Illinois Water Resources Center
Annual Technical Report
FY 2005

Introduction

The Illinois Water Resources Center (IWRC) supports outreach, education and research to promote better understanding and use of Illinois water resources. In 2005, IWRC supported two research projects with state funding and monitored four projects funded with 104G money. We co-sponsored the Governor's Conference on the Illinois River and began planning the Illinois Water 2006 conference, a conference we orchestrate. We redid our web site to include easier navigation and more information as well.

IWRC continues to receive EPA funding for a regional center that provides research and other forms of technical assistance to drinking water systems in small communities. The Midwest Technology Assistance Center (MTAC) started in November 1998 and is a collaborative effort of the IWRC and nine other water resources research institutes in the Midwest and the Illinois State Water Survey.

IWRC staff members also assist in administering the research component of the Illinois-Indiana Sea Grant College Program in partnership with the University of Illinois, Purdue University and the National Oceanic and Atmospheric Administration (NOAA). IWRCs involvement in this program has increased the Centers opportunities for coordinating research activities with other water-related programs in the Midwest. Research topics include: water quality tracking, aquatic nuisance species mitigation, oyster disease, and aquaculture. Outreach topics include: aquatic nuisance species education and prevention.

Research Program

Research priorities for IWRC include: Watershed and stream protection; integrated water management for multiple users; wetland processes; and emerging issues, including other innovative research topics that are not included in the priorities above. The Center takes a special interest in helping young scientists establish a record of accomplishment in water resources research. Virtually all projects supported by the IWRC contribute significantly to the education of students, both graduate and undergraduate, who participate in the research projects.

IWRC also strongly encourages researchers in Illinois to compete for 104G funding. We have been very successful in advancing water research in Illinois through this additional funding source. In 2005, we monitored four projects funded through this source.

Estimating shallow recharge and discharge in northeastern Illinois using GIS and pattern recognition procedure

Basic Information

Title:	Estimating shallow recharge and discharge in northeastern Illinois using GIS and pattern recognition procedure
Project Number:	2004IL49G
Start Date:	9/1/2004
End Date:	8/31/2006
Funding Source:	104G
Congressional District:	15
Research Category:	Ground-water Flow and Transport
Focus Category:	Groundwater, Methods, Models
Descriptors:	None
Principal Investigators:	Yu-Feng Lin, Albert Joseph Valocchi, Randall Hunt

Publication

Problem and Research Objectives

Evaluations of water availability and the management of water resources requires quantifying the interaction between components of the hydrologic cycle, including the rates and variability of the recharge and discharge (R/D) to aquifers. These R/D rates define the relationships among groundwater, precipitation, and surface water, and thus can restrict management options for water supply. The management of water resources in northeastern Illinois is complicated by interstate agreements, hydraulically coupled aquifer systems, natural and anthropogenic contamination, groundwater / surface water interaction, and conjunctive use of multiple resources. This research is developing an automated computer software system implementing several methods of estimating and mapping R/D, apply the resulting software to improve the understanding of spatial variability of shallow R/D in northeastern Illinois, and thus address a research priority of national importance and of broad interest.

Methodology

The first task to be addressed is the development of a Pattern Recognition Utility (PRU) to identify recharge zones within noisy spatial data and estimate R/D rates for each zone. The PRU will be a graphical user interface (GUI) tool and compatible with ArcGIS 9 that implements several advanced image processing methods and couples these to the R/D estimation codes of Stoertz and Bradbury (1989), Bradbury et al. (2000), and Lin (2002). The software will be tested on a USGS internal project (Krohelski et al., 2003) in Wisconsin to determine trends (spatial and temporal) in recharge rates and investigate dominant recharge processes occurring in select undeveloped, agricultural, and urban watersheds.

After the software is successfully tested, the approach will be used to assist in the estimation and mapping of R/D for the groundwater models that are part of a water resources assessment for northeastern Illinois (Meyer et al., 2002). Previous studies for regional R/D in this region are limited and the software will be applied to estimate the R/D to the shallow aquifers within a much short preparation time than current methods.

Principal Findings and Significance

In the proposal, UCODE (Poeter and Hill, 1998) was the parameter estimation code to be used to calculate the parameter values that provide a best fit between simulated output and calibration targets measured in the field. Due to the limitation of network management algorithm in the UCODE parallel computation which can not perform efficient computation for this project, another parameter estimation code, PEST (Doherty, 2005), has been evaluated and will be used for this project. PEST is the most widely used parameter estimation code, and is currently used by USDOE, USEPA, and USGS researchers.

The software is programmed in Visual Basic using the ArcObjects environment in ArcGIS 9. In addition to the integration of ArcGIS building functions (e.g., moving average, color ramp, rate options) in our Graphic User Interface (GUI), we have also adapted a recently developed image-processing algorithm, TV+L[1]. With assistance from scientists in Department of Electrical Engineering, UIUC, we have successfully included one of the most advanced image pattern filters, which are currently applied for medical image analysis such as Magnetic Resonance

Imaging (MRI) scan. Its scale-dependent character offers users the flexibility to extract variable degrees of details according to their needs.

We are currently in the refinement stage of the software development in order to make the PRU robust. We are testing the PRU using the example sites in Wisconsin. In addition, Dr. Hunt is preparing a test of the PRU by using an alternative recharge estimation method (Dripps, 2003). After the current testing stage, we will start to apply the software for the estimation of recharge/discharge patterns and rates in Illinois.

Literature Citations/References

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Carbonaceous Material Fractions in Sediments and Their Effect on the Sorption and Persistence of Organic Pollutants in Small Urban Watersheds

Basic Information

Title:	Carbonaceous Material Fractions in Sediments and Their Effect on the Sorption and Persistence of Organic Pollutants in Small Urban Watersheds
Project Number:	2004IL52G
Start Date:	9/1/2004
End Date:	8/31/2007
Funding Source:	104G
Congressional District:	15th Illinois
Research Category:	Water Quality
Focus Category:	Non Point Pollution, Sediments, Water Quality
Descriptors:	
Principal Investigators:	Charles J. Werth, Barbara June Mahler, Peter Chapman Van Metre

Publication

1. Yang, Y., C. J. Werth, 2006, Carbonaceous material fractions in sediments and their effect on the sorption and persistence of organic pollutants in small urban watersheds in the 12th Annual Environmental Engineering and Science Spring Symposium, the University of Illinois, Urbana, IL, 49.
2. Yang, Y., C. J. Werth, 2005, Carbonaceous material fractions in sediments and their effect on the sorption and persistence of organic pollutants in small urban watersheds in the11th Annual Environmental Engineering and Science Spring Symposium, the University of Illinois, Urbana, IL, 23.

