

**Illinois Council on Food and Agricultural Research (C-FAR)**  
**Strategic Research Initiative (SRI) in Water Quality**  
**Final Report**

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**Executive Summary**

The Water Quality SRI has undergone significant changes since the original two-day workshop (February 19 and 20, 1998) when researchers and industry leaders were invited to help define a water quality research program. The original discussion outlined a wide range of issues that included watershed management, microorganisms in drinking water, pesticide contamination, sediments, and nutrients. Although all are important water quality concerns, funding constraints made it necessary to pursue a more focused approach.

Agriculture continues to be identified as the primary source of impairment for rivers, streams, and lakes. Further, nutrients are often cited as the leading cause of impairment. As the SRI matured, concern over nutrients emerged as the priority water quality issue facing Illinois agriculture. The initial goal of the Water Quality SRI was to reduce nitrogen and phosphorus loads in Illinois waterways, while the stated mission was to identify cost-effective approaches for improving Illinois' water quality.

Previous SRI Leaders, Dr. Jim Westervelt, Dr. Derek Winstanley, and Dr. Mike Hirschi developed the organizational structure and plan for addressing this research need. Much of this report is based on their efforts.

The Water Quality SRI is organized into three integrated components. The ***Best Management Practices (BMP)*** group seeks to identify practices that reduce nutrients in water resources, and evaluate these practices from agronomic, economic, and environmental perspectives. The ***Mass Balance*** group works to understand the sources and movement of nitrogen through Illinois watersheds. The ***Modeling*** group is developing and employing models at the state, watershed, and field scales that may help predict consequences of alternative land management and agronomic practices. A fourth component, ***Outreach***, was intended to make research results readily available to stakeholders and to provide information to policymakers, the agriculture community, and Illinois citizens about possible solutions to water quality concerns in Illinois.

Although each group was self-managed, efforts were made to link to the other teams. A comprehensive web site (<http://web.aces.uiuc.edu/sriwq>) was developed that detailed individual projects, budgets, progress reports, and outcomes. An advisory committee, that included Susan Adams, Mark David, Mike Demissie, Mike Hirschi, Robert Hoefl, and Steven Kraft, was formed to help guide the process, and organize the three research teams. Robert Hoefl served as the leader for the BMP group, Mark David was the leader for the Mass Balance team, and Mike Demissie was the lead for the modeling component.

The Water Quality SRI included over 55 scientists, graduate students, and technicians from several universities and scientific surveys that collaborated on 28 different projects. The

following summaries will only briefly discuss these projects. Although projects are identified only by one principal investigator, most projects involved a team of scientists. A more comprehensive summary will be produced after all the projects are complete.

### **Best Management Practices (BMP)**

An experiment designed to evaluate the impact of rate and time of N application and the use of a nitrification inhibitor on the environmental fate of nitrogen and corn yield was established in the 2001 crop year and continued through the 2003 crop year at a site in Douglas County, Illinois (Hoelt). A pattern tile field was selected that contained 54 tile lines that had been installed on 100-foot centers several years ago. Automatic samplers were installed on each tile line and programmed to record flow volume and to systematically collect water samples on a weekly basis for analysis for nitrate-N.

Results of this study have shown that use of the best management practices including application in the spring or as a side-dress treatment at the recommended rate will minimize N loss from the field and optimize yield in most years. It is also evident from the data that application in excess of the optimum rate to corn will result in enhanced loss in the year following when soybeans are grown.

In addition, simulation models (Hudson) have been focused on this farm and the model was tested using actual rainfall records. Tests of transient transport of nitrogen species were successful for these conditions. Work on the hydrologic portion of the model has resulted in several improvements to the original hydrologic model.

Another project was designed to improve the water and nitrogen mass balances for this field study (Kelly). They found that 75% to 90% of nitrogen coming out of tile lines is in the form of nitrate. The remainder of the nitrogen is primarily organic, with ammonium accounting for less than 1%.

