Report as of FY2006 for 2006MI69B: "Natural Resources Integrated Information System"

Publications

Project 2006MI69B has resulted in no reported publications as of FY2006.

Report Follows

Institute of Water Research
Annual Technical Report
FY 2006

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

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 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.

Project Number: 2006MI69B

Start: 03/01/06(actual)

End: 02/28/07 (actual)

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

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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 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 over the past two years 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

Water Withdrawal Assessment Tool

In addition to a significant role in developing the assessment tool, we anticipate a major role in using the results of our project for application in a new water use conflict resolution process. Those seeking permits for large quantity withdrawals are encouraged by the new legislation to establish a Water User Committee for that permit to evaluate current water resources, water uses, and trends in water use in the watershed and assist in long-term water resource planning in the watershed. Water User Committees will include all water withdrawal registrants, water withdrawal permit holders, and local government officials in the watershed. Solutions to water use conflicts developed by these committees could include water conservation offset credit as pioneered by this project. While this committee process is not required, it will certainly behoove any permit seeker to follow this process in light of Michigan's recent history with time-consuming court cases and formidable public opposition to large water withdrawals.

The new legislation also calls for the state Department of Environmental Quality (DEQ) to use "clear and convincing scientific evidence" in determining whether adverse resource impacts "are, or are likely, to occur from one or more large-quantity withdrawals in the watershed." The DEQ will be responsible for notifying the watershed Water Users Committee or meeting with water use registrants and water withdrawal permit holders to attempt facilitation of an agreement for using voluntary measures to prevent adverse resource impacts.

We anticipate that the findings regarding our voluntary, water conservation offset credit approach may be directly applied to create a science-supported scheme that accommodates all water users and avoids costly, time-consuming legal conflicts and divisive dissatisfaction in the community. By integrating our data into a readily-usable and web-accessible system for Water User Committees, timely and valuable information will be delivered to those who need it most. Future opportunities appear abundant for assisting the local watershed conflict resolution process and for creating viable options, including offsets and conservation credits, to prevent adverse resource impacts. These scenarios will be supported by science-based research supported by the GLPF.

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. *See report 2006MI114S Grant No. 07HQGR0003 Developing the Water Withdrawal Assessment Tool.*

Figure 1. Nation-Wide Digital Watershed http://www.iwr.msu.edu/dw

Web-based Offerings

Our web-based offerings continue to expand. A Nation-Wide Digital Watershed web site (Figure 1) 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."

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

The Institute of Water Research at Michigan State University and the Michigan Department of Agriculture (MDA) have teamed up to land a $600,000 Conservation Innovation Grant (CIG) to improve and protect water quality in three state watersheds.

The grant, awarded by the USDA Natural Resources Conservation Service (NRCS), funds implementation of the Institute's new GIS-based High-Impact Targeting (HIT) program in three Michigan watersheds. NRCS funds will be distributed by the MDA as incentives to qualified farmers for supporting the implementation of conservation best management practices (BMPs).