Problem and Research Objectives: Particle-associated contaminants (PACs), including chlorinated organic compounds, trace elements, and polycyclic aromatic hydrocarbons (PAHs), are an important contributor to urban non-point source pollution across the Nation. In the past decade, researchers at the U.S. Geological Survey (USGS) investigated the extent to which the contaminant concentrations and trends recorded in sediment cores were associated with suspended sediment in influent streams (Van Metre et al., 1997). Van Metre and Mahler (2004) indicated that in small urban watersheds, concentrations of some PACs on suspended sediment in influent streams can greatly exceed those in bed sediment in the downstream reservoir, and that trends may not be preserved in cores for some PACs. Their observations present a problem for effective sediment monitoring and best management practices for mitigating PAC occurrence. Although the significant loss of contaminants during transport and soon after deposition has been attributed to the solubilization of some contaminants, and the solubilization and mineralization of some solid-phase carbonaceous materials (CMs), relatively little is known about the role played by CM in the transport and fate of PACs in small urban watersheds.

The overall objective of this study is to determine how CM fractions affect the persistence of PACs, with a focus on PAHs in small urban watersheds. The specific objectives include determining the persistence of different CM fractions in sediments during suspension, sedimentation, and burial, determining the CM fractions that control the sorption and persistence of PAHs in urban reservoirs, and developing a model to predict PAH sorption to urban sediments.

Methodology: This research project consists of three phases.

Phase I: Sampling and PAC analysis. Lake Como and Lake Fosdic watersheds in Fort Worth, Texas were chosen to be urban "laboratories". Samples of lake sediments, suspended sediments and bed sediments in influent streams, soils, street dust, and parking lot dust were collected from each watershed. One split of the samples was used for PACs analysis and the determination of sediment deposition time at the USGS National Water Quality Lab (NWQL), and the other split is being used for CM fractionation, characterization, and sorption in our laboratory. Also, small amounts of Como bulk samples were sent to Tuebingen University in Germany for PAH extraction and petrographic analysis.

Phase II: Enrichment and characterization of CM fractions. All samples except suspended sediment were density separated with a sodium polytungstate solution to obtain loose particulate carbonaceous material (LPCM), occluded particulate carbonaceous material (OPCM), and the remaining humified and mineral associated fraction (HFr). Each fraction will be subject to a series of chemical and/or thermal treatment steps to obtain sub-samples enriched in different CM fractions, such as total CM, humic acid, fulvic acid, kerogen plus black carbon, and black carbon (Jeong and Werth, 2005).

Bulk samples and sub-samples will be quantified and characterized. The C/O ratio will be determined by CHN analysis, energy dispersive spectroscopy, and X-ray photoelectron spectroscopy. Surface functional groups will be analyzed with Fourier-transform infrared spectroscopy. Surface area will be determined by N_2 adsorption.

Phase III: Measurement and prediction of sorption isotherms for PACs. Sorption isotherms will be measured at 25°C using established batch equilibrium methods (Xia and Ball, 1999) with bulk samples and sub-samples, using radio-labeled phenanthrene as sorbate to distinguish spiked sorbate from background contaminants.

The sorption isotherms and the surface properties characterized in Phase II will be used to develop models to predict PAHs sorption in other sediments and to identify mechanisms that control the sorption and persistence of PAHs in urban reservoirs.

Principal Findings and Significance: Work in the past year has reached phase II and III. USGS NWQL completed PAC analysis for all Como samples and Fosdic sediment samples. For Como samples (Figure 1), results indicate that asphalt street dust in the

residential area has the lowest concentrations of PAHs, while the sealed parking lot dust in the commercial area has the highest concentrations of PAHs, i.e., three orders of magnitude higher than those in the asphalt street dust. The high PAH concentration in sealed parking lot dust agrees with the expectation that parking lot sealants may be a potential PAH source in urban watersheds (Mahler et al., 2005). For both sediment samples, PAH concentrations in the suspended sediment in the inflow stream are higher than those in the bottom sediment in the inflow stream and the lake reservoir. This observation is consistent with previous published work (Van Metre and Mahler, 2004). For most kinds of PAHs, the concentrations increase with the depth of the sediment.

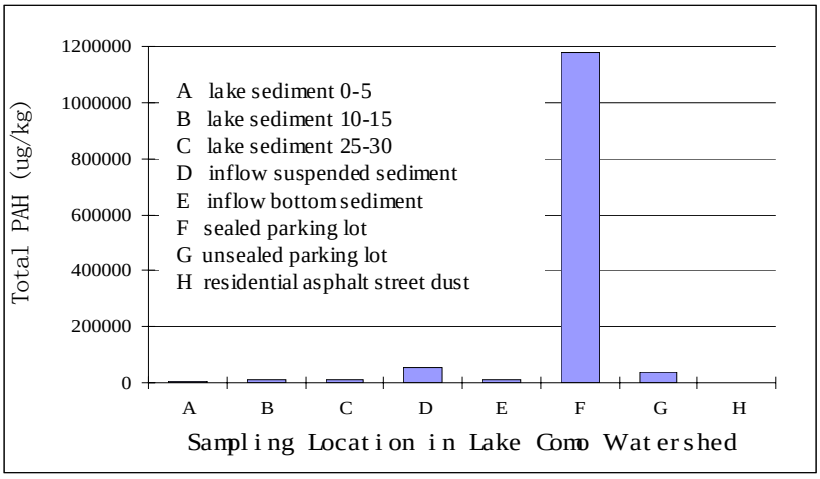

Figure 1. PAH concentrations in Lake Como Watershed

All Como samples and Fosdic sediment samples have been density separated. The fraction of HFr dominates the mass contents in bulk samples, ranging from 97.8% to 99.9% (Figure 2). The HCl treatment has been applied to all HFr samples to remove inorganic carbon. Due to the widespread limestone in these two watersheds, mass loss after this step was about 16.5-48.7%. The HCl-treated samples are being treated with HF to remove silicates and get total CM.

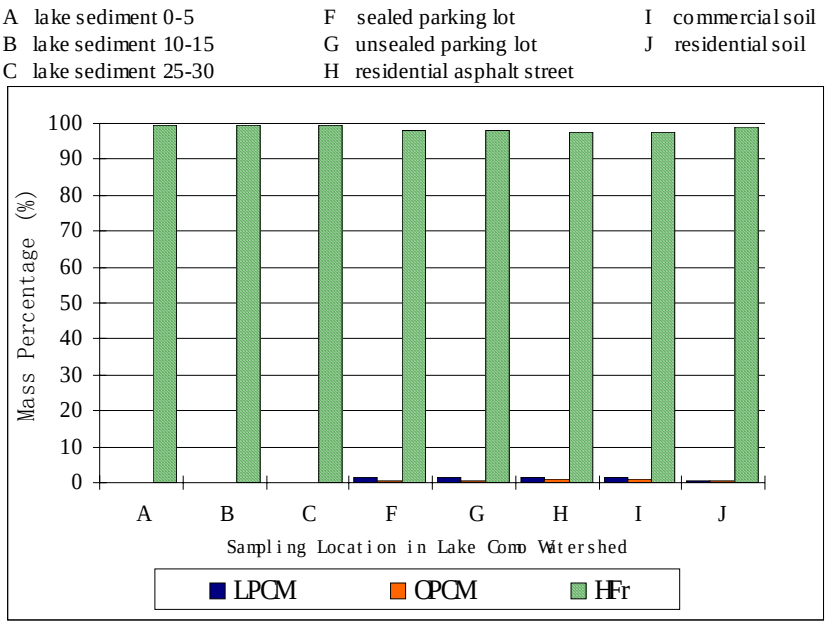

Figure 2. Mass percentages of light (LPCM, OPCM) and heavy (HFr) fractions in Lake Como Watershed

The organic carbon contents in different fractions may be correlated with different CM fractions and their properties, and will influence the sorption and persistence of PAHs. The mass percentages of OC in OPCM of Como sediment samples are about 30.4-35.6 %, higher than that of LPCM (14.3-21.4%), and much higher than that of HFr (3.6-5.0%). However, the total amount of OC is greatest in HF due to its considerable mass content.

