

Indiana Water Resources Research Center

Annual Technical Report

FY 1998

Introduction

The IWRRC has established a strong foundation and infrastructure for continuing to adapt modern information technologies in support of water resources research, decision-making, and general communication. Our goal for the future is to play a leadership role in this emerging area at all levels; local, state, and within the National Institutes for Water Resources at the federal level.

Research Program

Basic Project Information

Basic Project Information	
Category	Data
Title	Investigation of Three-Point Scheme for Identifying Local and Regional Groundwater Flow Characteristics as Applied to Wellhead Protection and Site Remediation
Project Number	C-01
Start Date	09/01/1996
End Date	08/31/1998
Research Category	Ground-water Flow and Transport
Focus Category #1	Groundwater
Focus Category #2	Methods
Focus Category #3	Water Supply
Lead Institution	Purdue University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Stephen E. Silliman	Professor	University of Notre Dame	01

Problem and Research Objectives

This project is targeted at increasing the information available from local measurement of water levels in a series of wells at a field site. The goal is to provide direct estimates of the local variability in the hydraulic gradient and, thereby, to provide means of identifying uncertainty estimates for wellhead capture zones.

Methodology

The project is being completed through a combination of small field projects, analysis of existing data sets from a number of field sites throughout the midwest (and the state of Washington), and through analytical and numerical analysis.

Principal Findings and Significance

(i) Identification of field conditions under which the LGE (local gradient estimator) provides significant insight into local and regional hydraulics. Entering this project, it was known that the LGE worked well for uniform regional flow, but was untested under conditions which deviated from uniform regional flow. In this project, it has been shown that the LGE provides valuable insight into local and regional hydraulic behavior under uniform conditions, conditions of strongly converging or diverging flow, and conditions such as a karst environment in which flow converges to local zones of high permeability. This portion of the work was accomplished through analysis of a number of field data sets available through state and federal agencies (primarily superfund sites).

(ii) Identification of the impact of measurement error on the LGE and our ability to assess the hydraulic gradient at field sites. Prior to this project, the LGE was utilized only in two-dimensions and without consideration of measurement error. Within the present project, the three-dimensional data were available, the LGE provided results which were hydraulically and intuitively unreasonable. This led to a study of why these results were consistently unreasonable when essentially all applications of the LGE in two-dimensions provided solid results. Measurement error was shown to be the primary reason for the unusual results in three-dimensions. The implication of this result is that the precision with which we are collecting water level data in three-dimensional systems is commonly insufficient to provide us with the ability to actually estimate the vertical component of the gradient.

(iii) The observation on measurement error led to a simple field experiment designed to quantify the source of measurement error in the field. This effort led to the observation that both the surveying of the surface elevation of well casings and error in the measurement of depth to water was substantially reduced if the survey station used was mounted only once for all wells (rather than returning to a field site multiple times to measure clusters of wells as they are completed). Further, it was observed that electronic depth to water meters provided consistently better results than did steel tapes with chalk.

(iv) This work with measurement error led to the development of a statistical technique whereby field depth to water measurements can be rapidly analyzed (with a lap top computer in the field) to determine

whether any measurements are anomalous. Anomalies can be attributed to two sources: measurement error or unusual hydraulic behavior. As such, this technique provides the field technician with a rapid, in-field method of determining whether any of the recorded data should be remeasured. The potential of this technique is significant as it provides a means of allowing the field hydrologist to remeasure "bad" points in the field prior to returning to the office for further assessment.

Descriptors

Groundwater hydrology, aquifer characteristics, resource planning

Articles in Refereed Scientific Journals

Silliman, S.E., and C. Frost, 1998, Monitoring of the hydraulic gradient using a three-point estimator, Journal of Environmental Engineering, 124(6), 517-523.