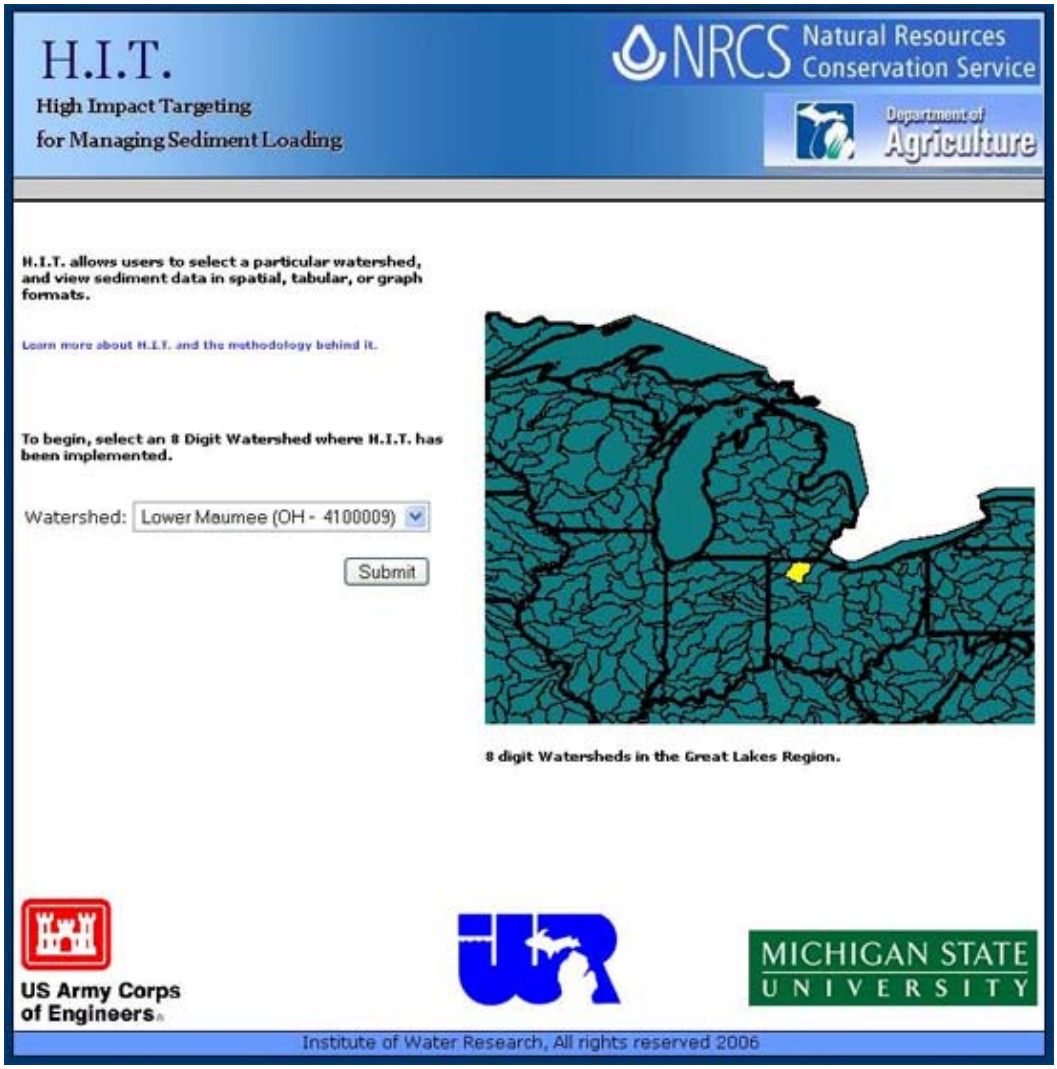

Figure 2. Conservation Innovation Grant (CIG). http://www.iwr.msu.edu/CIG-MDA/

"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.

"The CIG is a wonderful opportunity that will allow farmers and landowners to improve water quality, prevent soil erosion, and enhance wildlife habitat through a targeted approach," said Mitch Irwin, MDA Director.

“Michigan’s conservation districts will benefit from using this new technology to target their conservation work to areas in critical watersheds to greatly improve water quality and wildlife habitat,” said Gordon Wenk, MDA Environmental Stewardship Division director.

“We’re enthusiastic about this collaborative project, which builds on our long and successful relationship with the Michigan Department of Agriculture,” Bartholic said. “We look forward to using our research and outreach capacity in cooperation with the MDA to deliver this new HIT technology in watersheds where it can best be used to improve water quality and prevent soil erosion.”

The project team is made up of the NRCS, the USDA’s Farm Services Agency, the Michigan Departments of Environmental Quality, Natural Resources, and Agriculture as well as the MSU Institute of Water Research and Huron, Lenawee, and Clinton County soil conservation districts. Visit: http://www.iwr.msu.edu/CIG-MDA/ for more information.

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. 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

As a key technical component of Midwest Spatial Decision Support System Partnership, the Institute of Water Research's Digital Watershed (DW) website has been recognized by EPA Office of Research and Development as an important environmental computing portal for a suite of EPA's environmental decision support tools. Funding is underway to support the future development of DW to achieve this goal. The first step is to integrate EPA's ATtILA (Analytical Tools Interface for Landscape Assessments) tool into DW and provide watershed comparison function at 8-digit watershed level. This work will lay a solid foundation for the integration of other EPA decision support tools such as Regional Vulnerability Assessment Program's EDT (Environmental Decision Toolkit).