Preliminary experiments indicate that sorption of phenanthrene to pulverized sediment and soil samples reaches apparent equilibrium in 7 days. Sorption isotherms of phenanthrene to Como bulk sediment and HFr are close to linear, with Freundlich exponents, *n*, greater than 0.91. The isotherms of the bulk samples and the corresponding separated HFr almost overlap due to the dominance of sorption in HFr. Over a wide equilibrium concentration range (1-1000 μg/L), the sorption contribution of HFr to the bulk samples range from 79.4% to 98.1%. The sorption of phenanthrene to Como bulk sediment at the medium (10-15cm) and deeper (25-30cm) depths is slightly greater than for the top (0-5cm) sediment, which may be attributed to the slightly higher OC contents in the medium and deeper sediment. A similar trend was also found with the separated HFr from bulk sediments of different depths.

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Development of Water Use Benchmarks for Thermoelectric Power Generation in the United States

Basic Information

Title:	Development of Water Use Benchmarks for Thermoelectric Power Generation in the United States
Project Number:	2004IL56G
Start Date:	7/1/2004
End Date:	8/15/2006
Funding Source:	104G
Congressional District:	Illinois 12th
Research Category:	Social Sciences
Focus Category:	Water Use, Methods, Models
Descriptors:	
Principal Investigators:	Ben A. Dziegielewski, Tom Bik

Publication

1. Dziegielewski, Ben, 2005, "Altering Water Demands of Thermoelectric Power Generation in Proceedings of the XIIth World Congress on Water Resources, November 22-25, 2005, New Delhi, India. (Published in both hard copy book and CD-ROM proceedings).
2. Xiaoying Yang and Benedykt Dziegielewski. 2005. Water Withdrawals by Thermoelectric Power Plants in the U.S. Journal of the American Water Resources Association (Approved for publication, In press for 2006).

Problem and Research Objectives
This research project aims at providing a basis for understanding water use in thermoelectric generation by developing indicators of water usage in electric power plants using different types of generation and different cooling systems.

The main focus of this project is the development of average rates of water use both as withdrawals and consumptive use per unit of generated energy, as well as unit usage rates that represent the available levels of efficiency in water use (i.e., efficiency-in-use benchmarks).

Methodology
The data for the study is obtained from the EIA 767 annual reports as well as a survey of power plants and site visits. The data on water intake and related factors is analyzed using multiple regression and stochastic frontier analyses.

Principal Findings and Significance
1. Average rates of water usage vary widely between individual plants and cooling systems depending on plant and cooling systems characteristics as well as the levels of technical efficiency in using water in the process of power generation.

2. A preliminary stochastic frontier analysis showed the estimated average technical efficiency of individual cooling systems to be 48.1 percent in once-through systems and 55.1 percent in closed-loop systems with cooling towers.

3. The results indicate that there may be a significant potential for improving technical efficiency of cooling water use in the existing power plants – both those with once-through and closed-loop cooling systems.

The Flow Dimension of Groundwater Resources in Northeastern Illinois

Basic Information

Title:	The Flow Dimension of Groundwater Resources in Northeastern Illinois
Project Number:	2005IL62B
Start Date:	3/1/2005
End Date:	2/28/2007
Funding Source:	104B
Congressional District:	15
Research Category:	Ground-water Flow and Transport
Focus Category:	Groundwater, Water Supply, Methods
Descriptors:	
Principal Investigators:	Douglas D. Walker, Albert Joseph Valocchi

Publication

1. Walker, D. D., P. A. Cello, A. J. Valocchi, and B. Loftis, 2006. Flow dimensions corresponding to stochastic models of heterogeneous aquifers, Geophys. Research Letters. vol. 33(4), L07407, doi: 10.1029/2006GL025695.
2. Walker, D. D., P. A. Cello, A. J. Valocchi, and B. Loftis, 2006. High-Throughput Computing for the Analysis of Tracer Tests in Fractured Aquifers, Illinois State Water Survey Contract Report 2006-4, Champaign, IL.
3. Cello, P. A., D. D. Walker, A. J. Valocchi, and B. Loftis, 2005. Identifying Models for the Heterogeneity of Hydraulic Conductivity in Fractured Aquifers, 50th Annual Mid West Ground Water Conference, Urbana, IL, November, 2005.
4. Walker, D. D., P. A. Cello, A. J. Valocchi, and B. Loftis, 2005. Flow dimensions corresponding to stochastic models of heterogeneous aquifers, AGU Fall Meeting, San Francisco, Dec, 2005.
5. Cello, P. A., D. D. Walker, A. J. Valocchi, and B. Loftis, 2005. The behavior of tracer tests in aquifers with noninteger flow dimensions, AGU Fall Meeting, San Francisco, Dec, 2005.

Problem and Research Objectives:
Characterizing groundwater flow and contaminant transport in fractured rock aquifers is complicated by their highly heterogeneous nature, translating into uncertainties in managing groundwater resources. An alternative approach to interpreting aquifer tests is the Generalized Radial Flow (GRF) approach, which infers the geometry of groundwater flow via an additional parameter, the flow dimension, which describes the effective flow area and how it changes with the radius of investigation. This research will elucidate the relationship between aquifer heterogeneity and the flow dimension, with the specific focus on the characteristics of fractured dolomite aquifers that are part of the groundwater resources in northeastern Illinois.

Methodology:
The principle tasks of this research are:
1. Reinterpret existing aquifer test data from ISWS archives to infer the range of flow dimensions observed for fractured dolomite aquifers in northeastern Illinois. This task will use nSIGHTS, an advanced software package created by Sandia National Laboratories for the analysis of hydraulic tests.
2. Enhance the Monte Carlo simulation to include additional statistical analyses and thus help define the relationships between the flow dimension and aquifer parameters. Determining the flow dimensions for complex models of aquifer heterogeneity requires a Monte Carlo analysis of numerical models. In collaboration with and funded in part by NCSA, the ISWS has adapted public domain programs for geostatistical simulation (GSLIB) and transient groundwater flow (MODFLOW2000) to estimate the expected value and variability of the flow dimension for an aquifer test in candidate models of heterogeneity. The computational burden of this analysis is managed through the use of the NCSA TeraGrid set of distributed computing resources.
3. Manually calibrate the parameters of candidate models until the results of the Monte Carlo simulation reproduce the observed flow dimensions.