Two projects focused on reducing nitrogen loss through tile lines (Cooke). In one study, shallow tiles placed closer together appeared to show positive water quality results. Peak tile flows and flow volumes were generally decreased with shallow tiles and delivered less nitrate-N compared to tiles installed 4-ft deep. The second project developed design criteria for field-scale subsurface bio-reactors for removing nitrates from drainage water.

On-farm experiments were conducted in ten fields in 2002 and six fields in 2003 located throughout Illinois to analyze the spatial variability of corn response to nitrogen fertilizer (Khanna). Preliminary analysis of the data has shown that corn response to nitrogen fertilizer is not constant across fields but varies in a non-random manner. These results suggest that corn production functions vary among field sections and are probably related to site-specific soil characteristics and topographic attributes.

A related project that was partially funded from the water quality SRI was the development of the Enhanced Farm Research Analyst (EFRA) software (Bullock). The program is being used by farmers, consultants, and researchers for the demarcation of management zones in production fields, and also to determine site-specific response functions from producers' fields.

## Mass Balance

In order to support the mass balance effort, stream-flow, sediment, and nutrient data were collected for quantitative analyses (Keefer). The major findings of this study are that nitrate-N concentrations are significantly higher in Big Ditch than Big Creek, sediment is higher in Big Creek rather than Big Ditch, and the other nutrient concentrations are similar between the two stations.

Quantification of N<sub>2</sub> fixation and N fertilizer usage by crops were needed to compliment soil, water, and atmospheric measurements being made as part of the Big Ditch N cycle (Below). Comparisons of nodulated and non-nodulated soybean plants and fertilized and unfertilized corn were used to determine estimates of soil N mineralization, N<sub>2</sub> fixation, and fertilizer uptake efficiency averaged over a three-year period (2000-2002).

Another group measured organic C and total N concentrations of soil samples collected from fifteen fields in east central Illinois that had been previously sampled in either the 1901 or 1957 soil surveys (David). Their results suggested that soil N pools are not decreasing from current agricultural practices, and therefore net mineralization of N is not an important term in N mass balances.

Monitoring the concentrations and forms of nitrogen in streams and drainage tiles in the Big Ditch watershed helped researchers understand the role of in-stream denitrification (David). They found that the large nitrate loads (mainly from tile flow) found in all streams in east-central Illinois were relatively unaffected by denitrification within the stream environment, and only large reservoirs such as Lake Shelbyville would have a significant effect on reducing the nitrate load leaving Illinois.

In order to account for the variability of nutrient loads of streams, existing data and new data sets were used to investigate how the frequency of data collection affects nutrient load calculations and how much variability existed in nutrient concentration in a stream cross-section (Demissie). The main conclusions of the analyses were that more frequent sampling (weekly versus monthly) results in less error in estimating loads than less frequent sampling, and a data collection program with longer duration can collect data less frequently without losing accuracy of the load estimation.

In 2000, twenty-five face-to-face interviews were conducted with farmers in the Big Ditch Watershed regarding their use of N fertilizer and compared the results to previous surveys in the region (McIsaac). In 1995, the average N fertilizer application to corn was 40 lb N/ac greater than the Illinois Agronomy Handbook, while in 2000, the average rate of over-application had decreased to 18 lb N/ac. It appeared that some progress had been made in reducing N fertilizer applications, but also that there was room for improvement.

One group focused on shallow groundwater by monitoring water table depth, flow rates, and nutrient concentrations collected at a number of wells established for this study (Mehnert). Overall, N concentrations tended to be low in the groundwater, while phosphorus was rarely detected in groundwater samples. Also an analytical, steady state, groundwater flow model was developed and calibrated using water levels and stream-flow data.

Another project provided a detailed characterization of the hydrologic response of a tile-drained field over a several year period (Ellsworth). The intense monitoring data provide the ability to calibrate and evaluate alternative models for flow and transport in small tile-drained watersheds.

