentation in Muskegon, Michigan at the Michigan State of the Lakes Conference, October 2003.

Publications Resulting from Projects Prior to FY 2003

4. Nelson, S.A.C., P.A. Soranno, K.S. Cheruvilil, S.A. Batzli and D.L. Skole. 2003. Regional assessment of lake water clarity using satellite remote sensing, *Journal of Limnology*.
5. Cheruvilil, K.S., N.A. Nate, P.A. Soranno, M.T. Bremigan 2003. A field-test of the unimodal relationship between fish growth and macrophyte cover in lakes, Submitted to *Ecological Applications*.
6. Nelson, S.A.C., K.S. Cheruvilil, and P.A. Soranno. 2003. Remote sensing of freshwater macrophytes and the influence of lake characteristics. Submitted to *Aquatic Botany*

Pertinent Publications and Presentations

Ouyang, D., J. Bartholic, and J. Selegan. 2003. Assessing Soil Erosion and Sediment Load from Agricultural Croplands in the Great Lakes Basin, *The Journal of Great Lakes Research*. (In review).

Bartholic, J., 2003. Presented "Water Supply and Resource Management" at the 45th Annual NARUC Regulatory Studies Program sponsored by the Institute of Public Utilities of Michigan State University. August 10, East Lansing, MI.

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Michigan Institute of Water Research Water Research Institute Program Report for FY 2003 Submitted by Dr. Jon Bartholic, Director

Introduction

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Project Number: 2002MI1B

Start: 03/01/03 (actual)

End: 02/28/04 (expected)

Title: Natural Resources Integrated Information System

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

Focus Categories: M & P, WQL, MOD

Congressional District: eighth

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

Areas of Relevant Research

The management of water resources, appropriate policies, and data acquisition and modeling continue to be at the forefront of the State Legislature's 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.

Results and Benefits

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 decisionmakers and managers with a more refined understanding of the hydrologic cycle and water balance functions at watershed and statewide scales.

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." A special web site was prepared for the Kalamazoo Watershed project to assist them in prioritizing and developing a watershed management strategy. A substantial effort has been completed using all the digital orthoquads (DOQQ) available across Michigan. These have been acquired and seamlessly integrated with quality control and compression algorithms. This information now serves as a backdrop on our "Know Your Watershed" web

site. The DOQQ integrated data set is also used as a backdrop for soils information on IWRs new EZMapper web site. This site was specifically designed to aid with Comprehensive Nutrient Management Plan development for agricultural farms throughout the state. The system allows downloading of software to outline fields and utilize the available data.

IWR, Purdue University, and EPA Region 5 organized a workshop that examined web-based tools for land use and watershed planning. The Mapper is now under way to serve up these tools across all states within Region 5, along with obtaining the same data that would be common for each state.

The web-available Mapping is used extensively in IWRs Virtual Watershed Management courses. This past year we completed Module 4 in the series for Watershed Management Certification. There are now over 200 students registered per year in this course series.

Our work with the Michigan Department of Environmental Quality (DEQ) continues at a high level. With funding, between \$700,000 and \$1M dollars per year, it is largely the result of the Institutes' responsibilities being recognized statewide.

Our strategic plan for the Michigan Institute of Water Research (IWR) over the next five years has been developed and submitted to the Director of the Michigan Agricultural Experiment Station, the Dean of the College of Agriculture and Natural Resources at Michigan State University (CANR-MSU), and subsequently to the Office of the Vice President for Research and Development. The strategic plan outlines a number of key strengthening components for the MI IWR. (1) The affiliate positions within the Institute. These positions might be 25% time in the IWR and 75% in a discipline department. A group of affiliates would greatly strengthen the discourse relative to problems and techniques for solving them as well as the information dissemination. Additionally, adjunct faculty are generally somewhat less involved but enhanced mutual awareness of our programs would greatly enrich the pool of expertise of water scientists from which we could draw upon in order to more effectively address issues of concern within IWR. (2) Enhanced funding for the IWR: New Fiscal Support: Facilitating a competitive grants program in the water arena has been proposed. Preliminary discussions relative to the plan are leading to the strong possibility of adjunct and joint affiliate positions, but any new funding is on hold in light of the State's budget difficulties.

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 \$60,000 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 \$30,000-\$40,000 (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.

Evaluation and Decision Support System for the Regulation of High Capacity Groundwater Withdrawal in Michigans Lower Peninsula

Basic Information

Title:	Evaluation and Decision Support System for the Regulation of High Capacity Groundwater Withdrawal in Michigans Lower Peninsula
Project Number:	2003MI25B
Start Date:	3/1/2003
End Date:	2/28/2004
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Water Quality
Focus Category:	Groundwater, Non Point Pollution, None
Descriptors:	
Principal Investigators:	Jo Ann Beckwith, Jo Ann Beckwith, LeRoy Kettren

Publication

1. Beckwith, J. and Kettren, L. (Presenter). 2003. Evaluation and decision support system for the regulation of high capacity groundwater withdrawals in Michigan's Lower Peninsula, 2003 Midwest Ground Water Conference, Western Michigan University, 2003
2. Kettren, Leroy P., Miller, Steve, Hunt, Pamela B.K., Simard, Andreeanne, and Bartholic, Jon. 2004. Investigating the groundwater quantity effects on ecosystems and human activities for informed groundwater policy, Universities Council on Water Research Conference, Portland, OR, (In Preparation)

Basic Information

Title: Decision Support System for High Capacity Groundwater Withdrawal

Project Number: 2003MI25B

Start Date: 3/1/2003

End Date: 2/28/2004

Funding Source: 104B

Congressional District: Eighth

Research Category: None

Focus Category: Management and Planning, Water Quality, Models

Descriptors: None

Principal Investigators: JoAnn Beckwith and Lee Kettren

I. Introduction

This phase of the project was designed to develop decision support systems for evaluating proposals for regulating high capacity groundwater withdrawals in Michigan. The decision support systems will also be suitable for evaluating proposed high capacity wells.

II. Research Program

The first objective of the work was to review the laws and administrative rules of other Great Lakes states and Provinces to better understand the various approaches to regulating high capacity groundwater withdrawals. Once the review began it was decided to expand the review to other Midwestern and Eastern states that follow the Riparian-Beneficial Use doctrine towards groundwater access rights.

The review considered the laws and administrative rules of 30 Midwestern and Eastern states, the Canadian Provinces of Ontario and Quebec, the Delaware River Basin Commission, the Susquehanna River Basin Commission, and five Water Management Districts in the State of Florida. The results of the review were compared to recent and newly proposed legislation in Michigan.

This task is essentially complete, however ongoing work develops new information, which is continually added the results of the review.

A second related task was to contact appropriate officials in the various state agencies. These contacts were designed to clarify ambiguities in the published laws and regulations and to obtain first hand information regarding the effectiveness of each agency's program. This task is still in progress.

The results of the review and agency contacts were tabulated and compiled on several spreadsheets. The spreadsheets are being updated and refined as additional information

becomes available. These documents are designed to be posted on the Institute's upon completion.

A third task was to obtain information regarding decision support and management systems that could be used to evaluate proposals for regulating high capacity groundwater wells or to evaluate the proposed well itself under legislation adopted by the State of Michigan. Management science literature and case histories of Alternate Dispute Resolution and Adaptive Management techniques was reviewed with respect to application in environmental disputes. In addition policies and procedures used in Pennsylvania and Virginia to mediate environmental conflicts were also reviewed as were procedures of the U.S. Institute for Environmental Conflict Resolution at the Morris K. Udall Foundation in Tucson, AZ. This task is still in progress.

III. Information Transfer Program.

The results of the current research have been disseminated in several forms. Early results of the work were presented in a paper at the Midwest Groundwater Conference at Western Michigan University in October 2003:

Beckwith, J. and Kettren, L. (Presenter), Evaluation and decision support system for the regulation of high capacity groundwater withdrawals in Michigan's Lower Peninsula, 2003 Midwest Ground Water Conference, Western Michigan University, 2003

A second, more extensive publication is in preparation and will be presented at the Universities Council on Water Research Conference in July 2004 in Portland, Oregon:

Kettren, Leroy P., Miller, Steve, Hunt, Pamela B.K., Simard, Andreanne, and Bartholic, Jon, Investigating the groundwater quantity effects on ecosystems and human activities for informed groundwater policy, 2004, Universities Council on Water Research Conference, Portland, OR, (In Preparation)

Preliminary results of the review of state groundwater withdrawal laws and administrative rules were provided to officials of the Illinois State Water Survey and Illinois Department of Natural Resources.

Applying Hierarchical Groundwater Modeling to a Case Study: Saginaw County, Michigan

Basic Information

Title:	Applying Hierarchical Groundwater Modeling to a Case Study: Saginaw County, Michigan
Project Number:	2003MI30B
Start Date:	3/1/2003
End Date:	2/28/2004
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Ground-water Flow and Transport
Focus Category:	Groundwater, Models, Solute Transport
Descriptors:	
Principal Investigators:	Shu-Guang Li, Andreeanne Simard

Publication

BASIC INFORMATION:

Title: Applying Hierarchical Groundwater Modeling to a Case Study: Saginaw County, Michigan

Project Number: 2003MI30B

Start Date: 3/1/03

End Date: 2/28/04

Funding Source: 104B

Congressional District: Eighth

Research Category: Groundwater Flow and Transport

Focus Category 1: Groundwater, Models, Solute Transport

Descriptors: Groundwater, Groundwater Modeling, Groundwater Flow and Transport

Primary PI: Shu-Guang Li, Ph.D., P.E.