Principle Findings and Significance:
In the first year of this two-year project, we have enhanced the Monte Carlo simulation and have used it to determine the flow dimensions of several candidate models of aquifer heterogeneity. The results indicate that the flow dimension is a useful diagnostic for selecting a model for aquifer heterogeneity and that the flow dimension is sensitive to the parameters of heterogeneity models. The results also indicate that several commonly used models of aquifer heterogeneity do not produce the flow dimensions observed in aquifer tests of fractured dolomite aquifers.

Occurrence and Ecological Effects of Pharmaceutical Chemicals in Chicago Metropolitan Area Streams

Basic Information

Title:	Occurrence and Ecological Effects of Pharmaceutical Chemicals in Chicago Metropolitan Area Streams
Project Number:	2005IL63B
Start Date:	3/1/2005
End Date:	2/28/2007
Funding Source:	104B
Congressional District:	9
Research Category:	Water Quality
Focus Category:	Water Quality, Toxic Substances, Ecology
Descriptors:	
Principal Investigators:	Emma J. Rosi-Marshall

Publication

Problem and Research Objectives

Since the 1970's, aquatic ecologists and toxicologists have become increasingly concerned with the presence of human associated contaminants in the environment. In recent years, the occurrence and effects of pharmaceuticals and personal care products (PPCP's) in our rivers and lakes have received increased attention (Kolpin et al. 2002). Significant amounts of PPCP's such as hormones, antibiotics, caffeine and antacids persist after their intended use and enter wastewater treatment facilities. Treatment facilities are not designed to remove these chemicals so they are discharged into our nation's rivers. Currently the presence of PPCP's has been detected (Kolpin et al. 2002); however, the ecological effects of these novel contaminants in surface waters have not been measured.

Metropolitan areas affect the aquatic ecosystems draining them in numerous ways, including altered hydrology, increased nutrient loading and increased exposure to contaminants such as pesticides, trace metals and organic contaminants (Paul and Meyer 2002). Recently pharmaceutical chemicals have been detected in surface waters receiving wastewater treatment (WWT) effluent in highly urbanized watersheds (Kolpin et al. 2002, Gross et al. 2004, and others). The US Geological Survey conducted a nationwide survey of surface waters and detected numerous PPCP's in Illinois streams (including hormones, caffeine, and painkillers) (Barnes et al. 2002). Given the large amounts of permitted wastewater discharged into streams draining the Chicago area, the prevalence and ecological significance of PPCP's in these streams may be high.

The goals of this project are measure the concentration of pharmaceutical compounds in the Chicago area and measure the effects of PPCP's on four major components of stream ecosystems (algae, detritus, grazers and shredders). Per advice from reviewers, we have focused our attention on measuring the effects of PCPPs in a laboratory setting, rather than measuring concentrations extensively in the field.

Our first major task was to narrow down the list PCPPs present in surface waters to a few that might affect aquatic taxa. A group of commonly used PPCP's are H_2 histamine receptor antagonists. Histamine is a neuroactive amine found in the nervous systems of animals from diverse phyla (Hashemzadeh-Gargari and Freschi 1992). In humans, H_2 histamine antagonists are commonly used for the treatment of acid related gastrointestinal conditions. The H_2 antagonist reduces acid stimulation by competitively binding to parietal cells in the stomach. Since the introduction of the first of H_2 antagonist in 1967, the effects on mammals has been well documented. Cimetidine HCl (Tagamet®) continues to be one of the most commonly used H_2 antagonists today. Consequently, an estimated maximum concentration of cimetidine found in 84 samples from U.S. streams was 0.58µg/L (Kolpin et al. 2002). Although invertebrate histamine receptors have not been widely studied, research has shown histamine to be a regulator in invertebrate functions. Histamine stimulates pyloric rhythm and gastric mill rhythm in the stomatgasric nervous system of the crab (*Cancer borealis*) and these actions were blocked by cimetidine (Christie et al. 2004). This research has provided valuable knowledge into the neurological effects of cimetidine on invertebrates.

In addition, we are also examining the effects of the generalized anti-microbial agent, Triclosan, a popular antimicrobial and antifungal agent found in consumer products ranging from dish soap to toothpaste to makeup, on microbial communities and litter decomposition. Triclosan

is classified as a specific biocide; it functions by a physical-chemical mechanism that targets a specific biochemical pathway in bacterial and fungal cells. Triclosan was found to have a concentration of 0.14 ugL^{-1} in a recent US Geological Survey (Kolpin et al 1999). Triclosan targets the fabI protein Enoyl-acyl protein Reductase, blocking the synthesis of lipids in cells (McMurry 1999). As lipid synthesis is critical for the integrity of the cell membrane and for cell replication, Triclosan ultimately causes lysis of cells (McMurry 1999).

Methodology

In order to adequately assess exposure concentrations to contaminants in a laboratory experiment, effective analytical chemistry to measure compounds is essential. We have been developing a high-performance liquid chromatography (HPLC) method to extract and detect pharmaceutical compounds in water samples (cimetidine method is complete and successful and triclosan in development). The input of PPCP's is continual via WWT effluent, but it is not known how long these compounds persist in aquatic ecosystems. We are currently employing these analytical techniques to measure the concentrations of compounds in the artificial streams and are analyze Chicago area surface waters for cimetidine to put our results in context.

Instantaneous growth and mortality experiments have been performed using the pharmaceutically active compound cimetidine. Chironomids were collected and then exposed to 0.07 µg/L, [x10], [x100], [x1000] and [0]. Organisms were placed in an incubator for 1 week under controlled conditions, and then growth and mortality were analyzed. Microbial communities have been used to measure the effects of Triclosan, another PPCP found in Illinois Rivers. To determine the ecological impact of Triclosan, I incubated leaves (source of microbes) with concentrations of 0.14 µg/L, [x10], [x100], [x1000] and [0]. Microbes were incubated in LB agar with the same concentrations.

The artificial stream facility has been set up with 48 recirculating streams of 4 meter length. Each stream contains unglazed clay tiles to measure algal growth, leaf packs to measure decomposition, and two species of aquatic invertebrates. The streams are currently being used to look at the effects of cimetidine on stream ecosystems. This experiment is ongoing and will last 4 months. In the fall, a similar experiment will be started looking at the effects of triclosan on the decomposition pathways in stream ecosystems.

We are also conducting some fieldwork in the Chicago area, mainly to collect specimens for our laboratory experiments. In addition, we are striving to put our laboratory experiments in context, i.e., to determine if the endpoints we observe in the artificial streams are occurring in the field. The sampling sites focus on proximity to three major waste water treatment facilities in the Chicago area including Stickney, North Side and the Kirie Water Reclamation Plants. 10 established sampling sites have varying degrees of urbanization and inputs of waste water treatment effluent. At these sites, a number of Loyola University Chicago supported undergraduate research projects are being conducted in conjunction with this research.