Finally, there is an ongoing effort to integrate all projects funded by the SRI in the mass balance section and produce a range of scientific and outreach materials in various formats (David). An extensive scientific publication is planned, with chapters summarizing each area of the nitrogen cycle studied in the Big Ditch watershed, along with background information about the watershed. This publication will also have an overall nitrogen budget for two years in the watershed during which the SRI was active.

### **Modeling**

Linking water quality models and monitoring with economic processes and opportunities in watersheds was a major effort in southern Illinois. One group is developing a decision support system that helps a watershed optimize water quality and economic opportunities by evaluating alternative cropping systems across all farms in the watershed (Beaulieu).

Another group seeks to enhance water quality and farm income (Williard). This project included two intertwined components: 1.) field-scale water quality monitoring of the benefits of riparian buffer zones and 2.) a farmer/landowner spatial decision support system for riparian buffer zone management.

Several projects evaluated existing models for their applicability in Illinois watersheds, and to identify potential shortcomings. A model called ADAPT was found to simulate the monthly nitrate concentrations in the streams with reasonable accuracy, however, it appeared that the model overestimated N fixation by soybeans (McIsaac).

Another project investigated approaches for calculating riverine nitrogen loads, and in-stream sinks, as employed in the SPARROW model (Hudson). They found a systematic error in the calculated loads, which produced an overestimation of nitrogen losses in rivers and streams by the SPARROW model. They proposed an alternative approach that uses actual river channel network data in conjunction with hydraulic geometry relationships to derive rates of N consumption by biogeochemical processes in sediments and stream waters.

One project investigated the factors governing the hydrologic processes unique to tile-drained watersheds so that watershed water quality models can be improved or modified (Kalita). They found that DRAINMOD produced the best tile flow simulated results compared to AnnAGNPS (AGNPS 98) and RZWQM.

Finally, a Dynamic Watershed Simulation Model (DWSM) for storm events was developed to simulate surface and subsurface water, propagation of flood waves, upland soil and streambed erosion, sediment transport, and agrochemical transport in agricultural and rural watersheds (Borah). In addition, the following 11 watershed-scale models were reviewed and compared: AGNPS, AnnAGNPS, ANSWERS, ANSWERS-Continuous, CASC2D, DWSM, HSPF, KINEROS, MIKE SHE, PRMS, and SWAT. This review is very useful for selecting the most appropriate watershed model for an application.

## **Strategic Research Initiative (SRI) in Water Quality: Principal investigators**

Jeff Beaulieu	Agribusiness Economics	Southern Illinois University
Fred Below	Crop Sciences	University of Illinois
Matreyee Bera	Watershed Science Section	Illinois State Water Survey
Charles Boast	Nat. Resources & Env. Sciences	University of Illinois
Deva Borah	Watershed Science Section	Illinois State Water Survey
David Bullock	Agriculture & Consumer Economics	University of Illinois
Donald G. Bullock	Crop Sciences	University of Illinois
Andrew Carver	Forestry	Southern Illinois University
Richard Cooke	Agricultural Engineering	University of Illinois
George Czapar	Extension	University of Illinois
Mark David	Nat. Resources and Env. Sciences	University of Illinois
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Timothy Ellsworth	Nat. Resources and Env. Sciences	University of Illinois
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Michael Hirschi	Agricultural Engineering	University of Illinois
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Thomas Holm	Groundwater Section	Illinois State Water Survey
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Robert Hudson	Nat Resources and Env Sciences	University of Illinois
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Thomas M. Johnson	Geology	University of Illinois
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Madhu Khanna	Agricultural and Consumer Econ	University of Illinois
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Steven Kraft	Agribusiness Economics	Southern Illinois University
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Gregory McIsaac	Nat Resources and Env Sciences	University of Illinois
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Helena Mitsova	Geography	University of Illinois
Richard Mulvaney	Nat Resources and Env Sciences	University of Illinois
Emerson Nafziger	Crop Sciences	University of Illinois
John Nicklow	Engineering	Southern Illinois University
Jon O'Brien	Forestry	Southern Illinois University
Todd Royer	Nat. Resources and Env. Sciences	University of Illinois
Robert A. Sanford	Civil & Env. Engineering	University of Illinois
Raja Sengupta	Geography	Southern Illinois University
Jean Sogbedji	Nat Resources and Env Sciences	University of Illinois

