

Institute of Water Research

Annual Technical Report

FY 1999

Introduction

Fiscal Year 1999 Program Report Institute of Water Research Michigan State University, East Lansing, MI 48823-5243 Michigan Report No.99-G2026-01 Award No. 1434-HQ-96-GR02677 for U.S. Department of the Interior, Geological Survey The research on which the report is based was financed in part by the United States Department of the Interior, Geological Survey, through the Michigan Institute of Water Research. The contents of this publication do not necessarily reflect the views and policies of the United States Department of the Interior, nor does mention of trade names or commercial products constitute their endorsements by the United States Government. Abstract During the 1999 program year, the Michigan Institute of Water Research (IWR) continued its activities and research program on the development of environmental information systems for environmental decision making; and on land use impacts and surface and groundwater contamination and protection, which are both top priority issues within the state. The IWR also initiated work on a watershed information system focusing on research, and extended education programs on watershed management and surface and ground water protection. One project entitled "Decision Support System for Natural Resource Planning" (02) was funded to address these problems and issues. In addition, support for the Institute of Water Research Information Dissemination, Retrieval, and Reference Service Program (22) was continued. Descriptors: agriculture, aquifer characteristics, conferences, data analysis, data storage and retrieval, denitrification, environmental information system, fertilizers, geographic information systems (GIS), groundwater hydrology, groundwater modeling, groundwater movement, groundwater quality, groundwater recharge, herbicides, hydrogeology, information dissemination, information transfer, lakes, land use, land-water interactions, Michigan, microcomputer, nitrogen, nonpoint source pollution, pesticides, pollutants, pollution control, ponds, research, retrieval, regional watershed analysis, septic tanks, soil metabolites, systems analysis, technology transfer, urban water systems, water quality, water quality management, watershed management, wetlands Water Problems and Issues Introduction Michigan has a very abundant and diverse supply of freshwater due, in part, to its unique geographical location within the Upper Great Lakes Region. Michigan is surrounded by four of the five Great Lakes, and contains 11,000 inland lakes greater than 5 acres in size. Water flows through 36,000 miles of river channel, and Michigan possesses a vast groundwater supply. These waters provide a wealth of resources for the diverse agricultural, industrial, and recreational opportunities of the state. However, the ever growing number of activities in the state continually add stress to this resource and can lead to further degradation of water. Because almost all of Michigan's waterborne wastes drain to the Great Lakes where the impact is accentuated due to the slow flushing rate of the system, water resource problems are largely concerned with water quality issues. In some specific areas, however, water quantity concerns relative to agriculture, minimum stream flows, and drought conditions can be of major importance also. Many of these water quality and water quantity problems are shared by other states in the Great Lakes region and the nation. Within Michigan, water quality problems commonly are divided between the Great Lakes and inland waters and are often related. Groundwater contamination is also becoming increasingly prevalent in local areas, particularly in the southwestern part of the state where land use impacts are high, and sandy type soils exist. Pollution Sources Two of the most critical environmental problems presently facing the state of Michigan are surface and ground water quality management and the absence of land use planning that considers resources and the integrity of the ecosystem. The long history of acute and chronic toxic substance contamination has had a

significant impact on the state's water resources. Toxic chemical and nonpoint source pollution have the potential to affect the chemical, physical, and biological balance of the state's surface and/or groundwater adversely. These toxic chemicals may be translocated into all parts of the atmospheric, terrestrial, and aquatic ecosystems. They also bioaccumulate in organisms, especially in the aquatic ecosystem. The widespread use and careless handling of toxic materials are even more critical than the nutrient enrichment problems because they pose a threat not only to human health but also to all other forms of life, both terrestrial and aquatic. Excessive nutrients, primarily from non-point source pollution, accelerate the eutrophication process and can lead to an aesthetically undesirable aquatic environment. The 1972 Michigan ban on phosphorus in detergents coupled with mandatory removal of phosphorus from municipal wastewaters has substantially reduced the phosphorus loading to the surface waters of the state. In addition, upgrading the municipal wastewater treatment plants throughout the state has markedly reduced BOD loadings to the rivers. Despite these gains, inland streams and lakes are receiving continued, albeit reduced, nutrient enrichment primarily from nonpoint sources. The contamination of Michigan's lakes and streams reached significant proportions in the late 1960s and early 1970s. Subsequently, public concern was raised over the pervasiveness of these substances and their potential capability to affect the environment adversely. Consequently, state and federal legislation was enacted to control these materials. Since then, most industrial discharges have been greatly reduced, and some have been eliminated. As a result of these reductions, today's most serious environmental problems are leaking underground storage tanks and improper disposal of toxic and hazardous chemical wastes and the leachate from old, abandoned landfill disposal sites, especially those near rivers, streams, and lakes. Over 3000 hazardous chemical contamination sites have been identified by the Michigan Department of Natural Resources. Additionally, over 300 Michigan landfills are sources of contaminated groundwater. They raise the prospect of major toxic substance problems as they contaminate land as well as ground and surface waters for years to come. In 1992, Michigan's Relative Risk Analysis Project identified the absence of land use planning as the most critical problem facing Michigan. Land use and water resources are unequivocally linked. Almost every water quality problem can be traced back or associated with a particular land use activity. The type of land and the intensity of its use will have a strong influence on the receiving water resource. Whether the source is natural or comes from a human activity, the impact of any land use practice on either the quantity or quality of water can be substantial. In general, the water quality across the United States and in Michigan has improved over the last 20 years. The combination of regulations, best management practices, and a renewed stewardship ethic has been helpful in controlling many problems that had previously resulted in a decline in water quality or a decrease in water availability. However, an increasing population, developmental pressures, absence of land use planning, and competition for water resources, continually contribute to the degradation of water resources. Managing water resources on a watershed basis will help address potential impacts. Groundwater Whereas most of Michigan's groundwater resources are of sufficiently high quality for domestic use, the Michigan Department of Natural Resources has identified over 50,000 sites of known, suspected, or potential groundwater contamination. Of the more than 9000 sites with environmental contamination listed as a result of a survey mandated by the Michigan Environmental Response Act (Public Act 451, Part 201, formerly PA 307), 96 percent were expected or known to have adverse effects on water quality. Of these sites 56 have been targeted for clean up under the federal Superfund program. The glacial definition of Michigan's soils, the abundant groundwater deposits, and over 100 years of disposing of municipal and increasingly complex industrial wastes have combined to challenge the groundwater quality. Unlike surface water, groundwater, once contaminated, has no known natural processes available to detoxify it. Thus, the costs to evaluate the magnitude of this problem and then treat groundwater contamination are staggering. Nitrate is one type of contamination that has been identified in many areas of the state. Nitrates easily infiltrate the soil, enter groundwater aquifers, and contaminate wells. Because they are relatively easy and inexpensive to detect, nitrates are currently being used as indicators to identify areas where more toxic compounds such as pesticides may have entered the groundwater. Throughout agricultural areas of the Midwest, agricultural herbicides, a persistent and relatively mobile group of pesticides, have been detected in groundwater. Studies of drinking water wells in high risk areas of southwestern Michigan have detected the herbicide atrazine. Most concentrations were very low, indicating non-point source contamination, and probably occurred in pulses following application. The Michigan Department of Agriculture sampled groundwater at agricultural handling facilities and found herbicides (primarily atrazine) detectable at several of these sites. Studies

with lysimeters in corn growing areas have shown varying amounts of atrazine and nitrate leaching from the root zone under various irrigation management strategies. Research and education are needed to reduce the dependency on chemicals in agriculture and to reduce losses of pesticides and fertilizers from farm fields. Inland Surface Waters