Principal Findings and Significance

A growth and mortality experiments have been done using cimetidine and aquatic invertebrates. These results showed increased concentrations of the pharmaceutical compound had significant effects on the mortality rates of the test organisms. Cimetidine is an H2 histamine antagonist and has been detected in Illinois streams (Kolpin et al. 2002). The continual input of cimetidine and other PPCP's could affect mortality of and growth rates aquatic invertebrates in

the Chicago area and areas downstream. We are using the concentrations measured in this small-scale experiment to guide our artificial stream experiment. We are also conducting a growth experiment within the artificial streams using caged invertebrates suspended in the cimetidine dosed water to confirm these findings.

The triclosan study showed that increasing triclosan concentrations lead to increased variation in microbial respiration. The concentrations of triclosan measured in US surface waters did not affect microbial respiration or microbial growth rates; however, this research is ongoing. We are also currently collaborating with Dr. John Kelly (Loyola University Chicago Microbial Ecologist) to examine if there is an effect of triclosan on microbial community composition. We are supplying Dr. Kelly with the sediment samples from the artificial stream experiment to enhance what we can learned from these experiments.

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Barnes, K.K., D.W. Kolpin, M.T. Meyer, E.M. Thurman, E.T. Furlong, S.D. Zaugg, L.B. Barber. 2002. Water-Quality Data for Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, U.S. Geological Survey Open-File Report, 92 pages.

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Development and Validation of a 3D Coupled Hydrologic-Biogeochemical Model for Evaluation of the Impact of Water-Table Management on Nitrate Loads from Tile-Drained Agricultural Fields

Basic Information

Title:	Development and Validation of a 3D Coupled Hydrologic-Biogeochemical Model for Evaluation of the Impact of Water-Table Management on Nitrate Loads from Tile-Drained Agricultural Fields
Project Number:	2002IL7G
Start Date:	9/1/2001
End Date:	5/31/2006
Funding Source:	104G
Congressional District:	15th
Research Category:	Water Quality
Focus Category:	Nitrate Contamination, Non Point Pollution, Solute Transport
Descriptors:	
Principal Investigators:	Robert J. Hudson, Albert Joseph Valocchi

Publication

1. Feng Yue, A.J. Valocchi, R.J. Hudson, 2004, Physically-based 3D hydrologic conjunctive modeling of water flow in tile-drained agricultural fields in Groundwater Quality 2004 Proceedings, 4th International Conference, University of Waterloo, Ontario, Canada.

Problem and Research Objectives

One of the most promising approaches to minimizing nitrate export to rivers draining agricultural watersheds is water table management, or controlled drainage. The Illinois District of the USGS has conducted a field pilot study of the benefits of controlled drainage at an active farm in east-central Illinois. Two adjacent 40-acre plots, one with tile management and the other without, have been instrumented for collecting a variety of data. Modeling is required to fully interpret the field data and to extend the results to conditions on other farms.

The project involves developing and applying sophisticated simulation models to properly quantify the hydrologic and nitrogen cycle fluxes on such sites. Fully 3-D models of subsurface flow and nitrogen processes will be necessary in order to simulate both surface runoff/runon and subsurface flow between the adjacent managed/conventional plots. This will allow us to properly analyze the field data and assess the environmental benefits of water table management.

Methodology

We have been combining two different modeling approaches in order to interpret data previously collected by USGS researchers from the paired set of agricultural fields with and without controlled subsurface drainage.

For hydrologic analysis, we have employed a 3-dimensional model with accurate topography to simulate both surface runoff/runon between the fields and subsurface flow between the two halves of the study sites. These results are being combined with water budgets over both short and long time periods in order to characterize the water fluxes at the site.

For nitrogen cycle modeling, our initial plan was to employ the DRAINMOD model and develop a new model for in studying the field sites, but we have chosen instead to focus on an established model (DSSAT) with excellent and soil and plant process representations. Automatic calibration using the University of Arizona Shuffled-Complex Evolution algorithm has been employed to obtain optimal parameters for Illinois conditions and develop means of predicting N mineralization for sites based on simple soil N test results.

Principal Findings and Significance

3-D Physical Model Development and Testing: Following our previous work updating the hydrologic code in the CHM3D model, further tests of its suitability for application in this study were conducted. The relatively fast Alternating-Direction-Implicit method (ADI) was employed to solve the system of coupled differential equations. We found that the accuracy of ADI is limited to extremely small time steps (~10^{-3} s) when solving variably-saturated subsurface flows. Although the ADI method is known to be reasonably accurate in solving parabolic differential equations, those equations usually contain small diffusion coefficients. The subsurface flow equation is not such a case because the presence of specific storage coefficients on the order of 10^{-6} can results in large "diffusion" coefficients. If large time steps are employed, the numerical results with ADI showed strong artificial orientation errors when compared with the analytical solutions of some example problems. We believe this type of error is common the whole family of directional splitting methods. Therefore, in the future we would consider applying another robust numerical solver in the CHM3D model that aims at long term flow simulations.

Hydrologic Modeling of the Ford County Field Site: Hydrologic modeling efforts for the Ford County drainage site include: i) inspection of the field data, ii) analysis of water budgets, and iii) numerical simulations carried out with the integrated hydrology model HydroGeoSphere.

i) *Inspection of the Data:* The hydrologic data provided by the USGS were compiled and inspected for problems. The main problem that we are aware of is that during some periods, some drainage tiles became full, rendering the flow meter readings invalid. Alternate means of estimating flows are being examined.

ii) *Water budgets*: As an example water budget, we present here results over one time period that we carefully analyzed – Oct. 11-Nov. 14, 2001. The main terms in the budget include precipitation (15.4 cm), evapotranspiration (7.6 cm), drainage discharge (7.7 cm) and soil water storage change (<~2.5 cm), which are balanced to within the margin of error. The cumulative depth of water discharged from the managed side of the field was twice that of the unmanaged side. We are currently pursuing explanations of this counterintuitive result.

iii) *Modeling*: To generate the finite element mesh for the field site, actual topography data were used and all 16 tiles were given a uniform slope and diameter. Simulations were generated for a part of the period of the water balance above. The initial groundwater table was set right below the tile lines and the subsurface boundary fluxes were assumed to be zero everywhere except at tile drain outflow nodes. The critical depth boundary condition was used over the entire surface domain. To make calibration tractable, a uniform set of soil physical properties was employed. The simulated tile discharges from the conventional and controlled fields match the timing of the observed data reasonably well, but tends to underestimate the flow peaks in both fields.

Nitrogen Cycle Modeling of the Ford County Field Site: Nitrogen cycle modeling efforts at the Ford County drainage site include: i) inspection of the field data and ii) preliminary field N balances.

i) *Inspection of Data:* The chemistry and flow data received from the USGS include nitrate, nitrite and dissolved phosphorous concentrations. Due to gaps in flow and N data records, it is difficult to accurately quantify fluxes from the site. Unfortunately, the data on fertilizer inputs and crop yields were not available due to difficulties in communicating with the owners of the field site. To enable us to estimate the input of inorganic nitrogen to the field via mineralization of organic matter, we measured labile organic N for 120 samples collected from the field. The labile organic N was measured using the new Illinois Soil Nitrogen Test.

ii) *Preliminary N Balance*: While N export via tile discharge is considerably lower in the managed field, it is likely that subsurface export from the managed field added to the conventional field fluxes of water and nitrate. Our final N balance is pending.