Gary Stensland	Atmospheric Environment Sect	Illinois State Water Survey
Jennifer Tank	Biology	University of Notre Dame
Al Valocchi	Civil and Environmental Eng	University of Illinois
Edward Varsa	Plant Soil and General Agriculture	Southern Illinois University
Gerald Vigue	Agriculture	Western Illinois University
Stephen Went	Nat. Resources and Env. Sciences	University of Illinois
James D. Westervelt	Const. Eng. Research Lab	U.S. Army Corps of Engineers
Karl Williard	Forestry	Southern Illinois University
Derek Winstanley	Chief	Illinois State Water Survey
Alex Winter-Nelson	Agricultural and Consumer Econ.	University of Illinois
Renjie Xia	Watershed Science Section	Illinois State Water Survey
James Zaczek	Forestry	Southern Illinois University

## **Strategic Research Initiative (SRI) in Water Quality: Products**

Initially, the SRI collaboratively funded a set of projects with the Information Systems and Technology SRI (IT-SRI) in the summer of 1998 (FY99). The project titles were:

1. A User-friendly Website for Watershed Planning groups
2. Decision Analysis Support System Web Based Database Module
3. Data Mining for Site Specific Agriculture
4. MAP ILLINOIS: Interactive, Web-based access to Natural Resource Geospatial Data
5. MAP ILLINOIS: The Illinois Natural Resources geospatial data Clearinghouse
6. Validating Spatial Econometric Modeling of Land Use in Rural Illinois
7. The Dynamic Integrated Urban Expansion Model: an Ecological Approach
8. Development of DASS Toolbox Guidelines/Protocols/Standards

### **Web Sites**

Several of these efforts have been continued through C-FAR grants and other external funding sources. One example of a project that has been widely used and supported by other funding sources is the Illinois Watershed Management Clearinghouse (<http://www.watershed.uiuc.edu/>). The website was re-designed and expanded using funds from the Illinois EPA, Illinois DNR, and University of Illinois Extension. Also, the mapping tools that link to the website were enhanced and improved.

Another successful website was developed by Derek Winstanley, Mike Demissie, Steve Hollinger, Gary Stensland, and Ed Krug. "Conceptual Model of Nitrogen Cycling" (<http://www.sws.uiuc.edu/nitro/>) incorporates a series of models based on an extensive literature search. There have been 1,100,000 visitors to the Nitrogen Cycle web site, including 104,000 user sessions.

Walton Kelly and Robert Hudson initiated a data collection site in the summer of 2002 to collect weather and climate data and archive water and nitrogen balances. This project was designed to improve the water and nitrogen mass balances for the Best Management Practices (BMP) large-scale field study of nitrogen uptake and leaching from corn/soybean fields under different fertilizer application rates. The site is available at <http://www.sws.uiuc.edu/data/stations/ar/>.

### **Computer Software**

David Bullock and Donald Bullock developed a software program called the Enhanced Farm Research Analyst (EFRA). It is an extension for ArcView GIS 3.x (ESRI, Inc.), which is the most widely used GIS product in the world. This software allows farmers, consultants, and researchers to conduct complex field experiments on-farm. It is currently being used by researchers and producers throughout the world. The EFRA extension for ArcView GIS 3.x is available for download at <http://www.farmresearch.com/efra/>. A web-based tutorial for the EFRA site is currently being developed for economic analysis of on-farm experiments. It should be available for viewing in the near future.