The problems affecting surface water quality are diverse, with major causes being nonpoint source pollution, in-place toxic materials, combined sewer overflows, industrial and municipal wastewater discharges, and the discharge of contaminated groundwater into surface waters. Recent studies showed that the problem of toxic substances is even larger and more complex than had previously been envisioned. For example, diffuse atmospheric inputs may be responsible for up to 40 percent of the loading of pollutants such as PCBs and toxaphene into the Great Lakes and the inland surface waters of Michigan. The full scope of the toxic substance problem and its threat to human health and the environment has not yet been fully defined, and more effective controls to limit or eliminate these chemicals in the environment are critically needed. Recent Midwestern studies by the U.S. Geological Survey (USGS) have shown widespread contamination of surface waters by atrazine, and other studies have identified several agricultural chemicals (primarily herbicides) in rivers used as drinking water sources in northeastern Ohio. In the USGS study, over 50 percent of 150 sites showed detectable atrazine before spring field applications, and over 90 percent of those sites had detectable atrazine after field applications. Studies indicating impacts of pesticides on non-target, off-site organisms offer compelling evidence to support recommendations of reduced use and better management of these pesticides. The Upper Peninsula has fewer and less intensive water quality problems than the other parts of the state primarily because of the sparse population and limited industry. The few problems center around urban areas scattered along the Lake Superior shoreline, tributary streams, and inland lakes. The major causes of the water quality problems are domestic and industrial pollution. Much less is contributed by nonpoint runoff from agricultural lands, urban runoff, and natural erosion. Industries that contribute to the water pollution problems in the Upper Peninsula are primarily concentrated in the cities of Munising, Houghton, Hancock, and Marquette. Pulp mills, copper and iron mining companies, paper manufacturers, and power companies as well as small manufacturing firms are located in these and smaller municipalities. In addition to large discharges of heated water from electric power generating plants, these industries are responsible for the addition of coliform organisms, suspended matter, trace metals, oxygen consuming substances, and nutrients as well as phenols and other toxic materials discharged into Lake Superior and its tributary waters. As in the Upper Peninsula, the vast majority of the streams in the northern portion of the Lower Peninsula have good to very good water quality. While water quality problems have not yet reached serious proportions in the southern portion of the Lower Peninsula, they are more acute than further north due to the greater industrial, municipal, and agricultural activities. Seven stream segments representing less than one half of one percent of the state's streams were designated by the Michigan Department of Natural Resources as having poor water quality due to the bioaccumulation of toxic materials in fish. In several areas of Michigan, fish consumption advisories are currently in effect. The Great Lakes Much of the national and international attention to water quality in Michigan is focused on the Great Lakes. The Michigan Department of Natural Resources, the International Joint Commission, the Michigan Sea Grant College Program, and others have noted that Lake Superior, Northern Lakes Huron and Michigan are oligotrophic. Southern Lake Michigan is oligomesotrophic; southern Lake Huron and central Lake Saint Clair are mesotrophic, and the Saginaw Bay, western Lake Saint Clair and Lake Erie are eutrophic. The eutrophic areas of the Great Lakes, all associated with basins of high population density, indicate the relationship between human activity and water quality. The solutions to many of the problems of the Great Lakes lie inland, within the state. Consequently, by protecting the water quality of the inland lakes and streams, the Great Lakes can also be protected. In many near shore areas of the Great Lakes, sediments, water and fish exhibit unacceptably high concentrations of heavy metals and toxic organic substances because of urban and agricultural runoff as well as other discharges, both intentional and unintentional. Specifically, the FDA action levels for PCB and dieldrin are often exceeded in predator and forage fish taken from many of the near shore areas of the Great Lakes. However, fish are the only food group in which detectable levels of PCB are routinely found. One serious problem was the discovery of widespread mercury contamination of fish in many of the inland lakes. Despite decreases in domestic, industrial and agricultural uses and point source releases of mercury into the environment over the last two decades, relatively large quantities are still emitted by coal fired power plants, nonferrous smelters, and refuse incinerators. Unlike other heavy metals that are usually associated with particulates and fall to the ground within a