Plant-Soil Model Calibration: A critical part of modeling the effects of water table management on nitrogen fluxes is determining how it affects crop growth and soil N mineralization. Thus, we began working with a well-established plant-soil model (DSSAT). First, the model code was adapted for use in tile-drained fields by incorporating Hooghoudt's equation into the hydrology subroutines. Next, we employed automatic calibration by a genetic algorithm (SCE-UA) to determine optimal parameter values for simulating N mineralization and organic matter decay. We found a significant correlation between the quantity of N in the model's "slow SOM" pool (R^2=0.70, P<0.001) and ISNT measurements in fields where fertilizer rate studies had been conducted. This relationship can be used to develop strong constraints for model calibration at sites where N-rate trials have not been conducted, perhaps even permitting direct estimation of the initial magnitudes of the model N pools from ISNT and total soil C and N measurements. In other words, we expect to be able to accurately

predict net mineralization of soil organic N for the Ford County field site by combining the model and ISNT measurements that we have obtained.

Significance: We expect that our final results will show that accounting for losses of N via subsurface flow from fields with water table management will be important for assessing their net environmental impact.
In addition, we have developed methods of estimating net mineralization of N in fields by combining measurements of a labile soil N fraction (ISNT) with automatic calibration of a dynamic simulation model (DSSAT). Such results will be highly useful for managing fertilizer application rates in a way that reduces N losses to the environment impacts.

Rapid Solar Phototransformation of Nutrients in Natural Waters

Basic Information

Title:	Rapid Solar Phototransformation of Nutrients in Natural Waters
Project Number:	2005IL159B
Start Date:	3/1/2003
End Date:	12/31/2005
Funding Source:	104B
Congressional District:	15th
Research Category:	Climate and Hydrologic Processes
Focus Category:	Water Quality, Geochemical Processes, Surface Water
Descriptors:	
Principal Investigators:	Gary Peyton

Publication

PROBLEM AND RESEARCH OBJECTIVES - Solar irradiation of natural organic material (NOM) or nitrate can generate reactive species that cause transformation of nitrogen nutrients between forms such as organic nitrogen, nitrate, and ammonia, providing significant sources and sinks for the individual nutrient forms such as ammonia. Recognition of these contributions may impact the setting of water quality standards and best management practices for nutrients, as well as nutrient modeling and even sampling for analysis. The objectives of the project were to 1) measure the photogeneration of ammonia in several Illinois waters, 2) identify important transformation pathways, 3) identify potential impacts of these pathways, and 4) derive models for the process rates in terms of water quality parameters, which may be suitable for adaptation into water quality models.

METHODOLOGY - Photoammonification rates were measured in water samples brought to the laboratory, by irradiating them with simulated solar light and measuring ammonium formation. Ammonia evolution (vs time) was compared for samples taken during different seasons over two years to determine dependence on season and water quality. Possible pathways were identified by two types of experiment: 1) model sensitizers (sources of reactive species) irradiated in solution with model ammonia precursors that mimic various nitrogen functional groups known to be present in NOM, in order to determine which combinations lead to ammonia production, and 2) water samples spiked with sensitizers or model precursors and irradiated, to determine which may be present in the waters, and which component is the limiting factor in ammonia production. This information, along lamp emission and water absorbance spectra, water quality data, and published rate constants and quantum yields, was used to help determine which pathways might be responsible for ammonia photoproduction.

PRINCIPAL FINDINGS AND SIGNIFICANCE

Photochemical Ammonia Production in Natural Waters **-** Work was focused on three local waters (Homer Lake=HL, Collins Pond= CP, and Salt Fork River=SF) because of their differences in water quality and watershed, their close proximity, and variability throughout the year. For consistency, a UV/visible lamp was used for irradiation of the 0.2 µm-filtered samples in the laboratory. Ammonium formation occurred in almost all cases, with increases of 10% to 400% observed within 1-2 hours. This implies that the amount of ammonia measured in some environmental samples may depend significantly on previous sunlight exposure, i.e., time of day. The initial ammonia concentration, extent of production, and evolution curve shape for all fresh samples changed throughout the year, with no obvious seasonal dependence. Stored samples also changed, even when stored at 4^{o} C after microfiltration.

The curve shape for ammonia evolution should provide information about the process. Ammonia production requires a photosensitizer to produce reactive species, which then reacts with an ammonia precursor (a nitrogen-containing

functional group in the NOM) to produce ammonia. If both sensitizer and precursor are present, ammonia production should begin immediately and proceed until sensitizer or precursor has been exhausted. A delay in ammonia production indicates that sensitizer or precursor must be produced before ammonia can be generated. For the 17 photoammonification experiments on freshly collected local waters, 9 showed immediate, 5 delayed, and 3 very low ammonia production. Vegetation types in the watersheds matched expected C/N ratios for the waters, but no correlation with predominant curve type was noted.

Mechanisms of Ammonia Photoproduction - Reactive species investigated (see Table) were narrowed to 1) hydroxyl radical to represent free oxy-radicals such as hydroxyl, peroxyl, carbonate radical, 2) benzo-phenone to represent triplet states from aryl ketones, 3) and benzoquinone, to represent excited quinones and semiquinone radicals. Singlet oxygen was shown by competition calculation to be completely quenched by water, and was not considered further. The Iron concentration was too low to account for the observed reactions rates.

Nitrogen-containing functional groups known to be present in NOM includeamines, amides, and pyridine functionalities (including amino acids and ureas). Model compounds representing these precursor groups are listed in the Table, along with results obtained, where + and ++ denote possible and definite ammonia production or enhancement of ammonia production, and a minus sign indicates that no effect was observed. Only a trace (tr) amount of ammonia was formed by the reaction of hydroxyl radical with acetamide, but with diethylamine, ammonia production is almost quantitative. The benzophenone triplet excited produced ammonia from all but the pyridine or solutions of reconstituted Suwannee River Humic Acid (SRHA), and benzoquinone produced ammonia from all but Salt Fork River water. Parentheses indicate uncertainty.

The results show that 1) amides such as urea are probably not responsible for ammonia production, whether present in NOM or washed from the soil, 2) nitrate as a sensitizer could be responsible in some cases and not others (data not shown), 3) NOM sensitizers could produce ammonia from amines and amino acids, and NOM nitrogen functional groups could be converted to ammonia by OH radical, excited aryl ketones, and in some cases (but not all) quinones, 4) delayed ammonia evolution and enhancement of NOM by either added sensitizer or precursor indicated missing or multiple sensitizer/precursors, respectively.

Kinetic Analysis of Data – New information was presented at the 2005 Pacifichem conference, which indicates that charge-transfer complexes may in part be responsible for the photochemistry of NOM. If true, this implies that the photochemical kinetic calculations must be approached differently than the traditional isolated functional group chromophore model. This is currently being investigated for our system.