Other PI's: Andreeanne Simard

Applying Hierarchical Groundwater Modeling to a Case Study: Saginaw County, Michigan

By Andreeanne Simard and Shu-Guang Li

INTRODUCTION

Agriculture in many areas in Michigan relies on large amounts of groundwater withdrawals for irrigation. Residential wells in several areas of Saginaw County, Michigan, recently went dry after the beginning of the irrigation season. The relationship between the water-level declines in residential wells and ground-water withdrawals from irrigation wells has been the subject of many local investigations in the past. A numerical model is developed in this study to evaluate the possible effects on groundwater withdrawals from irrigation wells on residential wells. In particular, a new object-oriented technology, called Interactive Groundwater (IGW), is used to model an aerially expansive area while, at the same time, easily, freely, and interactively zooming into a hierarchy of nested sub-areas, or patches, from regional-scale to local scale to site scale. The IGW software automatically couples the scale-dependent model sequence and provides high-resolution solutions across multiple spatial scales. This report, demonstrates the complete process of modeling and visualizing groundwater flow, drawdown effects, and potential contaminant transport in response to irrigation events. This report also aids the decision support system for the regulation of high capacity groundwater withdrawals in Michigan's Lower Peninsula through the use of IGW, which helps provide a cost effective solution to help this dispute.

REAL-TIME GROUNDWATER MODELING TECHNOLOGY

Taking advantage of the recent developments in computer technology, contaminant transport modeling, and numerical simulation techniques, Dr. Li and his research team have recently developed a sophisticated combined research and educational software environment for unified

deterministic and stochastic groundwater modeling. Based on a set of new efficient and robust computational algorithms, the software allows simulating complex flow and transport in aquifers subject to both systematic and "randomly" varying stresses and geological and chemical heterogeneity. Adopting a new programming paradigm, the software eliminates a major bottleneck inherent in the fragmented traditional modeling technologies and allows fully utilizing today's dramatically increased computer processing power. For the first time, the software enables real-time groundwater modeling, real-time visualization, real-time analysis, and real-time presentation.

BENEFITS OF NEW APPROACH

The traditional method of modeling is inadequate to model large areas because the groundwater modeling of large areas is infeasible and too expensive. The traditional method is inadequate for simulating the more detailed local and site flow dynamics at individual well fields. A finer resolution is needed in some areas in order to accurately determine drawdown at or near the well of interest, better define wellhead delineation areas (WHPP) and contaminant transport problems. The traditional approach may provide results inefficiently and impractically in a number of critical problems involving water flow and contaminant transport provide such as: (1) defining wellhead delineation areas (WHDA) for low capacity wells in the community and (2) contaminant transport issues regarding multiple areas of contamination. In special complex groundwater cases, using the traditional approach to solve these problems will be very difficult to do and will be performed much less efficiently. IGW's hierarchical modeling capability allows the user to easily and interactively zoom into a local scale from the regional scale and can handle multiple areas of interest while at the same time saving computational cost and time.

APPROACH

Since the relationship between the water-level declines in residential wells and groundwater withdrawals from irrigation wells has been the subject of many local investigations, a numerical model is developed in this study to evaluate the possible effects on groundwater withdrawals from irrigation wells on residential wells. In this project, we have used the IGW software (2-dimensional version). We have modeled the Saginaw county area of interest based on the available data. Interactive Groundwater (IGW), that can be used to model an aerially expansive area while, at the same time, easily, freely, and interactively zooming into a hierarchy of nested sub-areas, or patches, from regional-scale to local scale to site scale. The IGW software automatically couples the scale-dependent model sequence and provides high-resolution solutions across multiple spatial scales. Described below, is the process used in modeling and visualizing groundwater flow, drawdown effects, and potential contaminant transport in response to irrigation events.

The Saginaw county area geology consists of two main aquifers, which are (1) the bedrock aquifer and (2) the drift aquifer (Figure 2). According to the available data there are irrigation and residential wells in both aquifers. The aquifers seem to be hydraulically distinct which means that when pumping from the drift there is no impact on the bedrock and vice versa.

Using the available data for the Saginaw County area a two-dimensional regional model was performed for the bedrock aquifer. Its thickness was obtained from available well logs. Figure 3 represents the plan view of the initial model area used to in calibration. This model was calibrated with 24-hour pump test data acquired for one of the irrigation wells. The calibration results obtained by using the 24-hour pump test data are presented in Figure 4. Once the initial model was calibrated, it was later expanded to include a larger area of Saginaw County in order to see the irrigation well interaction in the Saginaw aquifer. The calibrated model is presented in Figure 3. along with the expanded model found in Figure 5., which shows the irrigation wells interactions. Hierarchical modeling was also used to better determine the drawdown at or near the irrigation wells (Figure 6.). Reverse particle tracking was performed to better define the wellhead delineation areas of both the low capacity wells and the irrigation wells (Figure 7.).

SIGNIFICANCE AND FUTURE PLAN

Our longer term objective is to extend the pilot project to a full implementation calibrated to real-data live-linked with the detailed state-wide GIS database with the capability of real-time, interactive extraction of a hierarchy of submodels that can be used for a wide range of applications in water resources management, natural resource management, pollution control, groundwater site characterization, remediation design, and water security/defense issues.

The fully implemented statewide model will provide an innovative and highly effective platform for professional communication and for facilitating community-based environmental protection related to groundwater resources. The new technology will broaden opportunities and enable the informed participation of citizens and improve interactions between government institutions, their constituents, and consultants. The benefits from the real-time simulation technology will include the following:

1. Site planners, managers, and regulators could experience in real-time the impact and effectiveness of management, sampling, and cleanup scenarios to improve policy-making decisions; They can become much more effective in engaging the general public and informing high-level decision makers about the implications of the fate and transport of contamination and the impact on the groundwater environment and the affected communities.
2. Consultants could make much more effective use of the subsurface data, design better monitoring network to collect additional data, and characterize more accurately contamination site dynamics at much less cost. They also could more easily communicate a solution, a design, or strategy to their clients.
3. The local community could visualize the invisible subsurface and experience and understand the impact of a proposed management and cleanup schemes and pollution control measures in an intuitive, vivid, and interactive way. They can also visualize the potential impact of their own activities on the groundwater environment and their drinking water supply. Thus, they are motivated and

empowered to engage in the intricate process of community-based environmental management, planning, protection, and cleanup.

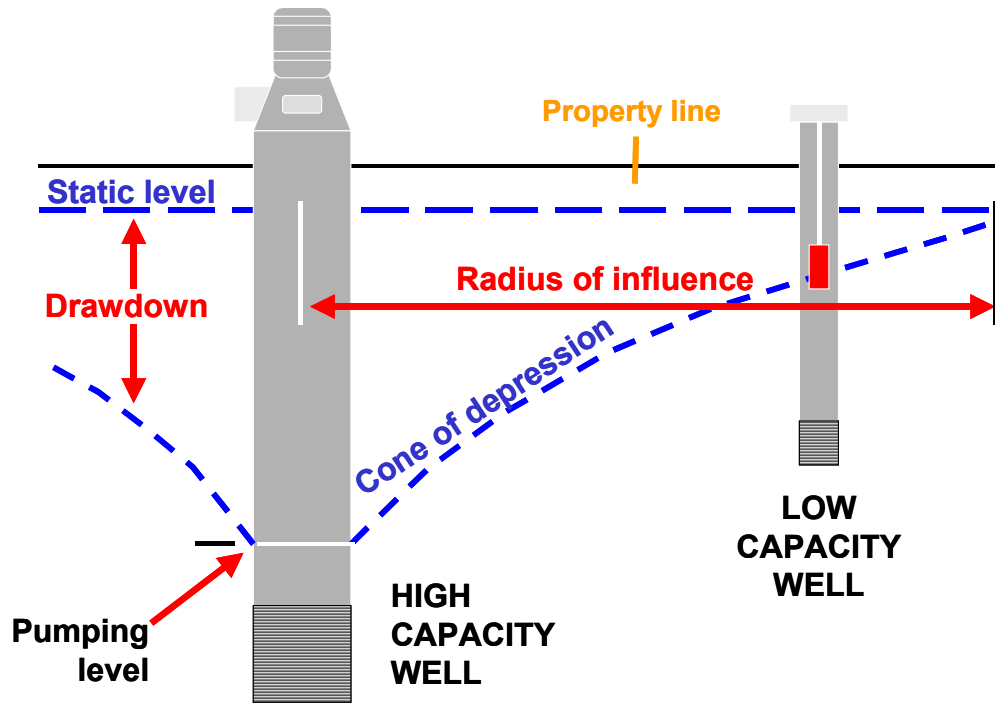
4. Policymakers and politicians could use real-time interactive simulation as a public relations effort to reveal future environmental plans related to groundwater resources management and remediation.

Coupled with the information explosion and the widespread popularity of computers, the new technology may significantly improve the true public involvement in groundwater protection where the 'public' is a major stakeholder.