short distance of their emission point, mercury does not because it is readily vaporized. Thus, additions from anthropogenic sources to those from natural processes continue the geochemical cycling of significant quantities of this highly volatile, toxic trace metal through the environment. Atmospheric transport is the major route for global deposition to aquatic and terrestrial ecosystems even in areas remote from where it was originally released. As a result, the Michigan Department of Public Health issued an advisory warning individuals, especially young children and pregnant women, to limit their consumption of fish from Michigan's inland lakes. Direct industrial sources of contaminants can more easily be pinpointed than the more diffuse airborne sources that also contribute a number of toxic organic compounds such as chlorinated aliphatic, aromatic and polyaromatic hydrocarbons. These are bioaccumulated by aquatic organisms; however, the full ecological impact is very difficult to determine and is unknown at this time. Moreover, while the known compounds were being studied, a number of additional organic compounds such as haloforms, bromoforms, chlorinated phenols, chlorinated hydrocarbons, mirex, dioxins, dieldrin, furans and aldrin were identified as potential problems in the Great Lakes. One of the serious toxic organic contamination problems from a point source has been identified at White Lake adjacent to Lake Michigan where chlorinated hydrocarbons such as carbon tetrachloride, tetrachloroethylene, and hexachlorocyclopentadine are seeping from a buried waste disposal site. The leachate from this site has increased the levels of a number of toxic chemicals in the water, fish, and sediments in White Lake. In contrast, the 1969 ban on DDT effectively reduced this compound in the fish and a commensurate decrease in PCB levels has also been recorded in fish since its ban in 1977. The International Joint Commission (IJC), a United States-Canadian commission created by the Boundary Waters Treaty of 1909, monitors the water quality of the Great Lakes under the terms of the Great Lakes Water Quality Agreements of 1972 and 1978. These international agreements foster intergovernmental cooperation to solve pollution problems. Based on state and provincial recommendations, the IJC has currently designated 43 Areas of Concern where environmental quality is degraded and beneficial uses of the water and biological communities are adversely affected. Each state or province is responsible for the preparation of remedial action plans for the Areas of Concern within its borders. Michigan is drafting such plans for the 11 Areas of Concern for which it is solely responsible and participates in three additional Areas of Concern where it shares this responsibility with a neighboring government. Problems in the Areas of Concern include: heavy metals, toxic organic substances, and conventional pollutants. Solutions As water resources are used and degraded, sound economic evaluations must be performed to develop institutional rules to govern them. The Michigan Great Lakes and Water Resources Planning Commission developed an economic/institutional analysis to manage the water resources of the state effectively with the purpose of maintaining water availability and quality adequate to meet the present and future requirements of all the users in the state. The Office of Water Resources, within the Michigan Department of Natural Resources, has since been formed to implement the recommendations made by the Commission. A complicating factor is that Michigan does not remain in a static situation in relation to the water problems of other states. As the major aquifers in the plains states continue depletion, economic forces may increase the need for agricultural water in Michigan to the point where its use as a clean resource will be threatened. Research conducted in irrigation, chemigation, conservation tillage, and other agricultural uses can establish sound procedures to prevent or minimize degradation. Modeling and analyses will improve the predictability of location, rate, and amount of surface runoff, infiltration, and evapotranspiration. These will further facilitate proactive measures against waterborne contaminants and subsequent degradation of groundwater. While efforts must continue to establish research in these areas, base-line monitoring must also continue. As Michigan puts higher value on its freshwater resources, the Michigan Institute of Water Research program is prepared to participate more actively in the research and information dissemination opportunities at hand. Program Goals and Priorities Due to reduced funding, only one research project in the Institute of Water Research's 1999 program was selected to address those priorities which constitute major problems not only with respect to Michigan's water resources but also regional and national water resource concerns. The goal of this project is to develop methods to deal with and integrate the vast amount of data being generated in Michigan and the Great Lakes Basin. In the meanwhile the multitude of water quality management and pollution problems in Michigan continues. This will be accomplished through the development of an information exchange integrated support system for watershed studies which emphasizes on land use and natural resource stewardship. The system supports research, studies by faculty and graduate students in several department as well as planning and management by local, county, state,

and federal agencies. The specific objectives of the project are to: 1) Integrate concepts and activities in watershed systems and extended education through a networking infrastructure of organizations and digital communication pathways with integrated distributed data sources and partners; 2) develop computer/network based Natural Resources Integrated Information System (NRIIS) with graphical interface and search mechanisms to access models, data, information, and GIS/graphic tools; and 3) to train graduate students to use the system to facilitate their research, see how their study is part of a larger system, and gain experience with NRIIS and its power for enhancing research, technology, and information transfer and communication for informed natural resource policy, planning, and management decisions. While they cannot all be resolved, selected research priorities have been identified in the Five-Year Water Research and Development Plan. The 1999 Institute of Water Research program focused its information dissemination and retrieval efforts in the following major areas: Definition of the mechanisms affecting the fate, transport, and effect of toxic/hazardous materials which enter the surface and groundwater as waste products or pollutants. Investigation of physical, chemical, and biological variables controlling groundwater quality and quantity. Investigation of mechanisms that influence non-point source pollutants, including urban and agricultural land runoff, residual waste disposal, on-site sewage disposal systems, atmospheric deposition, and water conservation through irrigation scheduling is underway. Identification of control mechanisms affecting lake eutrophication and the development of management strategies to minimize the impact on inland lakes and the Great Lakes are also being studied.

Research Program

Projects Funded Research projects funded with the fiscal dollars allotted. With a growing need in the Water Research Institutes in the Great Lakes region to develop new methods for integrating, and disseminating information and data concerning the priority areas identified previously, the study by Bartholic (01) entitled "Natural Resources Integrated Information System" presented a method for developing an information exchange integrated support system for watershed studies with emphasis on land use and not resource stewardship. The system will support research studies by faculty and graduate students in several departments, and planning and management by local, county, state, and federal agencies. Research project (02) entitled "Watershed Based Optimization Approach for Identification and Management of Non-Point Source Pollution," conducted by Professor Scott Witter of Resource Development and graduate assistant Da Ouyang, focuses on developing a watershed based optimization approach to help identify and manage non-point source pollution. In this project, we have identified and evaluated several water quality models including pesticide assessment and nutrient loadings. These models will help farmers, watershed planners, and other resource managers to determine NPS, implement best management practices (BMP), and make decisions more efficiently. Research project (22) entitled "An Information and Dissemination Program for Riparians and Citizens, conducted by Specialist Lois G. Wolfson, focuses on land use impacts that degrade water quality and the need for action at the watershed level. In order to stay informed of water quality changes over time, and to determine if efforts being made to reduce pollutants are proving effective, an education and monitoring 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 (see project 22 Synopsis for complete details).

Basic Project Information

Basic Project Information	
Category	Data
Title	Natural Resources Integrated Information System
Project Number	B-01
Start Date	03/01/1999
End Date	03/31/2001

End Date	02/28/2001
Research Category	Water Quality
Focus Category #1	Management and Planning
Focus Category #2	Water Quality
Focus Category #3	Models
Lead Institution	Michigan State University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Jon F. Bartholic	Professor	Michigan State University	01
Frank M. DiTri	Professor	Michigan State University	02

Problem and Research Objectives

Numerous federal and state agencies are increasing their emphasis on examining water problems from the watershed perspective. The watershed perspective is being emphasized in the reauthorization of the Clean Water Act, the new Farm Bill as well as several other pieces of legislation. Because of our Institute's long term position relative to national and state water programs, we function as a coordinator to assist with linkages, support education, research, and outreach with and among agencies in the broad water arena. Accordingly, we are in a unique position to facilitate watershed policy, planning, and management with a multi-disciplinary perspective. Our proposed effort includes three major thrusts. The first is the enhancement of integrated watershed systems that can be used for analysis of various management options. The second is extended education where the internet and advanced computer systems in addition to traditional conferences and workshops are used to extend new knowledge to agencies, organizations, and local level watershed and land use groups. The third involves developing a networking infrastructure to facilitate cooperation among partners such as the USDA, Natural Resource Conservation Service, USEPA, and state Departments of Natural Resources, Environmental Quality, and Agriculture, as well as township associations and county organizations. Research Objectives Goal Develop an information exchange integrated support system for watershed studies with emphasis on land use and resource stewardship. The system will support research, studies by faculty and graduate students in several departments, and planning and management by local, county, state, and federal agencies. Objectives 1. Integrate concepts and activities in watershed systems and extended education through a networking infrastructure of organizations and digital communication pathways with integrated distributed data sources and partners. 2. A computer/network based Natural Resources Integrated Information System (NRIIS) will be developed with graphical interface and search mechanisms to access models, data, information, and GIS/graphic tools. 3. Graduate students will use the system a) to facilitate their research, b) see how their study is part of a larger system, and c) gain experience with NRIIS and its power for enhancing research, technology, and information transfer and communication for informed natural resource policy, planning, and management decisions.