## Peer Reviewed Publications

Listed below are peer-reviewed publications that have been accepted, are currently in press, or have been published. An additional 23 manuscripts are currently being reviewed for publication.

Bergerou, JA, LE Gentry, MB David, and FE Below, 2004. Role of N<sub>2</sub> fixation in the soybean N credit in maize production. *Plant and Soil* (In press).

Borah, D.K. and M. Bera. 2003. Watershed scale hydrologic and nonpoint source pollution models: Review of mathematical Bases. *Transactions of the ASAE*. (In press).

Borah, D.K., M. Bera, and S. Shaw. 2003. Water, sediment, nutrient and pesticide measurements in an agricultural watershed in Illinois during storm events. *Transactions of the ASAE* 46(3): 657-674.

Borah, D.K., M. Demissie, and L. Keefer. 2002. AGNPS-based assessment of the impact of BMPs on nitrate-nitrogen discharging into an Illinois water supply lake. *Water International, International Water Resources Association* 27(2): 255-265.

Carver, A.D., S.D. Danskin, J.J. Zaczek, J.C. Mangun, and K.W.J. Williard. 2003. A GIS methodology for generating riparian tree planting recommendations. *Northern Journal of Applied Forestry*. (In Press).

David, M.B., G.F. McIsaac, T.V. Royer, R.G. Darmody, and L.E. Gentry. 2001. Estimated historical and current nitrogen balances for Illinois. *TheScientificWorld* 1:597-604.

Guo., Y., M. Markus, and M. Demissie. 2002. Uncertainty of Nitrate-N Load Computations for Agricultural Watersheds. *Water Resources Research*, Vol. 38, No. 10, 1185.

Guy, Y., C.W.-S Tsai, and M. Demissie. 2001. Accuracy and Precision of Nitrate Load Estimation with Different Sampling Frequencies for Illinois Agricultural Watersheds. *Proceedings, Bridging the Gap-Meeting the World's Water and Environmental Resources Challenges*. Environmental and Water Resources Institute of the American Society of Civil Engineers, Reston, VA, CD-ROM.

Isik, M. and M. Khanna, "Stochastic Technology, Risk Preferences and Adoption of Site-specific Technologies," *American Journal of Agricultural Economics*, 85 (2), May 2003.

Isik, M. and M. Khanna, "Uncertainty and Spatial Variability: Incentives for Variable Rate Technology Adoption in Agriculture", *Risk, Decision and Policy*, 7 (3), 249-265, December 2002.

Isik, M. and M. Khanna, "Variable Rate Nitrogen Application under Uncertainty: Implications for Profitability and Nitrogen Use," *Journal of Agricultural and Resource Economics*, 27(1), 61-76, July 2002.

Khanna, M., M. Isik, and A. Winter-Nelson, "Investment in Site-Specific Crop Management under Uncertainty: Implications for Nitrate Pollution Control and Environmental Policy," *Agricultural Economics*, 24 (1), 9-21, December, 2000.

Krug, E. C. and D. Winstanley. 2002. The Need for Comprehensive and Consistent Treatment of the Nitrogen Cycle in Nitrogen Cycling and Mass Balance Studies: I. Terrestrial Nitrogen Cycle", *The Science of the Total Environment*, 293(1-3), 1-29.

Krug, E. C. and D. Winstanley. 2003. Response to McIsaac and David, *The Science of the Total Environment*, 305(1) 257-262.

Markus, M., C.W.-S Tsai, and M. Demissie. 2003. Uncertainty of Weekly Nitrate-Nitrogen Forecasts Using Artificial Neural Networks. *Journal of Environmental Engineering, ASCE*, March 2003.

Muleta, M.K. and Nicklow, J.W. (2002). "Evolutionary algorithms for multiobjective evaluation of watershed management decisions." *J. of Hydroinformatics, IWA*, 4(2): 83-97.