For more information on the IGW software please visit the following website:

<http://www.egr.msu.edu/~lishug/research/igw/index.htm>

Figure 1:



**Provided by Brant Fisher from the MDEQ*

Figure 2:

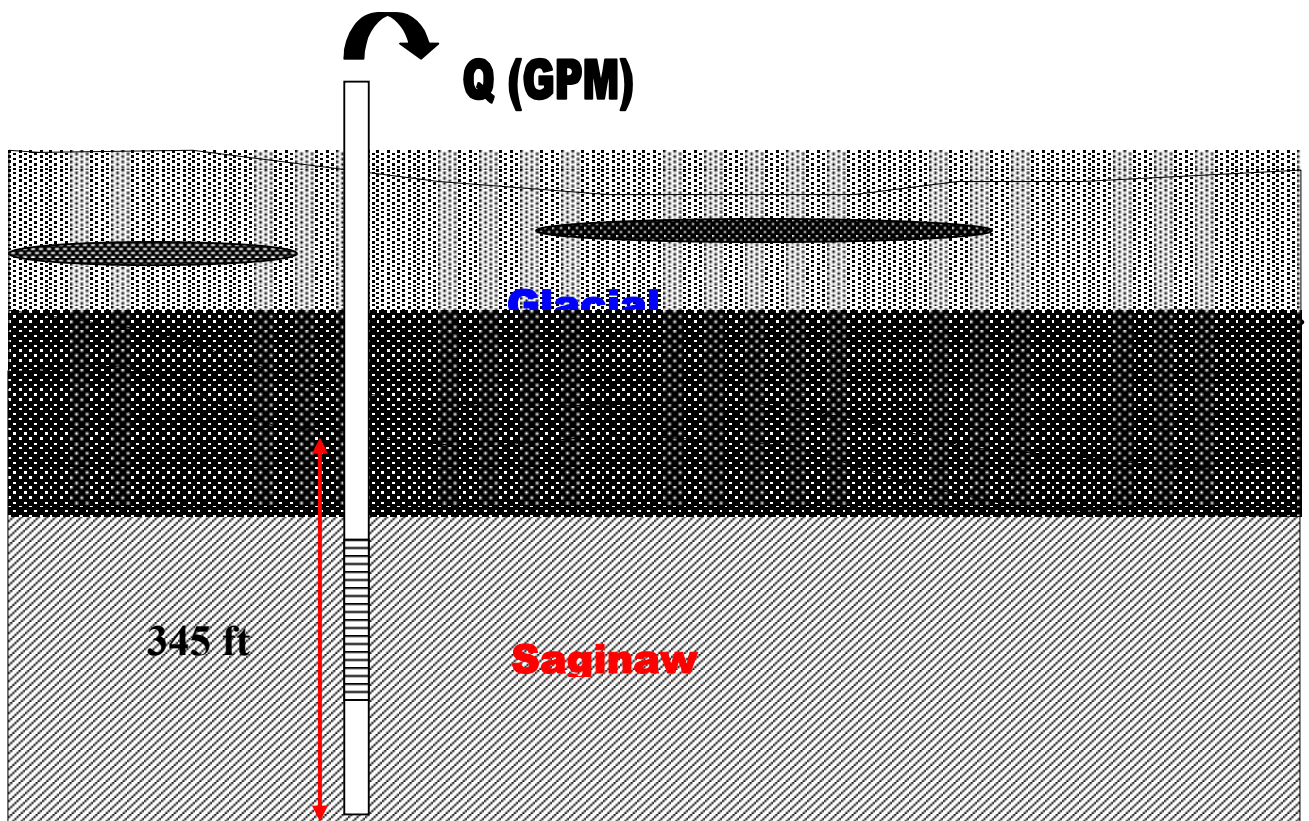


Figure 3:

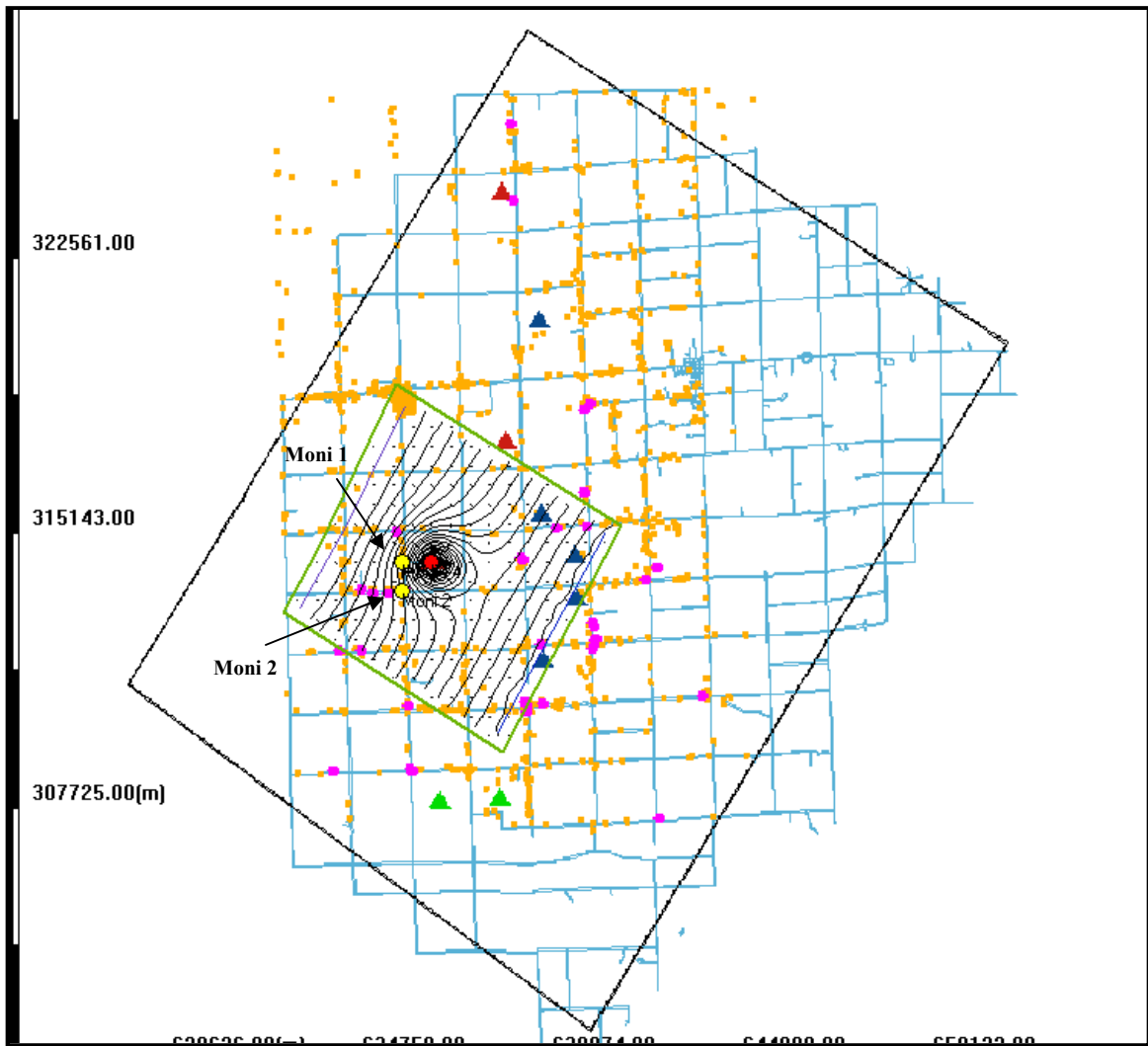


Figure 4:

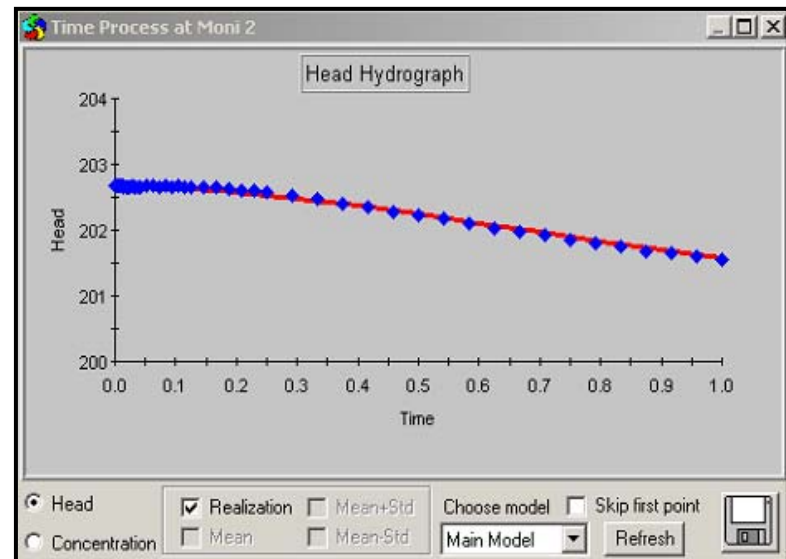
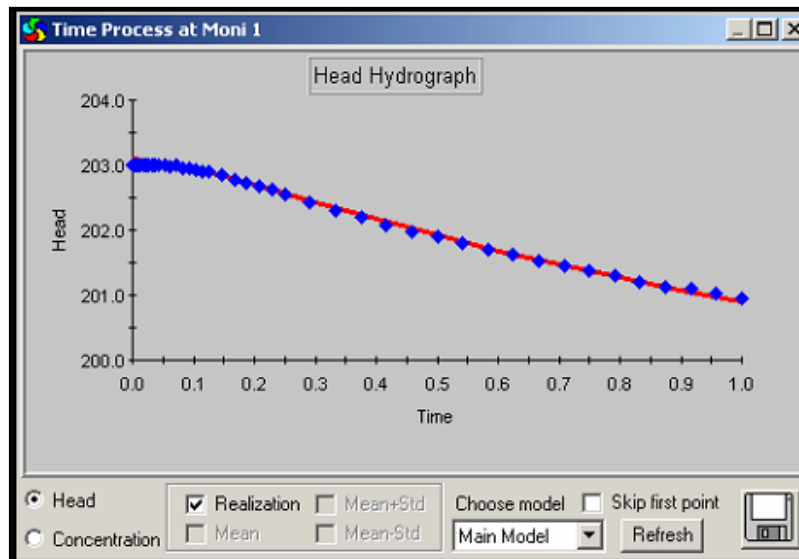


Figure 5:

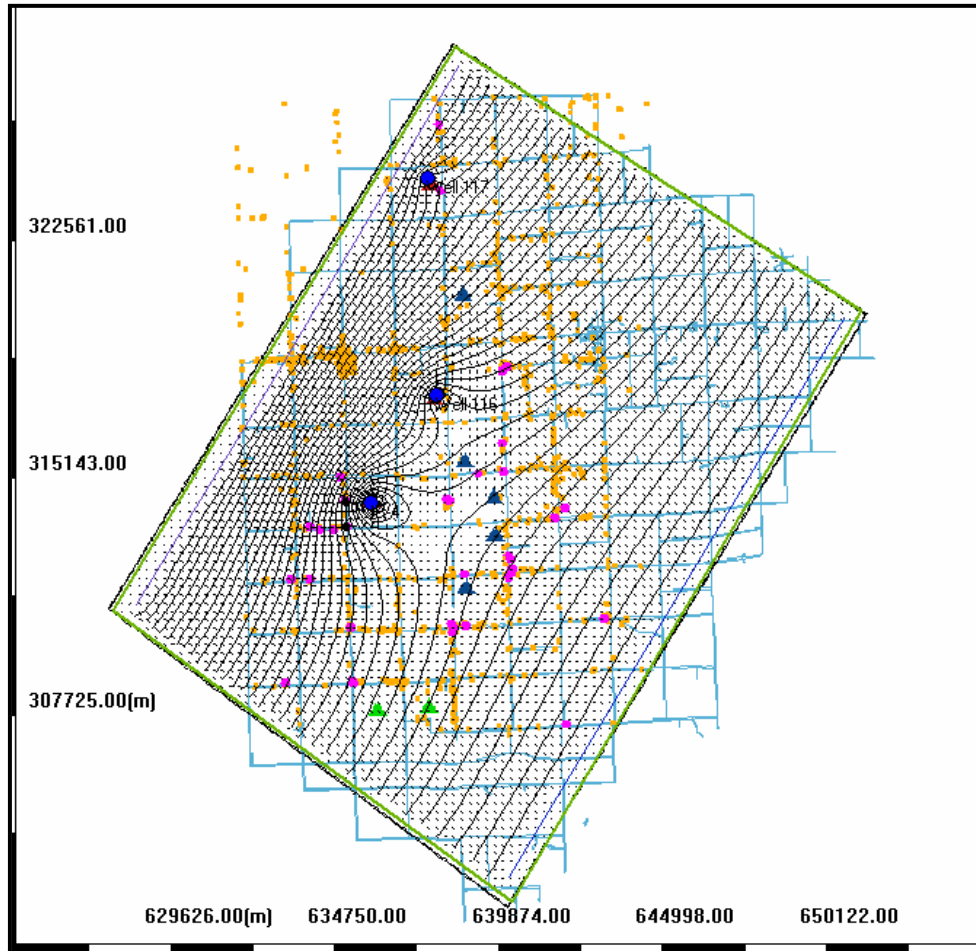


Figure 6:

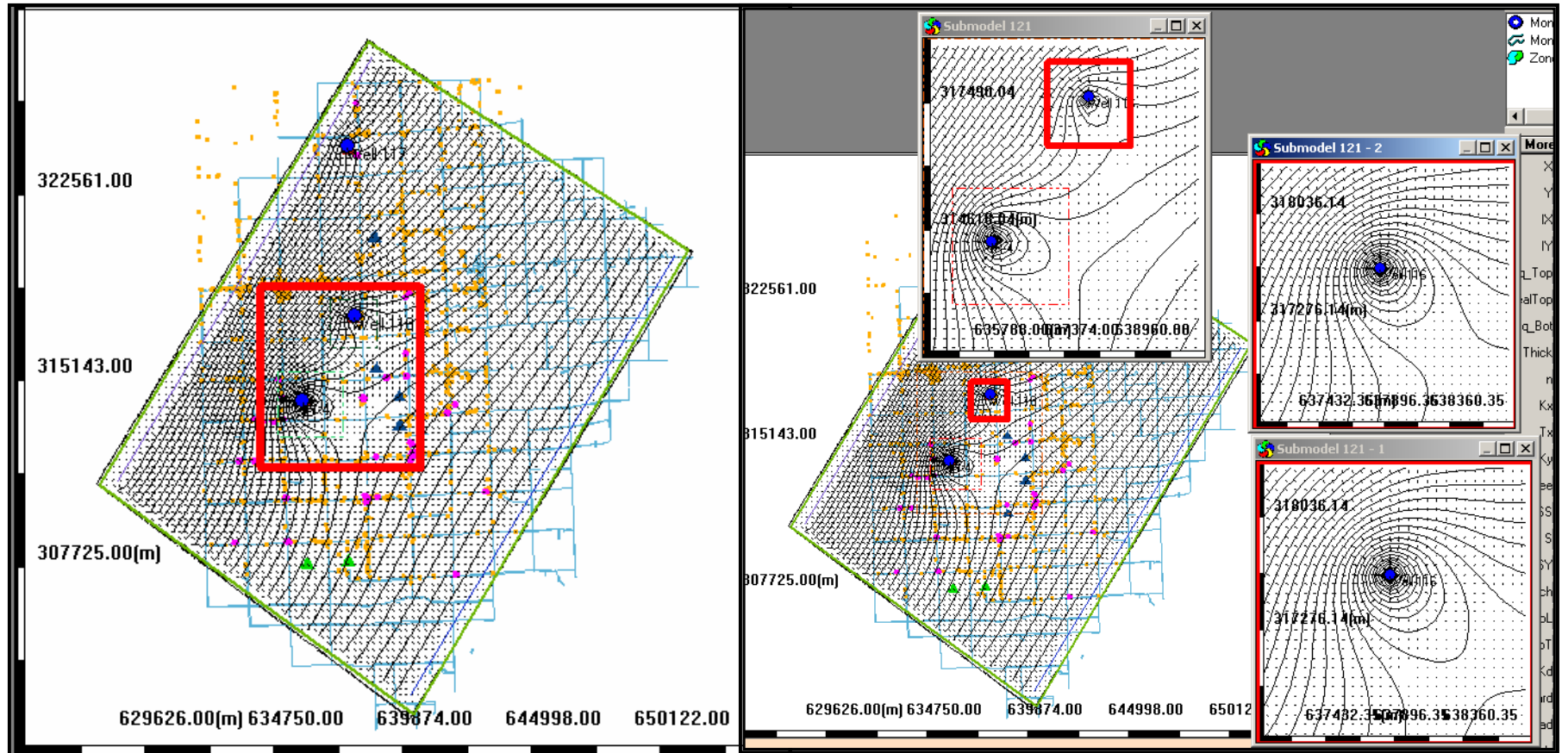
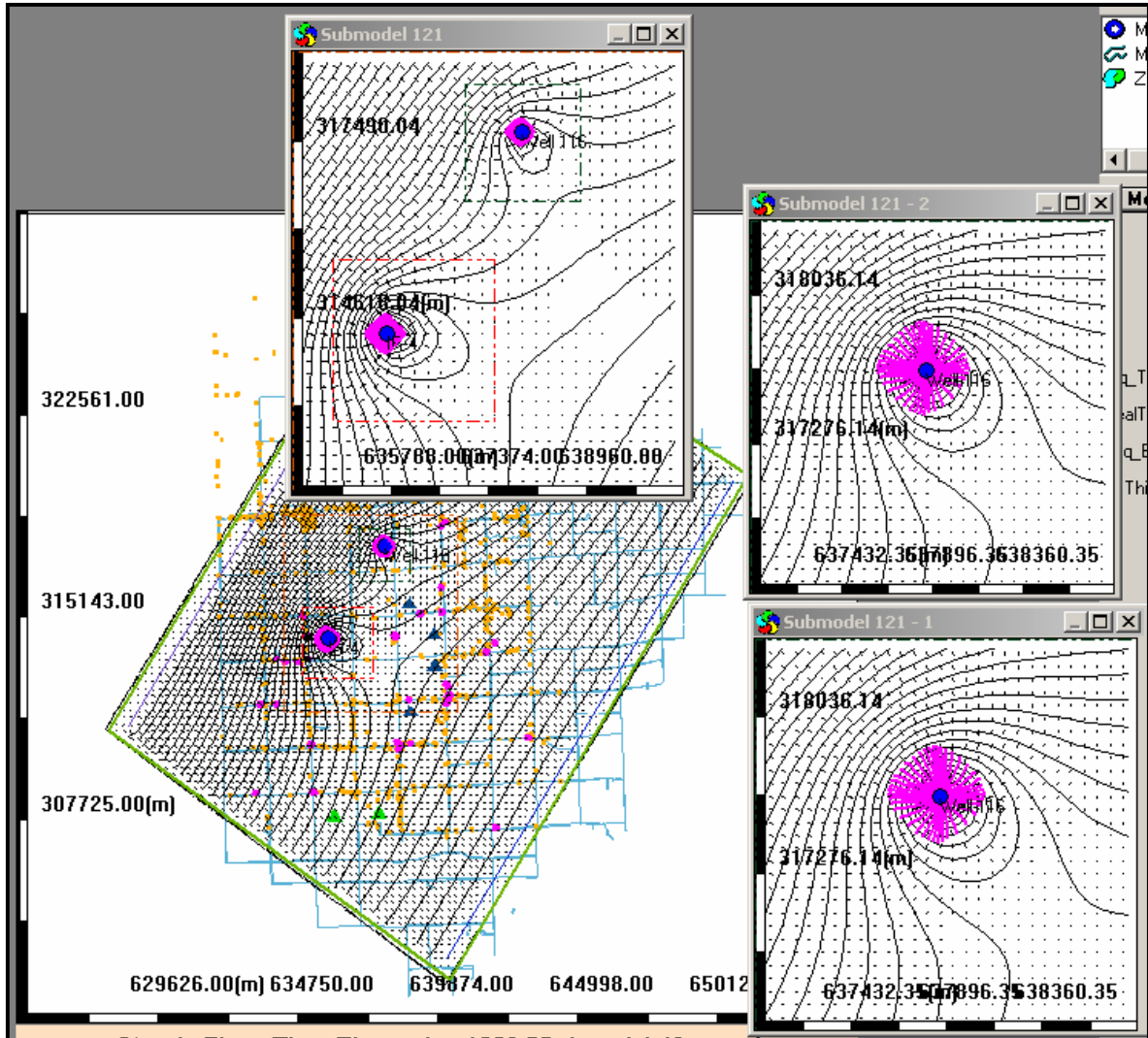


Figure 7:



Investigating the Groundwater Quantity Effects on Ecosystems and Human Activities

Basic Information

Title:	Investigating the Groundwater Quantity Effects on Ecosystems and Human Activities
Project Number:	2003MI31B
Start Date:	3/1/2003
End Date:	2/28/2004
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Not Applicable
Focus Category:	Groundwater, Water Quantity, Education
Descriptors:	Groundwater hydrology, Water Use Conflicts
Principal Investigators:	William J. Northcott, Pamela KB Hunt, Steve Miller