Methodology

We are using a multidisciplinary systems approach to this effort. We are attempting in many ways to use research knowledge, common knowledge, and databases from disparate studies of components of the

watershed and tie them into a systems approach to an integrative perspective to assist with wiser land use decisions which will result in better quantity water conditions. The overall picture incorporates a networking infrastructure for internal and external communications and to incorporate tools such as GIS, relational databases, etc. The second major component is the watershed system involving hydrologic land use and sociologic information. The third major component is the extended education in which the network is coupled with watershed systems information to be extended to end users for better understanding of their watershed and watershed processes. The entire effort is dependent on a variety of data sources and on partners for not only providing the data but being part of our focus groups, etc., as the system is designed and evolves. More detail the users interface with a graphical interface basically their computer system which contains a control engine that accesses system modules involving models, general knowledge, databases, GIS, and help documents. Methodology incorporates to a great degree human aspects through focus groups, surveys, and feedback on prototype systems to their evolved to more sophisticated versions.

Principal Findings and Significance

Overall, we are pleased with this effort and the number of individuals accessing the information. In utilizing an internet statistics package, we are able to assess user interest and frequency of addressing various pages of information. The number of individuals accessing information over the past three years has doubled over each subsequent year. Presently, the average number of user sessions per day is 170. The average number of pages viewed per day is 420. The most popular pages accessed involve our on-line modeling efforts specifically the Revised University Soil Loss Equation (RUSLE). A close second involves the general GIS information, and third deals with our Virtual University (VU) Watershed Management course information. Thus, it is clear that as more information is made available over the web, the number of users will continue to rise. Specifically, this past year we developed an extensive set of cooperative arrangements with the Natural Resources Conservation Service (NRCS), Michigan Department of Environmental Quality (MDEQ), and the Center for Remote Sensing and GIS (CRS-GIS) relative to the acquisition of digital and conversion of digital information. Soil series information at the county level is a critical requirement for numerous building development decisions. Also, there is one critical layer required for most of our modeling efforts dealing with hydrology and/or nutrient loadings. This past year the ability to place requirements on a watershed basis and have them transmitted to an off-line real-time ARCInfo system for analysis has been accomplished. Real time analysis from the off-line ARCInfo system is sent back to the server and subsequently to the end user. This capability has greatly expanded the dynamic flexibility of analysis for end users involved with land use and watershed decision making. One of our VU courses has been developed and three others are under development. The courses in total provide a certificate program for watershed managers. The first course, Watershed Concepts, is being offered for the second time. This course relies extensively on information that has been developed with watershed models and interactive GIS systems over the web as a basis for the learning process in the course. By developing a VU watershed management course, that relies heavily upon GIS modeling efforts, we are facilitating the transfer of the information and the knowledge of assuring additional utilization of the information being made available via the web. The additional Modules (courses) will utilize supplementary aspects and new developments that are presently underway relative to information integration and dissemination via the web.

Descriptors

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

Articles in Refereed Scientific Journals

Book Chapters

D'Itri, Frank M. 1999. Environmental Contamination and the Information Highway. In: Integrated Environmental Management: Development Information and Education in the Asian Pacific Region, Ann Arbor Press, Chelsea, MI. D'Itri, Frank M. 1999. What Education and Information Systems Can Do To Help Solve Environmental Problems: A Summary. In: Integrated Environmental Management: Development Information and Education in the Asian Pacific Region, Ann Arbor Press, Chelsea, MI. Ppg. 211-222. D'Itri, Frank, Y. Itakura, J.S. Eades, M. Kawashima, S. Endoh, and H. Kitamura. 1999. Integrated Environmental Management: Development Information and Education in the Asian Pacific Region, Ann Arbor Press, Chelsea, MI. Ppg. 288. D'Itri, F.M., A. Ushikubo, S. Kawasaki, H. Urushibara, A. Ebata, K. Kiriya, and K. Taguchi. 1999. The Treatment, Recycling and Disposal of Solid Wastes in the Japanese Food Industries. Manuscript in preparation.

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Ouyang, Da. 2000. Project Report for NutrientNet: Methods for calculating phosphorus loadings. Submitted to the World Resources Institute, Washington, D.C.

Basic Project Information

Basic Project Information	
Category	Data
Title	Watershed Based Optimization Approach for Identification and Management of Non-Point Source Pollution
Project Number	B-02
Start Date	03/01/1999
End Date	02/28/2001
Research Category	Water Quality
Focus Category #1	Management and Planning
Focus Category #2	Water Quality
Focus Category #3	Law, Institutions, and Policy
Lead Institution	Michigan State University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Da Ouyang	Professional Staff	Michigan State University	01
Scott Witter	Professor	Michigan State University	02

Problem and Research Objectives

Agricultural non-point source pollution (NPS) was identified as the major source for impaired streams and lakes. Pesticides, nutrients, and sediments are the primary pollutants from agricultural land. Because of the widespread, vigorous, and random nature of NPS, it is a challenge to identify and control. Developing a watershed based optimization approach will help identify and manage non-point source pollution. In this project, we have identified and evaluated several water quality models including pesticide assessment and nutrient loadings. These models will help farmers, watershed planners, and other resource managers to determine NPS, implement best management practices (BMP), and make decisions more efficiently.

Methodology

The use of pesticides in agricultural production has brought about environmental concerns, one of which is the potential for non-point source pollution in surface and groundwater. It is important to evaluate the potential risk of pesticide application on croplands and presented to the environment, particularly concerning water resources. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) and Agricultural Research Service (ARS) have developed a screening procedure to evaluate the potential risk of pesticide loss from soils. WIN-PST is a Windows-based computer program developed by the USDA National Water and Climate Center (NWCC). Based on the properties of pesticides and soils, climate, and cultural practices, WIN-PST evaluates the likelihood of pesticide loss and its potential risks to both humans and fish. Compared to other simulation models, this model has a user-friendly interface and requires a minimum set of input data. In this project, we evaluated WIN-PST by comparing it with a quantitative simulation model; the National Agricultural Pesticide Risk Analysis (NAPRA). NAPRA uses the USDA environmental fate model GLEAMS (Groundwater Loading Effects of Agricultural Management Systems) to estimate the potential loss of pesticides from fields via runoff and percolation, and potential environmental risks. The probability of pesticide loss that exceeds the EPA's Health Advisory Level (HAL) is calculated for a period over many years to assess the risk. The NAPRA process considers climate, soils, pesticide properties, tillage practices, field slope and length, and the method and rate of pesticide applications. The GLEAMS model is a widely tested continuous simulation field-scale model. We used NAPRA/GLEAMS to assess the newly developed and more qualitative WIN-PST. The probability of risk from NAPRA was calculated for 40-45 years in the study area. The relative risk from NAPRA was compared with risk ratings from WIN-PST. Selected scenarios include different soils, management practices (soil incorporated and surface application), rates of pesticide application, and pesticide toxicity levels which were used in both models.