Muleta, M.K. and Nicklow, J.W. "Decision support for watershed management using evolutionary algorithms." *Journal of Water Res. Planning and Mgmt.*, ASCE (accepted).

Nicklow, J.W. and Muleta, M.K. (2001). "Watershed management technique to control sediment yield in agriculturally dominated areas." *Water International, IWRA*, 26(3): 435-443.

Schoonover J.E. and K.W.J. Williard. 2003. Groundwater nitrate reduction in giant cane and forest riparian buffer zones. *Journal of American Water Resources Association* 39(2):347-354.

Sengupta, R., Bennett, D., Beaulieu, J., Kraft, S. "Evaluating the Impact of Policy-induced Land-use Management Practices on Non-point Source Pollution Using a Spatial Decision Support System" *Water International*, Volume 25, No 3, 9/2000.

Sogbedji, M.J. and G.F. McIsaac. 2002. Evaluation of the ADAPT model for simulating water outflow from agricultural watersheds with extensive tile drainage. *Transactions of ASAE* 45:649-659

Sogbedji, M.J. and G.F. McIsaac. 2002. Modeling streamflow from artificially drained agricultural watersheds in Illinois. *Journal of the American Water Resources Association* 38:1753-1765.

Vigue, G. T., T. L. Wesley and D. E. Wesley. 2001. Variable Rate N Management (VRNM): An Agronomic, Economic and Environmental Assessment; *Trans. of the Ill. State Academy of Sci.*, Supplement to Volume 94: 48.

Westervelt James and Jeffery Holland. 2002. Conceptual user interface for the land management system. *Journal of Hydroinformatics* 4:99-113

**Book Chapters:** The following book chapters were the result of SRI sponsored research.

Bennett, D.A., Sengupta, R., Beaulieu, J.R., Kraft, S.E. 2000. Integrating Simulation Models and Geographic Information for Environmental Problem Solving. In Spatial Information for Land Use Management edited by M. J. Hill and R. J. Aspinall

Borah, D.K. 2000. Hydrologic, Sediment, and Agricultural Chemical Module. Chapter prepared for the Watershed Management Simulation Modeling System: A proposed User's and Programmer's Manual. December 2000

Borah D.K., R. Xia, and M. Bera. 2002. DWSSM – A Dynamic Watershed Simulation Model. Chapter 5 In: Mathematical Modeling of Small Watershed Hydrology and Applications Vol. 2. Ed. V.P. Singh and D.K. Frevert. Water Resources Publications, LLC, Englewood, CO: 113-166.

Mitasova, H., Mitas, L. Modeling Physical Systems, In: Geographic Information Systems and Environmental Modeling, Parks B., Crane, M., and Clarke, K. eds., Prentice Hall. (in press).

Mitasova, H., Mitas, L. Multiscale Soil Erosion Simulations for Land Use Management, In: Landscape Erosion and Landscape Evolution Modeling, Harmon R. and Doe W. eds., Kluwer Academic/Plenum Publishers, (in press).

### **Conference Proceeding and Invited Presentations**

Scientists working on the SRI presented their results at numerous conferences. In addition, several researchers were invited to give presentations at national and international meetings. Approximately 132 conference presentations have been made over the course of the SRI. Many of those conferences also published proceedings, which are listed below.

Adams, J., J. Beaulieu, D. Bennet, L. Duram, S.Kraft, C. Lant, T. Loftus, J. Nicklow, and J. Ruhl. 2001. "Ecological restoration in multiple-ownership watersheds: The case of the Cache River in Illinois – Insights from multidisciplinary research" 2001 Governor's Conference on the Management of the Illinois River System, Eighth Biennial Conference. The Illinois River: Partnerships for Progress, Restoration, and Preservation. Peoria, IL

Allred, K.O., Nicklow, J.W., Muleta, M.K., and Duram, L.A. (2003). "A multiobjective SDSS for management of urbanizing watersheds: The case of the Lower Kaskaskia Basin, Illinois." Proceedings of the 2003 Conference of the Environmental and Water Resources Institute, ASCE. Philadelphia, PA, June 23-26.