Publication

BASIC INFORMATION

Title: Investigating the Groundwater Quantity Effects on Ecosystems and Human Activities

Project Number: 2003MI31B

Start Date: 3/1/2003

End Date: 02/28/2004

Funding Source: 104B

Congressional District: Eighth

Research Category: Hydrologic Processes

Focus Category: Groundwater, Water Quantity, Water Quantity

Descriptors: Groundwater, Hydrology, Water Use conflicts, GIS

Primary PI: William J. Northcott, Asst. Professor, Dept. Ag Engineering

Co-PI: Steve Miller, Institute of Water Research and Dept. Ag Engineering

Other PI's: Pamela Hunt, Research Assistant, Institute of Water Research

Investigating the Groundwater Quantity Effects on Ecosystems and Human Activities

By Pam Hunt

Project Relevance

The Michigan Legislature enacted water use and natural resources legislation entitled Public Acts 148 and 177 of 2003. Public Act 148 of 2003 addresses water use themes and Public Act 177 concentrates on aquifer protection and dispute resolution. "With no regulation, Michigan landowners maintain virtually own all rights to the water underneath their property" stated in a fiscal analysis by Jessica Runnells. However, Michigan citizens are being confronted with water use conflicts within the State. Cases brought to light in the news include; agricultural irrigation is being singled out as dewatering the local water supplies in Saginaw and Monroe Counties, the high capacity water withdrawals by a recently built water-bottling plant has been accused by a citizen's group of harming and most likely will harm the environment, and toxic levels of contaminants in nearby domestic wells have been traced to rock mining operations lowering the water levels. The distribution of water use data and subsequent educational materials are needed for dissemination for policy-makers to formulate plans and enact further legislative initiatives plus allowing the citizens to understand the policies and need for legislation.

Project Objectives and Deliverables

Based on the legislative initiatives, the public's knowledge of known water use conflicts, and a steering committee recommendation, one outreach material focused on reporting water use data compiled by the Michigan Department of Environmental Quality into a county and watershed format in a web site maintained by IWR-MSU. Michigan water use data can be retrieved by years, 1997-2001, for the five major sectors of water withdrawal: Thermoelectric Power

Generation, Public Water Supply, Self Supplied Industrial, Agricultural Irrigation, and Golf Course Irrigation. This site sorts the water withdrawal data by location and then respectively by category and years. The URL address is <http://www.hydra.iwr.msu.edu/iwr/wateruse/index.html>.

Due to the awareness of the hydrological relational properties of water quantity and quality by the local units of government and citizens groups (for example, watershed management organizations), a handout was created to indicate programs sponsored by the Federal and Michigan agencies to protect and manage their water resources at the local level. This material collates the varied programs in one document to serve as a one-stop shopping approach for best management practices, conservation easements, ordinance examples, planned units developments, wetlands and many other water-related topics. Many of these programs are supplemented by grant monies allotted for the restoration or facilitation of managing their resources.

Future Plans

Updating and entering the next year's available water use data to the MSU-IWR web site on an annual basis. The web site would be enhanced with graphical charts to illustrate the water withdrawal rates for each county or watershed selected.

The next step is to create a web site for the local units of government and citizen's groups illustrating the various programs and incentives for managing and protecting their resources locally.

Other Outreach Materials and Education Opportunities

Conferences and Exhibits

The MSU Natural Resources Programs Coalition provided a Natural Resources Stakeholder Reception which included a forum to review posters and exhibits from related MSU natural resources departments on March 6, 2003 during the MSU's annual Agriculture and Natural Resources Week. IWR-MSU displayed a flash program depicting the water and land alliance. Also, the web-based program, Know your Watershed was online. Participants were encouraged to navigate the sight and hone into their area of interest to review the land and water features provided by the aerial photography of the chosen locale. Explanations were provided on the connection of the land and water features for protecting the water resources.

An exhibit was created utilizing interactive software and web sites developed by the Institute of Water Research (IWR) – MSU at the Agriculture Conference on the Environment (ACE) sponsored by the Michigan Agriculture Environmental Assurance Program (MAEAP) on March 24, 2003. This forum was designed to illustrate tools that are available to plan and implement environmental stewardship programs for all agricultural producers. Two interactive software programs developed by the IWR-MSU, EZ-Mapper and Know Your Watershed, were demonstrated to conference participants to enhance their knowledge of the surrounding environs.

The conference participants also received brochures on the applicability of the web sites, which they could access on at their home businesses. An enclosed brochure was created to highlight the features of EZ-Mapper.

Ag Expo is an annual event sponsored by Michigan State University (MSU) and is largest farm show in the State scheduled in July. Educational exhibits highlighting MSU research and extension have always been the mainstay of the expo. IWR featured two interactive web sites, EZ-Mapper and Know Your Watershed to illustrate imagery available by the internet. Additionally, a color printout of their farm or another point of interest was printed for the visitors depicting aerial photography presenting water bodies, topography and land use features. IWR-MSU brochures were made available to the expo participants emphasizing the education components of protecting one's water resources.

Correspondence with Agriculture and Natural Resources Agents, MSU County Extension reviewing the mapping service provided by the IWR-MSU web-based EZ-Mapper with regards to individual Comprehensive Nutrient Management Plans. The attributes of EZ-Mapper fulfilled some of the following requirements needed for the completed plan, for example, a farm headquarters map, soils maps with legends for all fields that will receive manure, identification of fields for winter spreading, and other mandates as well.

Resource Systems

Articles and PowerPoint presentations about this project as well as the companion projects, *Groundwater*, *Groundwater Modeling*, *Groundwater Flow and Transport (2003MI30B)*, and *Evaluation and Decision Support System for the Regulation of High Capacity Groundwater Withdrawal in Michigan's Lower Peninsula (2003MI25B)* were posted via the Watershed Post. The Watershed Post is an online news source provided by the IWR-MSU which is emailed to over 2,000 subscribers and also accessible on the IWR-MSU home page. Questions and comments were received on all three projects via email.

Designed the enclosed companion bulletin for *Evaluation and Decision Support System for the Regulation of High Capacity Groundwater Withdrawal in Michigan's Lower Peninsula (2003MI25B)* entitled Regulations in the Great Lakes States for High Capacity Groundwater Withdrawals and integrating the water use web site as well. The audience for this outreach material has included staff at MSU-Extension, Michigan Department of Agriculture, and Michigan Farm Bureau.

Regulations in the Great Lakes States for High Capacity Groundwater Withdrawals

Reliable supplies of fresh water are an important resource for industry, agriculture and the general public. While surface water supplies can be seen and pollution or overuse can be readily recognized, groundwater is hidden and changes in quality/quantity are often not apparent.

Groundwater is that water that occurs in the pores between the grains of soil or rock. Groundwater is found nearly everywhere and is the primary source of water for most rural and many suburban residents. Groundwater is also a major source of water for public water supplies, agricultural irrigation and increasingly for industry, in addition to supplying water for streams and wetlands.

Historically, groundwater use was, and in many areas still is, regarded as a part of the rights of property ownership. Landowners are viewed as having the right to use the groundwater found under their property subject only to the doctrine of beneficial or reasonable use. That doctrine states that the water may be used as the property owner sees fit as long as the water is not wasted.

That view of water ownership is increasingly being challenged as increasing demand has led to the use of high capacity wells for industrial process water, agricultural irrigation and other uses. High capacity wells are commonly defined as those capable of producing 70 gallons of water per minute or 100,000 gallons per day. Such wells frequently cause interference with neighboring low capacity domestic wells.

Governments are being asked to resolve such conflicts in water use. Adopting regulations that provide adequate water supplies for all users while respecting important property rights is a challenge to legislatures. Some states have adopted policies for resolving conflicts between well owners after well interference has occurred. Other states regard groundwater as a public resource held in trust for the people by state government. These states prevent groundwater conflicts by requiring a water allocation permit prior to installing a high capacity well. As Michigan becomes more involved in this debate, it is helpful to examine how groundwater withdrawals are regulated in other Great Lake States.

<http://www.hydra.iwr.msu.edu/iwr/wateruse/index.html>

The screenshot shows a web browser window with the address <http://www.hydra.iwr.msu.edu/iwr/wateruse/index.html>. The page content includes the Michigan State University logo and the Institute of Water Research logo. A 3D diagram illustrates the water cycle and groundwater resources, with labels for 'Inland Lake', 'Surface water', and 'Ground water'. A well is shown tapping into the groundwater. Text on the page states: 'Water withdrawal data can be retrieved by county and watershed for water years 1997-2001 for the five major sectors of water withdrawal; Thermoelectric Power Generation, Public Water Supply, Self-Supplied Industrial, Agricultural Irrigation, and Golf Course Irrigation.' A disclaimer at the bottom reads: 'Disclaimer: This web site is a compilation of water use data from the Michigan Water Use Reporting Program, Department of Environmental Quality. For a program overview and reporting requirements, please visit the following web site, (http://www.michigan.gov/deq/0,1607,7-138-3313_3677_3704-72931-00.html).

Michigan water use data can be retrieved by county or watershed for years 1997-2001 for the five major sectors of water withdrawal; Thermoelectric Power Generation, Public Water Supply, Self-Supplied Industrial, Agricultural Irrigation, and Golf Course Irrigation. This web site is a compilation of water use data from the Michigan Water Use Reporting Program, Department of Environmental Quality.