Principal Findings and Significance

Our findings from this study include that WIN-PST can provide reasonably comparable results with the

more quantitative model, NAPRA. Most scenarios are “similar” or “same”. They correspond particularly well for pesticides with low toxicity and high application rates. WIN-PST somewhat over-estimates the risks for pesticides with high toxicity. In some cases though, it may also “over-estimate” the risk for applications with low rates. It suggests that WIN-PST may have provided a conservative assessment for environmental risk of pesticide applications. In terms of time and effort that require a user to collect and process the input data, WIN-PST provides a more efficient risk assessment tool with comparable results from other simulation models. Nutrients, particularly phosphorus, are major pollutants from non-point sources due to the use of chemical fertilizers and animal manures. Phosphorus is the most prevalent cause of eutrophication and degrades water quality. The most common form of phosphorus loading is the particulate phosphorus or sediment bounded phosphorus in which phosphorus components move with eroded soil particles to water bodies. Estimating phosphorus loading can help identify the potential high risk areas and prioritize the implementation of best management practices. Extensive literature review has been done on the methods used in estimating nutrient loadings. Several models, including empirical models and GIS-based models for estimating phosphorus loadings, have been identified. This includes soil erosion models, sediment delivery ratios and loading coefficients. Pros and cons of each model/approach have been discussed and reviewed. Based on our study, we have made a recommendation for other research projects relative to nutrient loading and NPS trading.

Descriptors

hydrologic models, nonpoint source, watershed management, water quality, policy analysis, stakeholders, acceptance, adoption, BMP maintenance

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Bartholic, Jon , D. Ouyang. 2000. USGS Project Progress Report: Watershed Based Optimization Approach for Identification and Management of Non-Point Source Pollution. Ouyang, Da. 2000. Project Report for NutrientNet: Methods for calculating phosphorus loadings. Submitted to the World Resources Institute, Washington, DC.

Conference Proceedings

Ouyang, Da. 1999. An Evaluation of the Windows Pesticide Screening Tool (WinPST) Institute for Agriculture and Trade Policy (IATP) Minneapolis, MN, 15 pps.

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Information Dissemination Retrieval and Reference: An Information and Dissemination Program for Riparians and Citizens
Project Number	B-22
Start Date	03/01/1999
End Date	02/28/2001
Research Category	Water Quality
Focus Category #1	Education
Focus Category #2	Groundwater
Focus Category #3	Surface Water
Lead Institution	Michigan State University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Lois Wolfson	Professional Staff	Michigan State University	01

Problem and Research Objectives

Michigan's water supply is abundant and widespread due in large part to Michigan's geographical location within the Upper Great Lakes Region. Michigan is surrounded by four of the five Great Lakes, and contains 11,000 inland lakes greater than 5 acres in size. Water flows through over 32,000 miles of river channel, and Michigan possesses a vast groundwater supply. These waters provide a wealth of resources for the diverse agricultural, industrial, and recreational opportunities of the state. However, the ever growing number of activities in the state continually add stress to this resource and can lead to further degradation of water. Because almost all wastes drain to the Great Lakes where the impact is accentuated due to the slow flushing rate of the system, water resource problems in the state are largely concerned with water quality issues. As land use impacts that degrade 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 of water quality changes over time, and to determine if efforts being made to

reduce pollutants are proving effective, an education and monitoring 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. Because educational levels and prior knowledge in the subject area are so varied, a number of transfer mechanisms are necessary. These range from the direct dissemination of brochures, pamphlets, and technical and nontechnical books to computer models, the publication of technical completion reports, and videos, conference and seminars for both lay audiences and professional groups throughout the state. Training sessions on water-related topics, such as lake eutrophication, nonpoint source pollution, and stream monitoring, 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. 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.
2. Review, edit, and publish water conferences and workshop proceedings.
3. Prepare lecture/demonstrations and audio-visual materials 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. Utilize the dissemination potential of the worldwide web by developing educational modules; interactive models; and virtual reality courses.
5. Cooperate with the Michigan State University Extension to make water-related information available through the county cooperative extension agents.

Methodology

The Institute of Water Research Technology Transfer and Information Dissemination Program began in the early 1970s, and has been expanded and improved to be more responsive to the informational needs of a wide variety of user groups. In order to promote the maximum exchange of information, the combination conference/workshop format has often been selected as the most versatile for scientific/researcher oriented groups. These conferences are open to public participation and present new and current information, often providing recommendations for future research and outreach.

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. In addition, the Institute of Water Research operates the Inland Lakes Research and Study Center (ILRSC) at Michigan State University. Located four miles south of the main campus, the ILRSC consists of a 200 acre fenced site with four manmade, shallow enriched lakes that average six feet in depth and total 40 surface acres. Additionally three artificial one-acre marshes are located at the ILRSC. They are tiered to a depth of three feet, lined with two feet of native clay, and have a typical complex of marsh vegetation. The four lakes and three marshes provide a diverse array of aquatic habitats and an opportunity for whole lake studies and demonstrations. The 160 acres surrounding the lakes can be utilized for terrestrial studies. The conference/workshop facilities of

the Center include an indoor demonstration/lecture room. Concrete boat launching ramps provide convenient access to each lake. The ILRSC is open for tours and workshops from April through October. Elementary, high school and college classes continually take advantage of the outdoor facility by holding classes there. IWR staff hold combination lectures and workshops, and cover a variety of water related topics. The Institute's technology transfer program is under the direction of Principal Investigators Dr. Lois G. Wolfson, with several Institute personnel contributing to the project, including Dr. Frank D'Itri, Ruth Kline-Robach, Elaine Brown, and Joseph Ervin.