The Institute of Water Research was also awarded a grant by the US Army Corps of Engineers Chicago District to create a tool that integrates a GIS-based sediment runoff predictive tool, MUSLE (Modified Universal Soil Loss Equation), into Digital Watershed (DW) and the Long-

Term Hydrologic Impact Assessment (L-THIA) system and its associated EQIP tools. The resulting modeling and decision support tool will be easily accessed and used by a wide variety of expertise levels in determining the effects of development and different agricultural practices to the sediment loadings within two tributaries to Lake Michigan in Northwest Indiana; Burns Ditch/Little Calumet East Branch and Trail Creek. We've recently completed EQIP and the preliminary MUSLE integration on the project. In the near future, users will be able to model different BMP scenarios using this online tool.

Another new function that's already up and operational on Digital Watershed is the Google Map and Google Earth interoperability capability. Users can explore their own watersheds on Google Maps or Google Earth by simply click a button on Digital Watershed interface. We've received a lot of positive feedbacks on this new development.

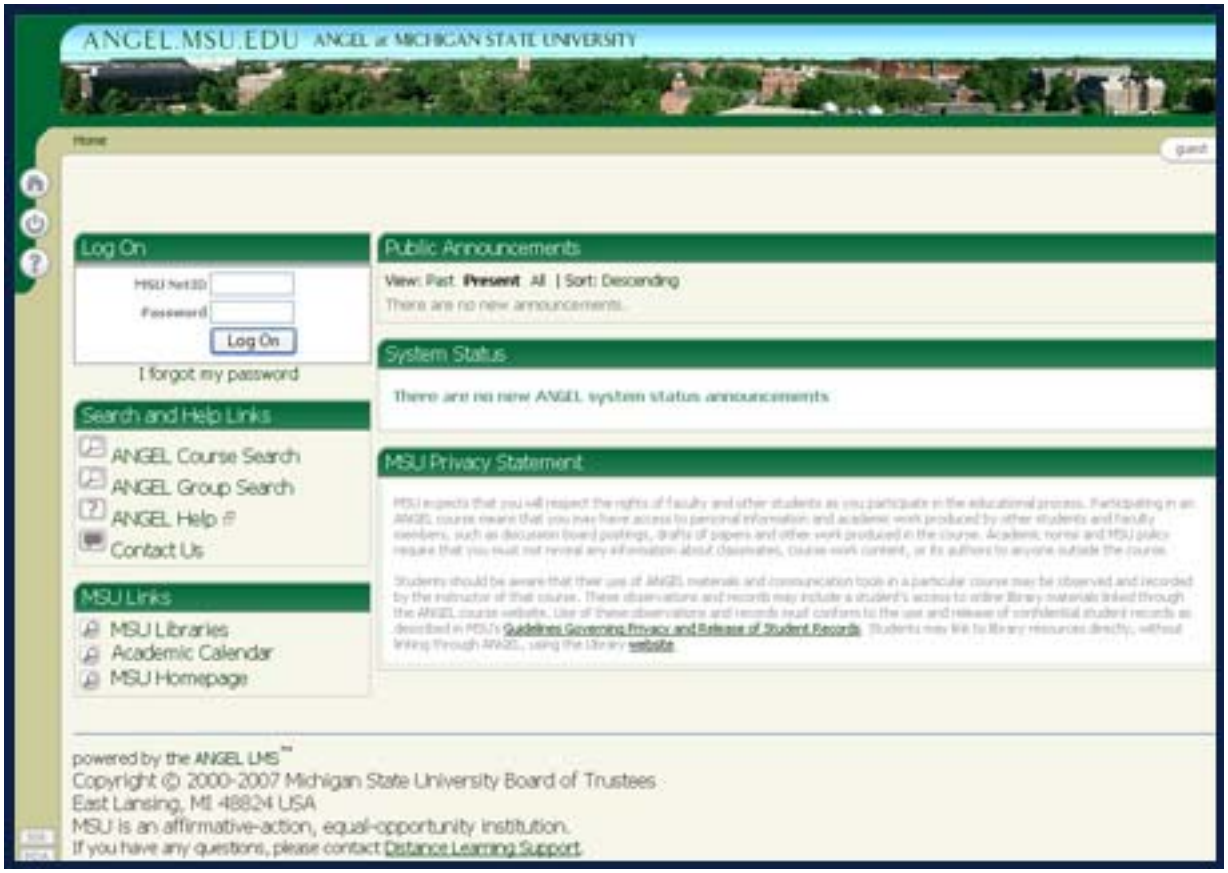

Figure 4. Virtual Watershed Management Courses

Virtual Watershed Management Courses

The web-available Mapping is used extensively in IWRs Virtual Watershed Management courses (Figure 4). 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.