For additional information on water use: contact Pam Hunt,
Institute of Water Research, Michigan State University,
115 Manly Miles Bldg., East Lansing, MI 48823
Phone (517) 432-4555

For more information on Regulations in the Great Lakes States, contact:
Lee Kettren, Institute of Water Research, Michigan State University,
115 Manly Miles Building, East Lansing, MI 48823 Phone: (517) 353-3742

Summaries of State Regulations within the Great Lakes Basin

Illinois

The procedures for the regulation of groundwater conflicts are administered by the Department of Agriculture through County Soil and Water Conservation Districts. The procedures are specified in the Illinois Water Use Act of 1983, (525 ILCS 45). No permit is required. Any person who plans to install a well that can be reasonably expected to withdraw more than 100,000 gallons per day must notify the local Soil and Water Conservation District, who in turn, notifies the Illinois Geological Survey, Illinois State Water Survey, local units of governments and other interested parties. The agencies evaluate the proposed withdrawal and its effect on other users and make a public report. The operator of the withdrawal must register with the local Soil and Water Conservation District. In water emergencies, a Conservation District may recommend to the Department of Agriculture that it impose restrictions on groundwater withdrawals. The Department reviews and may approve or disapprove the recommendation.

Web Site: www.legis.state.il.us

Indiana

No permit is required prior to installing a high capacity well. Legislation enacted in 1983 requires significant water withdrawal facilities to register and report annually to the Natural Resources Commission. Significant withdrawals are defined as at least 100,000 gallons per day. Groundwater disputes are triggered by a complaint from an owner of a low capacity well. High capacity facilities that cause failure of a smaller user can be required to provide an alternative water source. The Indiana Department of Natural Resources may restrict high-capacity groundwater pumping if the withdrawal exceeds the recharge capacity of the aquifer.

Web Site: www.in.gov/nrc/policy/water.html

Michigan

Michigan does not require permits prior to installing a high capacity well. Recent legislation, Public Act 148 of 2003, requires annual reporting of high capacity withdrawals defined as 100,000 gallons per day over a 30-day period; \$100 reporting fee to Department of Environmental Quality (DEQ); require agricultural wells with a capacity to pump over 100,000 gallons per day to register with DEQ and pay the reporting fee or register with Michigan Department of Agriculture (MDA) by submitting a water use conservation plan; produce a groundwater inventory and map; require the MDA to report the data gathered from the water use conservation plan and consumptive use by township to the DEQ for the inventory and map; create the Groundwater Advisory Council to the study the sustainability of the State's groundwater use, monitor the Great Lakes Charter and make recommendations on Annex 2001 compliance. Other recent legislation, Public Act 177 of 2003, establishes a procedure for the investigation and resolution of conflicts between high capacity wells and neighboring low capacity wells.

Web Site: www.michigan.gov/deq

Minnesota

Water Allocation Permits are required for withdrawals greater than 70 gallons per minute or 100,000 gallons per day. There are separate permits for agricultural, non-agricultural and general

Minnesota - continued

(temporary) withdrawals. Permit holders must report monthly water withdrawal in an annual report. Permit applications must show need and in certain cases, have approval of the legislature. If adequate water supplies are available and the proposed uses are reasonable and proper, but there is probable interference with public water supplies or private domestic wells as shown in the permit application, the applicant must provide all available construction details for existing public water and private domestic wells in the area. Aquifer tests may be required. The State Department of Natural Resources determines the probable interference based on computations, aquifer tests and hydrologic studies.

Web Site: www.dnr.state.mn.us/waters

New York

Permits are required for all withdrawals greater than 45 gallons per minute in Long Island counties. The Great Lakes Water Withdrawal Registration Program requires that water withdrawal greater than 100,000 gallons per day averaged over a 30-day period or 3,000,000 gallons during any 30-day period from the Great Lakes Basin be registered.

Web Site: www.dec.state.ny.us/website/dow

Ohio

In Ohio, groundwater withdrawals must be registered and reported. No permit is required. Groundwater stress legislation enacted in 1990 allows the Chief of the Division of Water to designate groundwater stress areas and require registration of withdrawals less than 100,000 gallons per day. This action requires registration of small withdrawal facilities and does not involve restrictions of groundwater withdrawal.

Web Site: www.dnr.state.oh.us/water/waterinv

Pennsylvania

Pennsylvania has no mechanism for addressing well interference conflicts. The Water Resource Planning Act recognizes that surface and groundwater are the same resource and requires registration of withdrawals greater than 10,000 gallons per day as a basis for collaborative planning. Permits are required for high-capacity wells installed for public water systems.

Web Site: www.dep.state.pa.us/dep/deputate/watermgt

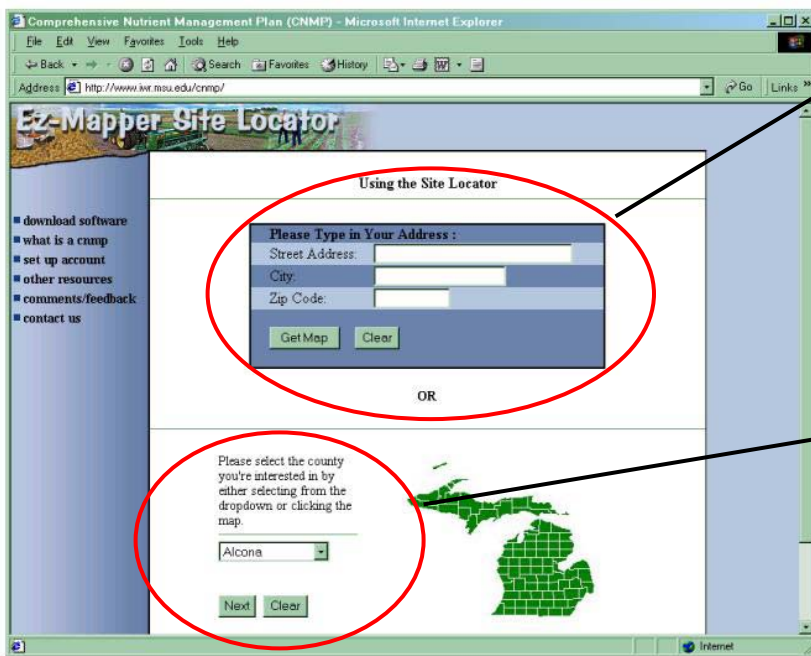
Wisconsin

Groundwater withdrawals must be registered; permits are required for withdrawals greater than 70 gallons per minute. Wisconsin regulates high capacity wells per 281.17 Wis Statute and NR 812 WI Admin Code, Well Construction and Pump Installation. The Wisconsin Department of Natural Resources (DNR) may specify more stringent regulation on well location and construction if necessary to protect public safety, safe drinking water and the groundwater resource. The DNR may deny a permit, limit a permit, or modify an existing permit on depth, location, pumping rate and ultimate use so that water for a public utility is not impaired. Current rules don't give DNR authority to restrict pumping rates beyond that needed to protect municipal water utility operations.

Web Site: www.dnr.state.wi.us/org/water/dwg/hicap.html

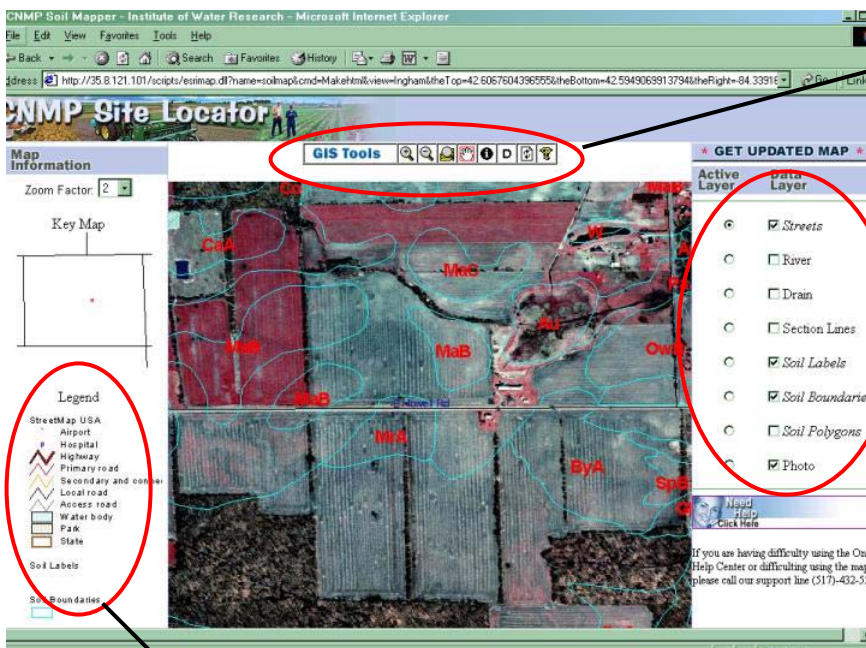
This site was created to assist farmers, citizens, and planners in developing digital maps. By typing an address, city, and zip code, users can retrieve a map containing: aerial photos, streets, streams, and soils information. By zooming in and out, users can view the entire area to be mapped. Once an area has been determined, users have the option to download a digital map of the area. The digital map contains the selected area including soil boundaries, labels, and aerial photo.

The web site provides a free map editing software called EZ-Mapper that can be downloaded to your computer. EZ-Mapper will allow you to outline areas of concern, draw field boundaries, label facilities, and title maps to be printed out.



This is the address input box. Type an address here and click the Get Map button to view a map of your designated area.

Or select the county option for retrieving a larger mapping area.