Book Chapters

Dissertations

Masters Thesis of Ms. Gloria (Arevalo) Mantz - Fall 1997

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Restoration of Degraded Midwestern Streams: Implications for Water Quality and Biological Communities
Project Number	C-02
Start Date	09/01/1997
End Date	08/31/2000
Research Category	Water Quality
Focus Category #1	Ecology
Focus Category #2	Surface Water
Focus Category #3	Water Quality
Lead Institution	Purdue University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Gary Lamberti	Professor	University of Notre Dame	01

Problem and Research Objectives

Streams and rivers of the midwestern U.S. have been subjected to a variety of anthropogenic impacts, both direct (e.g., channelization, woody debris removal) and indirect (e.g., riparian modification, wetland loss, watershed land use), that have cumulatively degraded both water quality for human use and stream habitat for aquatic biota. Indiana streams are among the most severely degraded in the region because of extensive row-crop agriculture and expanding urbanization. For well over a century, many central and northern Indiana streams have been diverted, straightened, and ditched to accommodate agriculture, to coincide with property boundaries or land developments, to drain wetlands, or to increase capacity to carry floodwaters. In the corn-belt states of Illinois and Indiana an estimated 30% or more of all streams have been channelized, and national estimates range from 6 - 70% depending on the region. The Council on Environmental Quality estimates that 41% of all streams in the U.S. have been subjected to channelization with resulting siltation and bank erosion.

The prevailing results of these practices have been reduced water quality for downstream systems and human uses together with degraded habitat for stream biota. In recent years, nationwide interest has been generated for the restoration of degraded or lost aquatic habitats, especially small streams and wetlands where such projects are feasible with local resources. Most previous riverine restorations have occurred in western streams impacted by logging or in methods or efficacy of stream restoration in the agricultural Midwest, even though there is a critical need for restoration efforts to improve surface water quality in this region. In this project, we are addressing this clear deficiency by studying the results of two stream restorations in northern Indiana, which would otherwise lack quantitative evaluation.

Our evaluation of these restoration projects includes both structural (state) and functional (process) variables over several levels of physical and biological organization. For biotic responses, we are evaluating parameters at the population, community, and ecosystem levels. Our primary objectives are to: (1) compare the geomorphic and hydraulic features of restored and unrestored reaches of the same streams, before and after the restorations, (2) identify and quantify a set of biological variables (endpoint criteria) useful for evaluating the success of other stream restoration projects in the Midwest, and (3) make recommendations for improvements of other stream restoration projects consistent with a cost-effective approach.

Methodology

We are evaluating two ongoing stream restorations: (1) Potato Creek within Potato Creek State Park near North Liberty, Indiana (41°32'N, 86°20'W), and (2) Juday Creek on the University of Notre Dame (UND) campus in South Bend, Indiana (41°43'N, 86°16'W). Both restorations were conducted by other parties and are now largely complete, thus allowing us to focus on evaluating ecological responses. Attributes of the two projects, and important differences, are presented in Table 1.

Table 1. Comparison of planned restoration projects in two 3rd-order Indiana streams

Stream	Upstream Reference	Before/After Restoration	Construction Level	Water Quality Manipulation	Fish Habitat Enhancement	Streamlength Restored
Potato Creek	Yes	Yes	Low	No	No	700
Juday Creek	Yes	Yes	High	Yes	Yes	660

Our study design has been to evaluate the streams before and after the restorations, including an unrestored reference site, with sufficient replication over time and space to draw reasonable statistical inferences about any changes in physical, chemical, or biological attributes. Physical habitat measurements have included (1) bank and riparian conditions, including bank stability, percent canopy cover, and riparian zone vegetation, (2) channel morphology, including cross-section, pool-riffle ration, sinuosity, and gradient, and (3) in-stream features, including substrate composition, discharge, velocity, temperature, and wood. Chemical measurements have included dissolved oxygen, pH, turbidity, and conductivity. Biotic variables being measured include algae (as chlorophyll and biomass), detritus (standing crop, retention, and decomposition), and fish (densities, community structure, growth, and movement). Invertebrate community structure is being studied by another graduate student at the University of Notre Dame, as a part of another project that will share information with us.