Principal Findings and Significance

Conferences Four conferences/workshops were held in FY 99 with the Institute as either sponsor or co-sponsor. The 9th annual Great Lakes conference, titled, The Great Lakes: Five Decades of Change was held in March. The one-day conference provided an overview of the tremendous changes in the Great Lakes that have occurred during the past half century and presented information on their current status. The four theme areas for the conference were: 1) Species introductions and invasions; 2) Water quality issues such as contamination of fish by toxic substances and the direct implications to human health of eating these fish; 3) Great Lakes Management; and 4) Restoration issues. A total of 125 people attended. The Institute also co-sponsored a conference in March on Watershed and Aquatic Plant Management with the Michigan Chapter, North American Lake Management Society. Issues concerning boating, exotic species, aquatic plants, and health were presented. Approximately 35 people attended. In August, the Institute's water quality coordinator assisted with the development and instruction of a two day workshop on Protecting Inland Lakes, Part I. This intensive training session was aimed at riparians and lake association personnel. The workshop consisted of general information on lakes and provided hands-on experience for testing lake water, collecting data, and interpreting results. The class was limited to 30 people and was filled to capacity. The Institute also sponsored and coordinated the 2nd Annual Michigan Groundwater Protection Conference: Building Partnerships for Drinking Water Protection in October. Topics included: Land Use Techniques for Water Resources Protection; Conducting a Contaminant Source Inventory; Groundwater Guardian Success Stories; Groundwater 101; Addressing Michigan's Abandoned Wells; Agriculture and Drinking Water Protection; Team Building and Contingency Planning for Wellhead Protection; and An Introduction to Global Positioning Systems. Concurrent sessions were held and a total of 120 people attended the two day event. Wetlands Tracking System The Institute worked with the Department of Environmental Quality (DEQ) to create a computerized Wetlands Tracking System (WTS). The pilot version of WTS provides a framework for assembling, accessing, analyzing, and linking external information to GIS data layers. This allows users to develop their own integrated information system, using any available data type or information source. Development of the pilot version focused on only one county; however, the WTS has been designed for expansion to state-wide coverage. The WTS was designed for flexibility, expandability, and ease-of-use, and is currently being used by district staff at one of the DEQ's surface water quality field offices. Information on the Web The Institute of Water Research (IWR), with funding provided by the MSU Extension Water Quality Committee, has developed a web-based program called the Water Quality Data Access System that allows a user to access a variety of water quality data by county or watershed and view summary information on the parameter(s) of interest as well as the location where the sample was originally taken. The data was obtained from STORET, but only Michigan data was downloaded and of the hundreds of variables available, only a limited number have been summarized. The program enables the user to obtain environmental water quality data by either county or watershed. The user can also access a map which includes the sampling stations where data was obtained, locations of rivers, intermittent streams, lakes, and the county or watershed boundary. The web address for this site is: <http://www.gis.iwr.msu.edu/storet>. As Water Quality Coordinators for MSU Extension, Institute staff assembled an Expert's Directory on the web for Extension personnel. The Directory highlights faculty

and specialist at MSU who are doing research, outreach and/or extension activities in water related areas. Each listing includes the person's area of expertise, publications, outreach materials, classes taught, and contact information. Demonstrations and Exhibits The Institute took part 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 competed in a variety of science related events. Winners of the event continued to the national finals. Another national high school event, the Michigan ENVIROTHON was also held at MSU, and one of the Institute staff served as the co-leader of the event. This event brought in hundreds of students to compete in science related events. 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. In FY 99, the Institute focused on land use and water quality. Coordinating efforts with the Michigan Groundwater Stewardship Program (MSGP), the Institute demonstrated the effects of various land use practices on both surface water and groundwater while the MGSP performed water testing analyses for atrazine and nitrate. Lectures, Workshops, and Training The Institute staff gave numerous presentations throughout the year on issues such as wetland functions; wellhead protection, water quality management for golf course superintendents, household hazardous wastes, indicator species for water quality testing, and nonpoint source pollution. Audience participation ranged from approximately 25 to over 100 for each presentation. Institute personnel also coordinated efforts with Extension and the Kellogg Biological Station in developing a workshop on Protecting Inland Lakes. The first part of the two part intensive training dealt with basic lake concepts, and provided hands-on training for participants. An Institute staff member assisted with the development of the manual, and served as one of the instructors during the hands-on training portion.

Descriptors

Water Quality, Watershed Management, Macroinvertebrates, Water Chemistry, Monitoring

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Wolfson, Lois, and Jon F. Bartholic. 2000. An Overview of Procedures and Techniques for Developing Watershed Management Plans for Michigan Communities. Presented at Watershed Management Conference, Kellogg Center, Michigan State University, East Lansing, MI.

Other Publications

Kline-Robach, Ruth and James McEwan. April, 1999. Plugging Abandoned Wells. MSU Extension WQ40. East Lansing, MI. Schultink, Gerhart., Richard Moore, Lois Wolfson, and James Dischinger-Smedes. 2000. Guidelines for Wetlands Identification and Evaluation: Needs and Opportunities for Local Protection. Agricultural Experiment Station, Research Report 572, East Lansing, MI. 82pp. Brown, E., A. Peterson, R. Kline-Robach, K. Smith and L. Wolfson. 2000. Developing a Watershed Management Plan for Water Quality: An Introductory Guide. Institute of Water Research, Michigan

State University, East Lansing, MI. 52pp. Wandell, Howard and Lois Wolfson. 2000. A Citizen's Guide for the Identification, Mapping and Management of the Common Rooted Aquatic Plants of Michigan. Water Quality Series, WQ 55, MSU Extension, Michigan State University, East Lansing, MI. 82pp. Hart, Steven, Michael Klepinger, Donald Garling, Howard Wandell, and Lois Wolfson. 2000. Integrated Pest Management for Nuisance Exotics in Michigan Inland Lakes, Water Quality Series, WQ 56, MSU Extension, Michigan State University, East Lansing, MI. 28pp

Information Transfer Program

Projects Funded Research projects funded with the fiscal dollars allotted. With a growing need in the Water Research Institutes in the Great Lakes region to develop new methods for integrating, and disseminating information and data concerning the priority areas identified previously, the study by Bartholic (01) entitled "Natural Resources Integrated Information System" presented a method for developing an information exchange integrated support system for watershed studies with emphasis on land use and not resource stewardship. The system will support research studies by faculty and graduate students in several departments, and planning and management by local, county, state, and federal agencies. Research project (02) entitled "Watershed Based Optimization Approach for Identification and Management of Non-Point Source Pollution," conducted by Professor Scott Witter of Resource Development and graduate assistant Da Ouyang, focuses on developing a watershed based optimization approach to help identify and manage non-point source pollution. In this project, we have identified and evaluated several water quality models including pesticide assessment and nutrient loadings. These models will help farmers, watershed planners, and other resource managers to determine NPS, implement best management practices (BMP), and make decisions more efficiently. Research project (22) entitled "An Information and Dissemination Program for Riparians and Citizens, conducted by Specialist Lois G. Wolfson, focuses on land use impacts that degrade water quality and the need for action at the watershed level. In order to stay informed of water quality changes over time, and to determine if efforts being made to reduce pollutants are proving effective, an education and monitoring 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 (see project 22 Synopsis for complete details).

USGS Internship Program

Student Support

Student Support					
Category	Section 104 Base Grant	Section 104 RCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	0	0	6	6	13
Masters	1	0	3	8	12
Ph.D.	0	0	1	4	5
Post-Doc.	0	0	0	0	0
Total	1	0	10	18	30

Awards & Achievements

Notable Achievements and Awards The Michigan Institute of Water Research conducted the annual water institute survey and compiled the results from the survey's received into a comprehensive Executive Summary for the NIWR organization. This yearly summary is utilized by institute directors as a national summary of water institute accomplishments resource for legislators and appropriations decision makers at the federal and state levels.