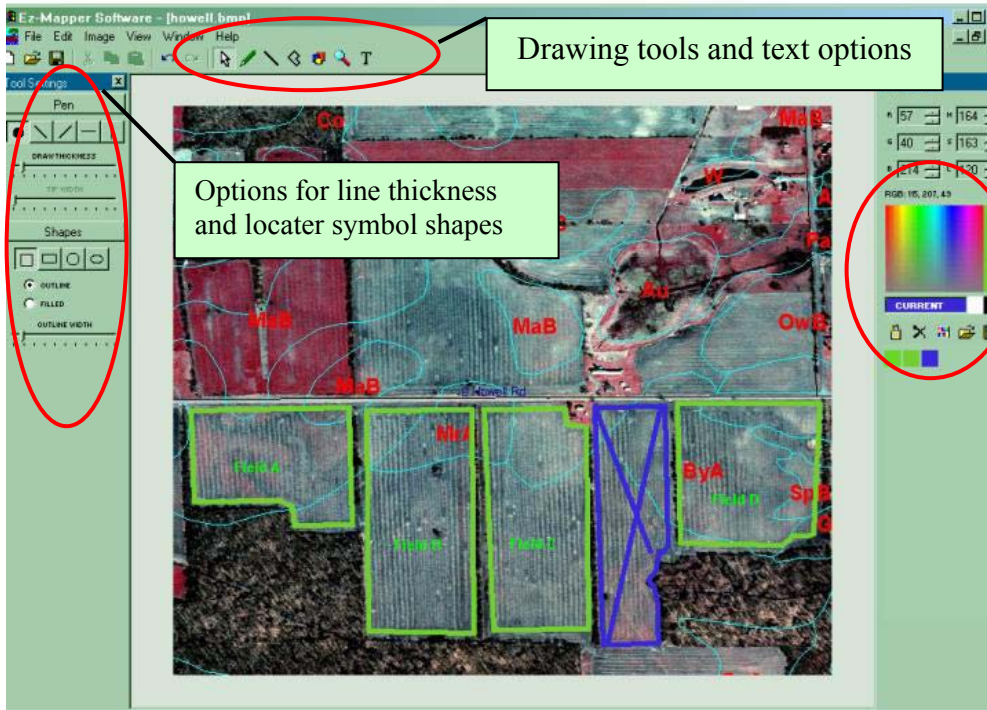


All GIS Tools are located here. They are used to maneuver around the map and to zoom in and out of areas. This is also where you download a copy of your final map and software.

These are your map data layers, such as streets, streams, soils, and aerial photos.

The Legend is located on the left side of the map and it is used to describe the colors of the data layers.

The EZ-Mapper software allows end users the ability to produce maps without the high-end costs of some GIS mapping programs. The software is geared toward those who need to produce digital maps that can be attached to supporting documentation. Anyone can use the online system and software for free, but in order to download the digital maps to your home computer and edit them, you will need to purchase a download card online. The website can be accessed at www.iwr.msu.edu/ezmapper



Drawing tools and text options

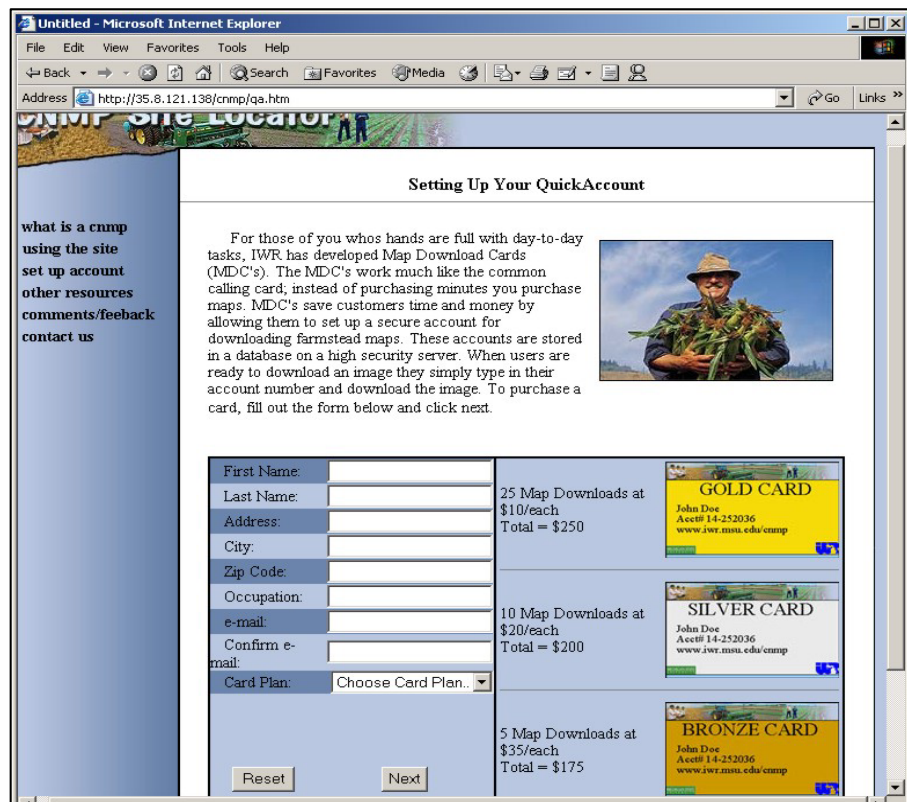
Options for line thickness and locator symbol shapes

EZ Mapper Software

This is the downloaded image that can be opened in the map editing program. Many tools are available to label the map. **Important note:** Before you use the software for the first time, click on the Help in the upper toolbar for detailed explanations for downloading your map as well the available mapping tools.

Color palette for lines and text

We use a method similar to prepaid calling cards to allow users to download farmstead maps. To set up your account, fill out the information on the set up account page and choose a card plan. You may still use the site and view maps without setting up an account, but you will not be able to download any images or software to edit them until you purchase a download card.



Contact Information

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Information Transfer Program

Information Dissemination and Technology Transfer Training Programs

Basic Information

Title:	Information Dissemination and Technology Transfer Training Programs
Project Number:	2002MI7B
Start Date:	3/1/2003
End Date:	2/28/2004
Funding Source:	104B
Congressional District:	Eighth
Research Category:	Not Applicable
Focus Category:	Education, Groundwater, Surface Water
Descriptors:	
Principal Investigators:	Lois G Wolfson

Publication

SYNOPSIS

Project Number: 2003MI17B **Start:** 03/01/03 (actual)

FY 2003 Federal Funds \$20,000 **End:** 02/28/04 (actual)

FY 2003 Non-Federal Funds \$41,165

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; Watershed Management; Macroinvertebrates; Volunteer Monitoring; GIS

Problem and Research Objective:

Science-based accurate information is essential in the development and implementation of an effective information dissemination program. It must be current, reliable and readily transferable to a wide audience in formats that are easily understood. In order to help protect, manage, and/or rehabilitate the water resources in the state, the Institute of Water Research has developed and expanded upon its information dissemination and training program addressing real-world problems and providing timely information to scientists, decision makers, farmers, riparians and other interested citizens throughout the state.

The objectives are to develop and present educational programs designed to increase the public's awareness and appreciation of the water quality and quantity problems in Michigan and to stress the economic trade-offs required to solve water related problems. These programs are offered in the form of conferences, training workshops, demonstrations, computer models and decision support systems, web-based programs, and printed material.

Methodology:

Methods used to meet the objectives are to: (1) sponsor state of the art conferences and workshops that deal with pressing water related issues; (2) prepare lecture/demonstrations, audio-visual materials; and power point presentations (3) develop training sessions and workshops to assess trends in water quality; (4) present web based programs that provide users with information and other data needed for decision making; (5) compile, interpret, and distribute water related information as well as directing users to appropriate sources of expertise and information; and (6) cooperate with the Michigan State University Extension Service to make water related information available through the county cooperative extension agents.

Principal Findings and Significance:

The dissemination portion has involved a number of technology transfer mechanisms such as

seminars, workshops, and conferences; web based information systems, data and virtual courses; and pamphlets, exhibits and demonstrations. Each program is designed to make the latest information available to the appropriate user groups. Local, state, and federal agency personnel as well as students, staff, and others are given the opportunity to hear and interact with outstanding researchers and have access to a variety of written materials and multi-media presentations. Participants have been able to use the information gained from these programs in their decision-making processes concerning water resources.

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INFORMATION DISSEMINATION AND TECHNOLOGY TRANSFER TRAINING PROGRAMS

by

**Dr. Lois Wolfson, Principal Investigator
Institute of Water Research
Michigan State University
East Lansing, MI 48823**

Project Relevance

Surrounded by four of the five Great Lakes, the state of Michigan is fortunate to have an abundant and widespread supply of water due in large part to its geographical location within the Upper Great Lakes Region. However, this high demand and use of the water resources often result in both water quantity and water quality problems. As activities within the state continue to increase, the state's water resources are at risk.

As impacts on water quality become more widespread, the need for action at the watershed level becomes more apparent. The movement of pollutants across a watershed is not constrained by political boundaries, and activities in one political jurisdiction may lead to water degradation in another. The difficulty in assessing impacts from erosion, nonpoint source pollution or shoreline development lies not only in the magnitude of the data collection efforts, but in the proper analysis and interpretation of the data needed for assessing the problem.

In order to stay informed about water quality changes over time, and to determine if efforts being made to reduce pollutants are proving effective, an education, monitoring, and evaluation program is appropriate. An effective information dissemination and training program facilitates the transfer of information needed to protect the water resources in the state, and helps to inform scientists, legislators, and citizens of the most recent information available. For further effectiveness, agency personnel, riparians, educators and others interested in protecting their water resources or in teaching others about it must understand the importance of collecting and/or analyzing information at the watershed level to ensure that reliable and appropriate information is being used to make sound decisions for water quality protection.

Project Objectives

The Institute of Water Research has a long history of providing effective information dissemination and training programs. These programs have involved close cooperation with other groups and organizations within the University and the state in order to enhance their

effectiveness. Partnering with other groups has become a critical component for successful programming and delivery. Because educational levels and prior knowledge in the subject area are so varied, a number of transfer mechanisms are necessary. With the increasing use of web-based programs, the Institute has put much of its resources into providing access to data, papers, models, programs, and other types of information that can be successfully accessed and utilized on the web. Other traditional methods such as conferences, workshops, written publications, and self-contained computer programs are utilized for both lay audiences and professional groups throughout the state. Training sessions are also offered to provide hands-on experience for a number of diverse audiences.

The following objectives relate to information dissemination programs arising from water-related activities at the Institute of Water Research.

1. Utilize the dissemination potential of the web by developing educational modules; interactive models; and virtual reality courses.
2. Develop and present educational programs such as conferences, seminars, and training workshops designed to increase the public's awareness and appreciation of the water quality problems in the state and to stress the economic trade-offs required to solve any problem.
3. Prepare lecture/demonstrations for presentations to college classes, secondary and elementary schools, and private groups on such topics as watershed management, wastewater treatment, wetland and lake ecology, water conservation, and groundwater contamination.
4. Cooperate with the Michigan State University Extension to make water-related information available through the cooperative extension network.