Principal Findings and Significance

The restoration of Potato Creek was delayed, and thus evaluation of that project is just now commencing. Thus, here we report preliminary findings for the restoration of Juday Creek. Juday Creek was divided into 3 reaches for evaluation: lower unrestored (reference) reach. A habitat survey of all reaches indicated that the abundance of large wood (>1 m in length and > 10 cm in diameter) increased from about 40 pieces before the restoration to over 160 pieces after the restoration (largely due to log placement during the restoration). The abundance of rootwads increased from 18 in the original channel to 40 in the restored channel. The number of debris dams remained similar at about 9 dams. After the restoration, the number of channel units also increased. The original channel consisted of 7 stream units, mostly 'runs' and only a single pool. In contrast, after the restoration, 25 channel units were found, 15 of which are either pools or riffles. Percent canopy was highest in the reference reaches at about 45% canopy cover, whereas the restored reach had approximately 15% canopy cover because of its new location. Prior to the restoration of Juday Creek, suspended sediment levels were approximately 5 mg/L at all sites. Following the restoration and installation of a sediment trap, levels drooped to below 4 mg/L in the restored reach (located below a sediment trap) while levels remained higher in the unrestored reach above the sediment trap.

Levels of benthic organic matter appeared to be similarly variable before and after the restoration, with amounts ranging from 532 to 4585 g/m². Organic matter retention is a reasonable indicator of reach complexity. Leaf and wood releases were conducted prior to the restoration to measure retention. *Ginkgo* leaf retention was 30%, 49%, and 48% while wood dowel retention was 63%, 18%, and 64% in the lower, middle, and upper reaches, respectively. Overhanging vegetation appeared to be the major retention structure in the unrestored reaches. We are currently preparing to conduct leaf and wood dowel releases to evaluate retention within the restored reaches.

Electrofishing and snorkeling provided us with initial information about fish communities. Prior to restoration, the estimated total populations of the lower reference reach, the middle restored reach, and

the upper reference reach were 52, 295, and 89 fish per 50 m streamlength, respectively. Two weeks following the diversion, fish were twice as abundant in the reference reaches than in the restored reaches, likely due to stream diversion into the new, fishless channel. The restored reach contained a total of 26 spawning redds, compared to none in the unrestored reaches, indicating immediate use of the restored reach by spawning salmonids.

Descriptors

Stream restoration, surface water quality, channelization, fish, algae, detritus, geomorphology, hydrology, habitat, siltation

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	FY 1998-99 State Water Research Institute Program
Project Number	B-01
Start Date	03/01/1998
End Date	02/28/1999
Research Category	Not Applicable
Focus Category #1	None
Focus Category #2	None
Focus Category #3	None
Lead Institution	Purdue University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Jeff R. Wright	Professor	Purdue University	01

Problem and Research Objectives

The Indiana Water Resources Research Center continues to work on the development of a distributed water resources information system known as WETnet, for Indiana Water Network. WETnet has evolved into a system used by water resources professionals and students for a variety of purposes and applications. The development of WETnet has not only focused on the design and implementation of a state-of-the-art distributed information system, but also a complete distance learning environment for use by participating organizations, students, faculty, practicing engineers and scientists, and other water resources “stakeholders” in and around Indiana.

The Center has also continued development of a comprehensive distributed database for the National Institutes for Water Resources (NIWR). Each of the 54 institutes in the NIWR responds to state and regional research, information transfer and training needs; all work closely with the national organization to meet national needs through the U.S. Geological Survey's Water Resources Institute Program (WRIP).

Through support from the Maple Point Foundation, the Indiana Water Resources Research Center coordinates the Maple Point Foundation Graduate Research Award for Women in Civil Engineering. This award is a cash award of \$5,000 given annually to a woman graduate student in the Purdue School of Civil Engineering to further the recipient’s progress toward her Ph.D. The student must be a full-time woman graduate student in the School of Civil Engineering with a clear intention of completing a Ph.D. degree at Purdue University. She must possess a record of outstanding academic achievement at the undergraduate and graduate levels, and have made significant contributions to the Purdue academic community. The student must also demonstrate that the receipt of this award will have a significant impact on her further academic and scholarly development. Special consideration is given to applicants working in areas related to water resources and environmental sensitivities, however applications from students in all areas of water related work are considered.