Pesticide Risk Assessment in Michigan (Da Ouyang/Jon Bartholic/Jeremiah Asher) The Institute has conducted several case studies on the potential risks of pesticide application in agricultural croplands in Michigan. The study areas include Clinton county, Cass county and St. Joseph county. Two models developed by the U.S. Department of Agriculture have been evaluated. Risks of pesticide application in croplands have been assessed for commonly used herbicides, different agricultural soils and tillage management practices. The goal of the study was to provide the risk assessment information needed for farmers, watershed planners, and other resource managers to minimize water contamination caused by the use of pesticides. The results of the study have been presented in a national watershed conference, and provided to county extension offices and crop consultants in Michigan, and the Institute of Agriculture and Trade Policy (IATP).

Development of an Online Soil Erosion Assessment Tool (Da Ouyang) Estimating soil erosion requires knowledge on soil erosion processes and information on a specific site, and can be time consuming. The Institute of Water Research, collaborated with the Natural Resource Conservation Service, U.S. Department of Agriculture (office of state Michigan), has developed the first online Soil Erosion Assessment Tool. This online tool uses the widely recognized soil erosion model Revised Universal Soil Loss Equation (RUSLE). It provides a user-friendly interface and real-time calculations. This online tool has been used by a variety of users including students, research scientists, educators, extension personal, and others within Michigan, nationally, and internationally. The web site address is: <http://www.iwr.msu.edu/~ouyangda/rusle/>

Interactive Web-Based Watershed Management Tool (Jeremiah Asher) The institute has developed a creative interactive web-based watershed management tool. The idea spawned from observing the growing need for watershed management tools

and seeing the opportunity to tightly couple with and support the watershed planning guide. The goal of the application is to assist local units of governments, interest groups, and citizens with watershed management planners by providing access to vast data sets, GIS tools, maps, and reports. The application provides an intuitive interface that allows users to simply type in their address and zip code. They are provided with a web-based mini-GIS with a point location of their address within the 14 digit watershed. This application is on the leading edge of its technology, ingenuity, and capability. Some of the data layers and capabilities are: roads, highways, hydrology, topo lines, digital elevation maps, drainage patterns, and digital orthophotography. In addition, there are capabilities to produce potential risk area maps within the watershed. These maps help citizens/planners prioritize areas within the watershed that may be at risk for erosion or nutrient loading into surface waters. The web site address is: <http://35.8.121.133/water/info.html> Pilot nutrient trading website (Da Ouyang/Jeremiah Asher/Jon Bartholic/Elaine Brown) The Institute of Water Research has provided consultancy and technical assistance to the World Resource Institute in launching the pilot NutrientNet.org website, an online nutrient trading marketing tool. This website aims to provide a cost-effective and market-based approach for improving water quality. Users such as farmers and industries can trade credits for nutrients (phosphorus and nutrient) discharge from non-point sources and point sources to meet the watershed water quality standards. IWR has conducted an analysis on methodologies and provided the soil erosion module, mapping, and web hosting for this pilot project. The web site address is: <http://www.nutrientnet.org> Source Water Assessment Program (Ruth Kline-Robach) The 1996 amendments to the federal Safe Drinking Water Act (SDWA) require states to develop a Source Water Assessment Program (SWAP). The purpose of SWAP is to: - Identify areas that supply public drinking water - Assess the susceptibility of those water supplies to contamination - Inform the public of the assessment results Source water assessments will be conducted for all public water supplies (PWS). A PWS is a waterworks system that provides water for drinking or household purposes to persons other than the supplier of the water. In addition to the 1500 Type I, community water supplies in the state, source water assessments will be conducted on each of Michigan's approximately 12,000 Type II, non-community water supplies. These non-community systems typically provide water to restaurants, churches, schools and campgrounds. In Michigan, almost all of these systems rely on ground water as the source of their drinking water. These source water assessments are being conducted by local health department personnel, with technical assistance and facilitation support provided by the MSU-IWR, in collaboration with six universities and organizations across the state. What will a Source Water Assessment Include? - determine the location of each well and intake using global positioning system (GPS) technology - use well record information to determine geologic materials or area hydrology around intakes to estimate the sensitivity of the source to contamination - examine well or intake construction, maintenance and use information to estimate the physical condition and integrity of the well or intake - examine existing water quality data - determine the source's susceptibility to contamination and evaluate isolation distances from land uses that may pose a threat to drinking water quality The SDWA requires that SWAP activities be completed by May 2003. Once completed, the source water assessments can be used to determine future monitoring requirements, provide the public with more information on water supplies throughout the state, and focus prevention resources on drinking water protection activities. Virtual Watershed Program: An Internet-Based Academic Credit or Professional Certificate Program in Watershed Management (Jon Bartholic) This course was designed by Scott Witter of Resource Development (RD), PhD student Karen Wayland who taught an RD Watershed Management course, and Jon Bartholic representing RD and the Institute of Water Research. It is designed as a quantitative in-depth watershed concepts course consisting of four modules addressing progressive levels of watershed management. The course lends itself to obtaining a Professional Certificate in Watershed Management for either non-degree students or degree-seeking students who wish to receive university credit. The course is also being adapted for county drain commissioner and personnel training. Also, Shiga University, Tokyo, Japan has expressed an interest in offering the course at their university. For more detailed information concerning the course, log on to web site address: <http://www.iwr.msu.edu/watershed/brochure.html> Watershed-based Effluent Trading Policy Research (Elaine Brown) Over the last 18 months has been conducting a comparative analysis of the air emissions trading program with pilot watershed-based nutrient trading programs to determine if the success of the air emissions programs could be applied to water resource policy. This policy research involved an analysis of federal statutes and policies for both media as well as case studies comparing a regional air emissions trading program with five

point-nonpoint trading programs. This study indicates that the property rights and institutional frameworks for air emissions trading are much more conducive to trading. It also indicates that the watershed based trading program may be in an early stage of development that requires a different approach. Since several states in the Midwest region and across the country are developing or have developed watershed based trading rules, this information can be used in the policy development process.

Michigan Agricultural Environmental Assurance Planning Committee (E. Brown) In the late 1990s, the State of Michigan developed a pollution prevention strategy. One of the action items was to establish a voluntary environmental assurance program for agriculture. The Michigan Agricultural Environmental Assurance Planning committee was tasked to develop this program. This program is a unique effort to assist producers in protecting the environment while remaining economically viable. The first phase of the program will be launched in January 2001. The goal is to have 80% of animal agricultural production in the program by 2005. IWR staff has served on the committee and aided in development of the program, and the development of content and educational outreach.