Description of the Project

The Institute of Water Research Information Dissemination and Technology Transfer Program began in the early 1970s, and has been expanded to be more responsive to the informational needs of a wide variety of user groups. Many modes of information exchange have been used to further this program and provide the latest research information to user groups. The following programs were developed and delivered for fiscal year 2003-2004.

Conferences

The Great Lakes are continuously faced with a multitude of threats that can degrade both their water quality and recreational potential. This year, the IWR cosponsored a day-long conference on *The Great Lakes: Managing and Understanding a System under Change* during Agriculture and Natural Resources Week (ANR Week) at MSU. The conference focused on the latest

information on waterborne diseases; chemical disinfectants in ballast water, the impact of the Asian carp, the possible control of zebra mussels, biodiversity, wetlands, and fisheries issues. The Office of the Great Lakes, Michigan Department of Environmental Quality joined as conference cosponsors. Approximately 150 people, including state and local agency personnel, researchers and educators, environmental organizations, and interested citizens attended the event, which was also cosponsored by Michigan Sea Grant, and the Department of Fisheries and Wildlife. Overall evaluations ranked the conference between very good and excellent.

Another conference, co-sponsored by the IWR and two key outside statewide organizations, the Michigan Chapter, North American Lake Management Society; and the Michigan State Section, American Water Resources Association was the Groundwater/Surface Water Connection: Impacts on Aquatic Ecosystems. The conference focused on the movement of contaminants from groundwater to surface water and their impacts on biota. The conference drew about 120 people, with representatives from government, universities, environmental organizations, and local agencies.

Volunteer Monitoring

Institute personnel were involved in several Volunteer Monitoring programs. One involved an in-depth training for adult volunteers on stream monitoring in the southwestern part of the state. Topics for the sessions focused on physical, chemical, and biological parameters and include both lecture and hands-on activities. The other involved working with other states in exploring how to incorporate E. coli monitoring into volunteer monitoring programs. With funds from other sources, a six-state team, including Michigan State University, has been looking at various rapid assessment methods, comparing them with laboratory results, and developing training materials.

Lake and Stream Leader's Institute

To develop a core of local water/land resource leaders who will promote lake, stream and watershed management partnerships with state natural resource agencies and encourage and instruct other citizens in resource management, a Lake and Stream Leader's Institute was developed by the Water Quality team in Extension. IWR staff played a significant role in both the development and implementation of this program. This past fiscal year was devoted to working with alumni from the first year's class. Responsibilities of the IWR staff members included leading hands-on sessions on macroinvertebrate identification; phosphorus analysis; and general lake ecology. Other involvement included helping with logistics and serving on the advisory committee. Funds from other sources were utilized in this program.

Internet-Based Programs

IWR staff expanded on its Watershed Mapping program to make data more available as well as comprehensive and also incorporated evaluation techniques to ensure that the information was what user groups wanted or needed. Information added during this past fiscal year included soils data, the National Wetlands Inventory, and completion of digital orthoquad photographs in every

county in the state. The site was expanded and any address in the US can be accessed with its watershed delineated. However, the detailed information for Michigan has not been made available nationwide.

MSU Water

The goal of MSU-WATER (Watershed Action through Education and Research) is to link the university's water science research, outreach, and teaching programs to help manage and protect Michigan's surface and groundwater resources. The immediate thrust is to develop a watershed management plan for the MSU campus and collaborate with upstream and downstream partners to meet and surpass regulatory water quality standards in the Red Cedar River watershed. The Institute and the MSU Department of Resource Development provided critical leadership in this initiative and played major roles in the coordination of the program in this fiscal year. IWR staff took the lead in developing and implementing a Seminar Series that brought in noted speakers to present the research they have been doing in the watershed.

Lakescaping Demonstration and Training

A 120-foot long, 60 foot wide shoreline along a small pond was planted with a variety of vegetation. Erosion control structures were installed along half the length and the other half was left without any structure. The divided shoreline helped to illustrate good and poor practices with regards to erosion control, wildlife habitat enhancement, and water quality. The IWR coordinated efforts with the Water Quality Team of MSU Extension, and the Departments of Fisheries and Wildlife and Horticulture on this *lakescaping* demonstration. After two years, a significant difference could be seen between the two sites with respect to habitat, vegetation, and shoreline erosion.

Fairs and Exhibits

IWR staff members take part in various programs hosted by other University units or outside agencies. This year the IWR participated in the Michigan Science Olympiad by serving as the State Supervisor for Water Quality in the state finals. This annual event attracts nearly 100 junior high and high schools across the state who compete in a variety of science related events. Winners of the event continue to the national finals.

In late July, MSU's Ag Expo, an agricultural oriented exposition is held. Approximately 35,000 people attend this annual event. Each year the Institute features an educational exhibit. The IWR this year highlighted some of its web-based programs at the Expo, focusing on the Understanding Your Watershed program. Color printers were available for participants to download a rectified aerial photograph of their property along with several data layers such as rivers, streams, elevation, or watershed area. Approximately 500 people visited the tent and viewed all or part of the program.

The IWR again participated in the Children's Water Festival, an event that brings together nearly 1000 elementary school children from across the tri-county area to be introduced to a variety of natural resources and science-related topics. The IWR led two classes. One featured aquatic macroinvertebrates and their role as water quality indicators. The other focused on aquifer vulnerability and used ice cream, dyes, and candy to depict aquifers and contaminants. Five sessions for each class were held with 30 to 40 participants per session.

Lectures and Seminars

The Institute staff gave numerous presentations throughout the year on issues such as nonpoint source pollution, wellhead protection, indicator species for water quality testing, watershed management plans, and exotic species introduction. Staff gave class lectures in the Departments of Fisheries and Wildlife, Community, Agriculture, Recreation and Resources, Journalism, and Zoology. Audience or class participation ranges from approximately 25 to over 100 for each presentation.

Personnel and Facilities

The Institute of Water Research maintains such facilities and equipment as the latest software packages for desktop publishing, GIS, video editing and photographic equipment to support its Information Dissemination Program. It also has microcomputers, three Sun Sparc-20 work station, a graphic plotter, scanner, color printer, and digital camera to enhance its educational programs. For field demonstrations and research related opportunities the Institute also has a Data Sonde mini-probe for measuring chemical parameters in lakes. 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, Ruth Kline-Robach, and Jeremiah Asher.

Student Support

Student Support					
Category	Section 104 Base Grant	Section 104 RCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	1	0	0	0	1
Masters	0	0	0	0	0
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	2	0	0	0	2

Notable Awards and Achievements

Achievements

Project Title: Donnell Lake Funding Agency: Section 319 Program Effort Pays Off Due to the local efforts early on by the Joe Ervin from the Institute of Water Research at Michigan State University, the TMDL goal of reducing total suspended solids was already well on its way to being achieved by the time EPA approved the Yakima TMDL in 1998. According to Ecology, two years prior to the five-year target date of 2002, three out of four primary irrigation drains met the standard for turbidity. The Institute of Water Research (IWR) at Michigan State University took the lead in planning and implementing projects around Donnell Lake. IWR secured cost-share funding from the Section 319 program as well as the Water Quality Incentive Program. Alex Bozymowski, the Natural Resources Conservation Service (NRCS) district conservationist for Cass County, was contracted as a project planner and helped to organize local meetings and work with landowners. The Technical Service Providers (see box) were Michigan State University Department of Water Research and a local engineering firm, Whitman Associates. The success of the Donnell Lake watershed project activities helped remove downstream Christiana Creek from Michigans list of impaired waters, averting the need for a TMDL. Within 10 years, Ervin said, the project activities substantially reduced groundwater nitrate numbers throughout the watershed.

Wetlands GIS Integration Chad Fizzell from the Institute of Water Research (IWR) is currently working under a collaborative grant between the MI Department of Environmental Quality (MDEQ) and IWR to improve the analytical abilities of MDEQ wetland field staff through the use of Geographic Information Systems (GIS). Informational technologies (IT) including Geographic Information Systems (GIS), enhanced database software, web bandwidths, and other technologies are rapidly developing. Such information systems can aid numerous components of the Section 404 Program responsibilities of the Michigan Department of Environmental Quality's (MDEQ's) Geological and Land Management Division (GLMD). Presently, the missing link is assistance to provide training and support, education and applications development for individuals working on wetland assessment, permits, and assistance. This project addresses the missing link by providing a support individual with an understanding of the regulatory process, excellent communication skills, appropriate technical background, and experience with GIS, plus knowledge of technology transfer approaches.

Digital Watershed The Institute of Water Research built an environmental software system using the distributed computing technologies to build our collective abilities. To create a system to record patterns at different scales and understand different processes that shape these patterns is no easy task but it can be done if we aim high and act incrementally. This software will continue to grow with the ideal of once developed; new knowledge of our planet in the form of databases and models can be integrated into the system. We have developed two watershed information systems at different scale levels as our starting point and they are interconnected by the scaling function. The national system is for an 8-digit level watershed across the United States. The address for this system is <http://www.iwr.msu.edu/dw>.

Understanding Your Watershed The Institute of Water Research is proud to announce the addition of statewide aerial photography to its watershed management website, Understanding Your Watershed. Each county mosaic was derived from 1992 and 1998 series Digital Orthophoto Quadrangles (DOQs). This imagery has one-meter resolution on the ground, which means the users of this site have the ability to get a spatial perspective on very small parcels in their area. Aerial photography is the preferred backdrop to most Geographic Information Systems (GIS) as it lends a real-world perspective to any spatial analysis. It allows a first-time user to reference themselves locationally on the ground, thus rendering all the other data layers on the Know Your Watershed website more useful and simpler to interpret. <http://www.iwr.msu.edu/water>

Publications from Prior Projects