Methodology

Principal Findings and Significance

Descriptors

Articles in Refereed Scientific Journals

None

Book Chapters

None

Dissertations

None

Water Resources Research Institute Reports

None

Conference Proceedings

None

Other Publications

None

Basic Project Information

Basic Project Information	
Category	Data
Title	Development of a Distributed Database System for the 26th Annual Water Resources Planning and Management Conference
Project Number	S-02
Start Date	03/01/1998
End Date	07/01/1999
Research Category	Not Applicable
Focus Category #1	Management and Planning
Focus Category #2	None
Focus Category #3	None
Lead Institution	Purdue University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Jeff R. Wright	Associate Professor	Purdue University	01
German Gavilan	Student	Purdue University	02
Robert M. Wallace	Student	Purdue University	03

Problem and Research Objectives

An information system used in managing the American Society of Civil Engineers (ASCE) 26th Annual Water Resources Planning & Management Conference held in Tempe, Arizona June 6-9, 1999. This system managed information for conference organizers and participants such as:

- View all scheduled sessions. Conference papers (abstracts) are grouped into individual sessions. Each session consists of a title, moderator, schedule information (time, room assignment, etc.) and a list of papers assigned to that session
- Review abstracts submitted for the conference by searching for keywords in the title, abstract, or both title and abstract of all the papers available in the WRPMD 99 database
- Review the conference agenda, download the conference program and get information about the conference proceedings
- Links to hotel and travel information
- The ability to download the presentation instructions
- Search the participant profiles of other attendees
- Update their own personal profile
- Online conference registration
- Online hotel registration forms
- Information on featured speakers
- Information on technical tours and social events

Methodology

Principal Findings and Significance

Descriptors

Articles in Refereed Scientific Journals

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Water Resources Research Institute Reports

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Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Development of a NIWR Intranet Based on the World Wide Web
Project Number	S-01
Start Date	09/15/1998
End Date	09/14/2000
Research Category	Not Applicable
Focus Category #1	Management and Planning
Focus Category #2	None

Focus Category #3	None
Lead Institution	Purdue University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Jeff R. Wright	Professor	Purdue University	01

Problem and Research Objectives

The National Institutes for Water Resources represent a mature national network of 54 water resources research institutes at state land grant universities and colleges, one in each state, 1 district and three territories. Each institute responds to state and regional research, information transfer and training needs; all work closely with the national organization to meet national needs through the U.S. Geological Survey's Water Resources Institute Program (WRIP).

A principal strength of the national network is access to the latest water resources information through the clearing house resources of all institutes that can provide easy connection between water resources needs and expertise/research. That access might entail the latest research reports, ongoing projects, and connections to state and regional efforts. In effect, the National Institutes for Water Resources is a series of networks, beginning with a national network and proceeding to many regional, state, and local networks; all can be accessed via the national network.

A second strength of the network can be described as a water resources research analog of global diversity; that is, each institute has evolved to respond to specific state and regional contexts but maintains a general commonality with all other institutes. Sometimes this diversity can impede full access to the capability of the larger network, but it also provides a sensitivity to water resources needs unobtainable through either other federal or state programs.

This web-based system has several key attributes:

1. information provided by institutes will include material relevant to the many tasks of the institutes (national and state-based), but information entry requirements will be minimized.
2. input will be made through the extraordinary capabilities of the World Wide Web in forms that mimic the usual institute file-keeping systems,
3. output will provide reports, directories, and summaries that have been independently developed (sometimes almost duplicatively when different audiences need almost the same information) in the past but without replication of information entry and with relative ease and consistency.
4. output will include information not currently available nor easy to compile nationally because of the disparity in record keeping and computer platforms for the 54 institutes.
5. record keeping will be greatly simplified for all institutes with assurance that major reporting requirements can be more easily met than before.
6. the project is primarily aimed at meeting the various reporting requirements of the institutes, but as an additional benefit, we expect to continue national compilation of a publication database, expand our water resources expertise directory substantially, improve long-term trend monitoring of institute performance, and improve communication with the U.S. Geological Survey, the

Department of Interior and U.S. Congress. Parts of the information base may also be contributed or linked to U.S. and state agencies, institutes, and other web sites.