				Natural

Precursor Type	Reactive Species / Model Compound	Oxidizing Radical: OH radical (H_2O_2/UV, nitrate)	Aryl Ketone Triplet: benzophenone	Quinone Triplet and Semiquinone: benzoquinone	Waters (NOM, nitrate): HL, CP, SF, SRHA
Amine	**diethylamine**	+ +			H
	ethylamine	+ +	+ +	+ +	S
Amide	**acetamide**	tr	(-)		
	urea		tr	tr	-S?
Pyridine	**nicotinic acid**	+ +	- -	+ +	
Amino Acid	**Methionine**	+ +			H, C, S
NOM	**Homer Lake**	+ +	+ +	+ +	+ +
	Collins Pond	+ +	+ +		+ +
	Salt Fork R.	+ +	- -	(-)	+ +
	SRHA		+ +	(+)	+ +

Information Transfer Program

A major function of the Illinois Water Resources Center is to oversee a research program and convey the results of research and development within the water resources field to water professionals and the interested public. Information transfer is accomplished through workshops, conferences, published proceedings, a website, and maintenance of a library of Illinois Water Resources Center reports and videotapes. In addition, the IWRC staff sit on many advisory committees and planning groups and provide council to local, state and national officials.

Governor’s Conference on the Illinois River

Basic Information

Title:	Governor’s Conference on the Illinois River
Project Number:	2004IL130B
Start Date:	11/1/2003
End Date:	11/1/2005
Funding Source:	104B
Congressional District:	15th
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	conference, education, outreach, Illinois River
Principal Investigators:	Lisa Merrifield, Jennifer Fackler

Publication

1. Fackler, Jennifer, ed., 2005, Governor’s Conference on the Illinois River Abstract Book.
2. Fackler, Jennifer, ed., 2005 Governor’s Conference on the Illinois River Proceedings.

In 2005, IWRC co-sponsored the Governor's Conference on the Illinois River by preparing the abstract book in advance of the conference and the proceedings at the conclusion of the conference.

This conference began in 1985 when a group of concerned scientists, citizens and river activists began to focus new attention on the growing problems of sedimentation and erosion along the Illinois River and its tributaries. Over the past twenty years, conference attendance has grown from 150 to over 350 participants who represent a diversity of backgrounds, agencies, organizations, and communities. The Governor's Conferences on the Management of the Illinois River System have served as an important forum to bring together local, state, and federal leaders to create awareness of the problems of soil erosion and sedimentation, identify important river research initiatives, develop working coalitions, apply conservation practices to the watershed, prepare new river and watershed legislation, and provide for state and federal funding to address the problems of the Illinois River system. The foundations for the following programs can be directly attributed to successful interagency and multi-disciplinary cooperation, fostered at the Governor's Conference on the Illinois River System and subsequently implemented at the local, state and federal level.

The 2005 conference was attended and opened by the Illinois Lieutenant Governor and include a meeting of the state run Illinois River Coordinating Council. Sessions include updates from federal and state leaders, volunteer stewardship, wetland restoration, watershed planning, tourism, monitoring, sediment removal, technology, economic development, and more. A pre-workshop conservation tour took participants along the Illinois River from Peoria to Hannepin, Illinois. Tour participants explored the features of the Illinois River Valley, including recreational resources, historical cultural resources, backwater wetland restoration and aspects of a working waterway.

Midwest Groundwater Conference

Basic Information

Title:	Midwest Groundwater Conference
Project Number:	2004IL131B
Start Date:	1/1/2004
End Date:	11/1/2005
Funding Source:	104B
Congressional District:	15th
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	conference, groundwater, illinois
Principal Investigators:	Lisa Merrifield

Publication

The IWRC program specialist serves on the planning committee for the Midwest Ground Water conference to be held in November in Urbana, Illinois. IWRC contributes conference planning knowledge, budget information and other expertise to this effort.

2007 Governor's Conference on the Illinois River

Basic Information

Title:	2007 Governor's Conference on the Illinois River
Project Number:	2005IL154B
Start Date:	10/1/2005
End Date:	12/1/2007
Funding Source:	104B
Congressional District:	15th
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	conferences, outreach, Illinois River
Principal Investigators:	Lisa Merrifield, Jennifer Fackler

Publication

IWRC is again serving as a co-sponsor and on the planning committee for the Governor's Conference on the Illinois River. In 2005 we attended meetings as plans got underway for the 2007 meeting. We also committed to compiling the abstract book and the proceedings prior to and just after the conference, respectively.

This conference began in 1985 when a group of concerned scientists, citizens and river activists began to focus new attention on the growing problems of sedimentation and erosion along the Illinois River and its tributaries. Over the past twenty years, conference attendance has grown from 150 to over 350 participants who represent a diversity of backgrounds, agencies, organizations, and communities. The Governor's Conferences on the Management of the Illinois River System have served as an important forum to bring together local, state, and federal leaders to create awareness of the problems of soil erosion and sedimentation, identify important river research initiatives, develop working coalitions, apply conservation practices to the watershed, prepare new river and watershed legislation, and provide for state and federal funding to address the problems of the Illinois River system. The foundations for the following programs can be directly attributed to successful interagency and multi-disciplinary cooperation, fostered at the Governor's Conference on the Illinois River System and subsequently implemented at the local, state and federal level.

Illinois Water 2006 Conference

Basic Information

Title:	Illinois Water 2006 Conference
Project Number:	2005IL155B
Start Date:	10/1/2005
End Date:	11/1/2006
Funding Source:	104B
Congressional District:	15th
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	conference, education, outreach, Illinois water
Principal Investigators:	Lisa Merrifield, Jennifer Fackler, Stephanie Lage, Phil Mankin, Richard Warner

Publication

Beginning in 1998, the Illinois Water Resources Center has hosted the biennial Illinois Water conference. Drawing approximately 250 people, the conference focuses on Illinois water resource issues, scientific discoveries, social and cultural realities and outreach and education. The conference targets researchers, government officials, concerned citizens and students over two days of panel discussions, technical sessions and poster presentations.

In 2005, IWRC convened the Water 2006 planning committee to begin preparations for the 2006 conference. The committee determined that "Preparing for the Future" would be the conference theme and all sessions would look towards how we should apply the state of the science and practice to meet future demands. The keynote speaker will be Charles Howe. Howe, Ph.D., Stanford University, is a retired professor of economics at the University of Colorado - Bolder. He was the Chair for the National Research Council Committee on Privatization of Urban Water Services for three years and President for the Association of Environmental and Resource Economists for two years. He received the Warren A. Hall Medal of the Universities' Council on Water Resources for Distinguished Contributions to the Field of Water Resources in 2003 and Friends of UCOWR Award in 2000 along with many other awards. He will speak on the state of global water resources.

Themed sessions will include:

- Water supply and planning
- Emerging issues in human health and aquatic ecosystems
- Challenges facing Lake Michigan water management
- Data needs for water planning

Papers were invited for technical and poster sessions. A student career panel will also give students a glimpse of what water professionals really do. Student paper and poster presenters will compete for awards as well.