New and Expanded Animal Operations Citing and Odor Control Task Force (E. Brown) With the expansion and concentration of animal agriculture operations across Michigan, issues of appropriate citing and odor control have come to the forefront. In response to the situation the Michigan Legislature amended state law to require the Michigan Department of Agriculture to establish a program for citing new and expanding animal operations and to address odor control issues. IWR staff served on the task force that developed the new generally accepted agricultural management practice. This policy action required a state agency review and local government notification for new or expanding animal operations.

Manure Management in the New Millennium (Frank D'Itri) In June 2000, the Institute of Water Research organized a tour to Japan for four Michigan State University faculty researchers to establish contacts and exchange information with Japanese researchers, equipment manufacturers and animal producers on the latest animal manure management methods being employed in Japan. The group visited five animal production farms, two cooperative manure composting facilities, two national animal industry institutes and one university to observe the latest manure management and composting methods employed by the Japanese animal industry to comply with national environmental regulations. The latest and most important development in this area is the evolution of farmers' cooperative manure composting corporations. These facilities utilized specialized equipment to continuously turn and process animal manure automatically into finished compost. Consequently, the Michigan State University Department of Animal Science is proposing to purchase and import this technology to develop a central manure composting research facility at Michigan State University. The long-term goal of this project is to help animal producers in Michigan develop similar cooperative manure composting facilities to more effectively manage and recycle the manure while minimizing its negative impact on the environment.

New Watershed Planning Guide (Lois Wolfson/Ruth Kline-Robach/Elaine Brown) The Institute, in coordination with the Michigan Department of Environmental Quality (DEQ), has developed a guidebook to help local units of government and citizens develop watershed management plans that can then be submitted to the DEQ for approval under the Clean Michigan Initiative (CMI), a multi-million dollar environmental bond initiative established in Michigan for improving water quality. The guide, "Developing a Watershed Management Plan for Water Quality," provides a process for gathering stakeholders, information, and resources to protect and improve Michigan's water resources. Once the plan is approved, a grant application for CMI funding may be submitted to implement portions of the plan.

Environmental Sciences in Japan: International Training for American Students (F. D'Itri) The Michigan State University Institute of International Health in cooperation with the Institute of Water Research has developed a sustainable, international environmental science program in Japan for American undergraduate and graduate students which integrates courses in environmental sciences, seminars on environmental issues, field trips to environmentally sensitive sites, and internship programs with laboratories, universities, and government agencies. The keystone course for the Environmental Sciences in Japan (ESJ) program entitled "Japanese Environmental Issues from Meiji to Heisei" has been developed by Professor Frank M. D'Itri, Associate Director of the Institute of Water Research. Sixteen Japanese scientists and/or environmental activists will present the lectures in this course. These senior Japanese researchers will provide the students with first hand knowledge about a number of the most serious environmental problems that have occurred in Japan, primarily as the result of rapid industrialization initiated in the late 1800s (the Meiji period) and continuing through the post World War II recovery (the Showa period) to the present era (the Heisei period). The course lectures and field trips will provide the student with not only the historical

perspectives of Japanese environmental issues but also an understanding of how the post World War II actions of citizen groups influenced the political process to implement legislation to more effectively protect human life and the environment. An International Watershed Symposium (F. D'Itri) The Institute of Water Research has collaborated with the Michigan State University Japan Center for Michigan Universities and the University of Shiga Prefecture in Hikone, Japan to organize and convene a symposium entitled "Toward Sustainable Management of Lake Watershed Ecosystems" in Hikone, Japan on July 19-20, 2001. The goals of the symposium are to: 1) critically evaluate common environmental problems related to lake-watershed ecosystems and; 2) identify reliable methods to develop sustainable management strategies to restore and protect lake-watershed ecosystems. In addition, it is anticipated that the symposium will stimulate academic/research exchanges between American and Japanese scientists with the objective to develop methods to reduce the deterioration of lake ecosystems, especially from nutrient loadings as well as other xenobiotic contaminants from diffuse sources outside the watershed. Serve on the following committees (Ruth Kline-Robach) Michigan Source Water Assessment Program Advisory Committee National Groundwater Education Consortium Regional Wellhead Protection Program Education Committee Regional NPDES Stormwater Regulations Committee Conferences (Ruth Kline-Robach) Michigan Groundwater Protection Conference, November 1999 Presentations/Training Sessions (Ruth-Kline-Robach) Farm*A*Syst and Home*A*Syst Training MSU Wellhead Protection Program RISE Program University Committee for a Sustainable Campus Tri-County Children's Groundwater Festival State Science Olympiad Water Quality Finals Awards/Honors MSU-IWR designated as a National Groundwater Guardian Affiliate

Publications from Prior Projects

Articles in Refereed Scientific Journals

D'Itri, Frank M., A. Ushikubo, S. Kawasaki, H. Urushibara, A. Ebata, K. Kiriyaama, K. Taguchi. 1999. The Treatment, Recycling and Disposal of Solid Wastes in the Japanese Food Industries. Manuscript in preparation.

Book Chapters

Dissertations

Lee, Kyung-Hyuk, PhD. 2000. "The Effects of Ozonation Formation of Biodegradability in Drinking Water." Macheimer, Patricia, PhD. 1999. "Transferable Development Rights as a Growth Management Technique in Landscape Management: A Case Study Approach." Propasarra, Nilagupta, PhD., 1999. "Modeling future Demand for Energy Resources: A Study of Residential Electricity Usage in Thailand."

Water Resources Research Institute Reports

Bartholic, Jon F., F.M. D'Itri, L.G. Wolfson, R. Kline-Robach, E. Brown. 1999. Michigan Institute of Water Research, Five (5) Year Evaluation Report, FY1993-FY1997.

Conference Proceedings

D'Itri, Frank.2000. How to Survive a Research Intensive Environment II 62 MAES, OVRPGS, Kellogg Center, Oct 12 and Nov 29, 2000. Wolfson, Lois G. 2000. Michigan Irrigation: Opportunities and Challenges for Agriculture, Homer Nowlin Endowment, Kellogg Center, Nov 28, 2000. Wolfson, Lois G, and Jon F. Bartholic. 2000. An Overview of Procedures and Techniques for Developing Watershed Management Plans for Michigan Communities, Kellogg Center, Oct 11.

Other Publications

Wolfson, Lois G, Ger Schultink, Richard Moore, and James Dischinger-Smedes. 2000. Guidelines for Wetland Identification and Evaluation: Needs and Opportunities for Local Protection, Department of Resource Development, Michigan State University, East Lansing, Michigan. Wolfson, Lois G, Stephen Hart, Michael Klepinger, Howard Wandell, and Donald Garling. 2000. Integrated Pest Management for Nuisance Exotics in Michigan Inland Lakes. MI Department of Environmental Quality, State of Michigan and Department of Fisheries and Wildlife, Michigan State University.