Methodology

This distributed information system and database for use by the institutes of the National Institutes of Water Resources (NIWR) is being developed using the client/server compute architecture of the global Internet, but accessible only by users authorized by NIWR. This system is most properly viewed as a distributed intranet. Using this system, the institutes that comprise the NIWR will be able to accomplish such things as:

- Develop and manage consistent databases of NIWR project profiles including research projects, technology transfer and educational outreach projects, and institute administration projects;
- Develop and manage consistent databases of institute publications;
- Develop and manage consistent databases of human resources affiliated with each institute including research faculty and graduate student personnel, state professional personnel and water resources practitioners, institute staff, and other members of the water resources community within the state and region served by a particular institute;
- Maintain financial information about projects of the institute;
- Access and search these collective databases consistent with established security protocols and procedures;
- Electronically construct and submit a variety of institute reports including periodic review and evaluation reports, and annual applications for recurring federal support;
- Communicate effectively about technical issues in general, and about joint institute initiatives in particular, and about internal matters pertaining to the operation of the NIWR; and
- Make available to the professional water and environmental resources community a wealth of technical information that has been developed over several decades by the NIWR, and that does so using modern information search and retrieval technologies.

Collectively, these systems and functions will provide a comprehensive framework for communication within and among the NIWR institutes that will greatly extend the impact of individual institute initiatives. As a result of this enhanced virtual interconnectivity among the institutes, our program should become considerably more valuable to the water resources community within each state to the university research communities within each state, and to water resources "stakeholders" at large. A natural extension of this system could extend to state and USGS offices, and to other appropriate governmental agencies.

Principal Findings and Significance

Descriptors

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Information Transfer Program

Basic Project Information

Basic Project Information	
Category	Data
Title	Indiana WETnet Distributed Water Information Systems Design and Development
Description	Data, information and communication
Start Date	03/01/1998
End Date	02/28/1999
Type	Library And Database Services
Lead Institution	Purdue University

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Jeff R. Wright	Professor	Purdue University	01

Problem and Research Objectives

Indiana WETnet was developed to demonstrate full Internet functionality within the context of water resources research, education, planning, management, and sustainment.

Methodology

Indiana WETnet is a data, information, and communication server accessible, via the existing electronic communications infrastructure, to anyone in the state who is interested in communicating with other interested water-related professionals, viewing or retrieving data and information, and even posting or depositing their data or information. A simplistic metaphor for WETnet would be a public domain electronic bulletin board and filing cabinet for water-related information and communication accessible to anyone with a phone-line and any model of computer. The WETnet concept is hardware and software independent and includes no capital expenditure for the communications infrastructure other than the one computer that would be the server. This computer is connected to the Internet and consequently virtually every other computer in the world that is connected to the previously described existing electronic network of computers. The WETnet server is indifferent to what type of computer or operating system that a user has to communicate with it, nor will it care what type of software generated the data that are being supplied by or to the user.

Principal Findings and Significance

An important consequence of connecting currently isolated individuals or groups to the WETnet is that they then will have access to the World Wide Web of interconnected computers and all the services and benefits that they provide. The WETnet resource will provide training and education to new users for not only how to use the WETnet, but also an introduction to the sometimes intimidating amount of information and resources that can be found on the Internet. As the Information Superhighway is developed the WETnet resource will be positioned to take advantage of its yet unknown set of functionalities and tools for the water resources community. In the process of developing the Indiana Water Resources Data Communications Plan that resulted in the WETnet prototype several exciting new questions were raised that go beyond merely setting up a protocol or method for water resources communication and information sharing. How can water resources education benefit from this new hypermedia paradigm for structuring information and developing educational materials? Can the relationship between the general public and government policy makers and agencies be improved with these new computer mediated information dissemination tools? How can water resources modelers, decision makers and researchers benefit from tools that let them share ideas, test theories, and collaboratively communicate in a virtual, graphical environment from their own distributed work place essentially in real-time? These are just a sampling of the questions that the IWRRC plans to continue this research and outreach effort with by endeavoring to answer.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

USGS Internship Program