The conference will be held on October 3-5, 2006 in Urbana, Illinois.

IWRC Web Site

Basic Information

Title:	IWRC Web Site
Project Number:	2005IL156B
Start Date:	1/1/2005
End Date:	1/1/2011
Funding Source:	104B
Congressional District:	15th
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	web site, outreach, education
Principal Investigators:	Jennifer Fackler, Lisa Merrifield

Publication

1. Fackler, Jennifer, ed., 2006, Illinois Water Resources Center Web Site, www.environ.uiuc.edu/iwrc.

IWRC maintains a web site with news, publications, requests for proposals and other information of interest to the water resources community in Illinois. In 2005 we undertook a major site redesign which ensures that the information is up to date and presented in the most accessible and attractive format possible.

Menu items on the site include:

Center information – this section describes our operational and funding structure, staff, and other details about IWRC.

News and Announcements – in this section we list upcoming events, news headlines of interested to water professionals, and other time sensitive information.

Call for Proposals – we provide information about state and national funding on this page.

Publication – IWRC has over 200 research publications and almost 40 special publications available. We are currently working to make our publications available electronically to make access even easier.

Research – current, past and future research projects are briefly described here.

Conferences -- this page contains details about our biennial Illinois Water conference.

Kids – we provide links to various water-related resources for kids in Illinois.

Contact Us -- quick contact information, including our physical address, phone numbers and email addresses.

Links – these are links to water-related sites that might be useful to water resource professionals in Illinois.

IWRC Newsletter

Basic Information

Title:	IWRC Newsletter
Project Number:	2005IL157B
Start Date:	1/1/2005
End Date:	1/1/2011
Funding Source:	104B
Congressional District:	15th
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	newsletter, education, outreach
Principal Investigators:	Lisa Merrifield, Jennifer Fackler, Phil Mankin, Irene Miles

Publication

1. Miles, Irene, Jennifer Fackler, Lisa Merrifield, eds., Fall 2005, Illinois Water Resources Center Newsletter.

Each fall, IWRC produces a newsletter detailing our activities over the past year. We focus on research findings and funding, upcoming events, and other items of interest to water professionals in Illinois. Articles in the 2005 issue included:

- A profile of University Council on Water Resources dissertation award winner, Kara Sorenson;
- Upcoming research projects focusing on the Chicago metro area;
- A water security workshop hosted by partner agency, the Midwest Technology Assistance Center;
- The Governor's Conference on the Illinois River; and
- The Illinois Water 2006 conference.

The newsletter is sent to approximately 700 people around the state. Recipients include state and local government officials, concerned citizens, business and industry representatives, academics, students, and non-governmental organizations. State and national legislators also receive a copy of the news letter.

Midwest Technology Assistance Center

Basic Information

Title:	Midwest Technology Assistance Center
Project Number:	2005IL158B
Start Date:	1/1/2005
End Date:	1/1/2011
Funding Source:	104B
Congressional District:	15th
Research Category:	Water Quality
Focus Category:	Water Supply, Water Quantity, Water Quality
Descriptors:	small water systems, Midwest
Principal Investigators:	Richard Warner, Jennifer Fackler, Phil Mankin, Lisa Merrifield

Publication

1. Lau, Boris L. T., Gregory W. Harrington, Marc. A. Anderson, 2006, Arsenic and Bacteriophage MS2 Removal from Groundwater by Nanoparticulate Aluminum Oxide Coated Granular Filter Media: A Pilot-Scale Evaluation on the Effect of pH and Coating Density, Illinois State Water Survey, (FS06-01).
2. Moore, Michelle, 2006, Chlorine's Effect on Corrosion in Drinking Water Systems, Illinois State Water Survey, NDWC, Tech Brief #3, Item # DWBRPE52.
3. Winstanley, Derek, James R. Angel, Timothy P. Bryant, H. Vernon Knapp, Michael A. Palecki, Amy M. Russell, H. Allen Wehrmann, 2006, Drought Planning for Small Community Water Systems, Illinois State Water Survey,(FS06-02).

IWRC helps support the Midwest Technology Assistance Center for Small Public Water Systems (MTAC). MTAC cooperates closely with other regional technology assistance centers established by the USEPA, and with other partner agencies and organizations in order to ensure efficient response to the highest priority needs of small public water systems and Indian Tribal systems in the Midwest.

In 2005, MTAC conducted a number of trainings and workshops. Among them was a workshop on using sensor technology to monitor small water systems quality and quantity. Approximately 20 people from the senor technology and Technical Assistance Center communities attended the two day event and contributed to an interactive web site.

Over the last year, MTAC staff members have written fact sheets based on the findings of funded research. Fact sheets include:

> Arsenic and Bacteriophage MS2 Removal from Groundwater by Nanoparticulate Aluminum Oxide Coated Granular Filter Media: A Pilot-Scale Evaluation on the Effect of pH and Coating Density (FS06-01)
>
> Chlorine's Effect on Corrosion in Drinking Water Systems Drought Planning for Small Community Water Systems (FS06-02)

Outreach Projects conducted by MTAC include:

> Testing of Vulnerability Assessments & Emergency Response Plans, ERTC SIU Edwardsville
>
> Cross-Connection Control for Small System Administrators, ERTC SIU Edwardsville
>
> Groundwater Resource Assessment for Small Communities, ISWS
>
> Non-Community Water System Compliance to the New Arsenic Rule, ISWS

Competitive Grants and Applied Research conducted in 2005 included:

> Watershed Modeling to Evaluate Water Quality at Intakes of Small Drinking Water Systems, ISWS/U of I
>
> Technical, Managerial, and Financial Capacity Measures in an Assistance-Oriented Approach to Comparative Performance of Small Drinking Water Utilities, Ohio State University National Regulatory Research Institute
>
> Development of Low-Cost Treatment Options for Arsenic Removal in Water Treatment Facilities, ISWS/U of I

Chemical Addition for Arsenic Removal, ISWS/U of I

Microcosm Experiments for Arsenic Solubility Determination, ISWS/U of I

Time Series Sampling and Resampling Facilities with High Particulate Arsenic to Evaluate the Variability of Arsenic Concentration Small Community Water Supplies, ISWS/U of I

Assessment of the Needs, Requirements, and Available Tools for Drought Planning for Small Public Water Systems in Midwest, ISWS/U of I

Continuing Education to Support Smaller Water Systems Assessment, U of I

Improved Monitoring for Safe and Secure Water Supplies: An Integrated Approach to Emerging Monitoring Technologies, U of I

Building Technical, Financial, and Managerial Capacity for Small Water Systems: Consolidation, Partnership, and other Organizational Innovations, U of I

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	0	2	3	0	5
Masters	0	4	3	0	7
Ph.D.	0	7	0	0	7
Post-Doc.	0	0	0	0	0
Total	0	13	6	0	19

Notable Awards and Achievements

An IWRC nominated student won the University Council on Water Resources prestigious PhD Dissertation award. This is the third student nominated by IWRC to win the award in as many years.

Publications from Prior Projects