Beaulieu, J., Bennett, D., Kraft, S., Sengupta, R. "The use of a SDSS in the Watershed Plan. Proc. – Relative Economic and Ecological Impacts of Altern. Strat. to Control Soil Erosion." Ann. Meet. Of the Soil and Water Cons. Soc. 78/2000. Abs: 55:2000

Beaulieu, J., Bennett, D., Kraft, S. "Ecological-Economic Modeling on a Watershed Basis: Lessons From the Cache River of Southern Illinois" Proceedings of the 4<sup>th</sup> International

Conference on Integrating GIS and Environmental Modeling, Banff, Canada, July 2000.  
Currently available at <http://www.Colorado.EDU/research/cires/banff/upload/324/>

Beaulieu, J., Ferguson, J. “Assessing Soil Loss Restrictions on Farm Enterprises in the Cache River Watershed of Southern Illinois: A Representative Farm Approach, “ Ann. Meet. Of the S. Assoc. of Agr. Econ. 1/2000.Abs: Agr. And App. Econ. Vol. 32, 8/2000

Beaulieu, J., Kraft, S., Beck, R., Bennett D., Sengupta, R., and Peterson W. (2003) Regional Economic Impacts of a Watershed Process to Reduce Erosion and Stream Sedimentation. Proceedings of Annual Meetings of the American Agricultural Economics Association, Montreal, Canada. [http://agecon.lib.umn.edu/cgi-bin/pdf\\_view.pl?paperid=8872&ftype=.pdf](http://agecon.lib.umn.edu/cgi-bin/pdf_view.pl?paperid=8872&ftype=.pdf)

Beaumont, W.C., H.-H. Hwang, T.M. Johnson, E. Mehnert, and M. Wander, 2002. Denitrification in a tile-drained, agricultural, watershed in central Illinois. Environmental Horizons 2002, April 1 & 2, 2002, Illini Union, Champaign, Illinois, Proceedings, p. 76. (poster/abstract)

Bekele, E.G. and Nicklow, J.W. (2004). “Multi-objective evolutionary algorithms for cost-effective management of ecosystem services in a watershed.” Proceedings of the 2004 Conference of the Environmental and Water Resources Institute, ASCE. Salt Lake City, UT, June 27-July 1

Blattel, C.R. and K.W.J. Williard. November 3-7, 2002. Groundwater nitrate and phosphate levels in giant cane and forested riparian buffer zones. AWRA’s Annual Water Resources Conference. Philadelphia, PA.

Blattel, C.R., K.W.J. Williard, and S.G. Baer. 2003. Groundwater phosphate attenuation by giant cane and forest riparian buffers. In: J.D. Williams and D. Kolpin, eds. Proceedings of the AWRA 2003 Spring Specialty Conference on Agricultural Hydrology and Water Quality. May 12-14, 2003, Kansas City, MO.

Borah, D.K. 2002. Watershed Scale Nonpoint Source Pollution Models: Mathematical Bases. 2002 ASAE Annual International Meeting/CIGR World Congress, July 28-July31, 2002, Chicago, IL. Paper No. 022091, ASAE, 2950 Niles Rd., St. Joseph, MI 49085-9659.

Borah, D.K. and M. Bera. 2000. Watershed modeling with state and local partners in Illinois. 2000 Joint Conference on Water Resources Engineering and Water Resources Planning & Management, July 30-August 2, 2000, Minneapolis, MN. Proceedings on CD Rom, ED. R.H. Hotchkiss and M. Glade, ASCE-EWRI, Washington, DC.

Borah, D.K. and M. Bera. 2002. Modeling the Big Ditch Watershed in Illinois and Studying Scaling Effects on Water and Sediment Discharges. 2002 ASAE Annual International Meeting/CIGR World Congress, July 28-July 31, 2002, Chicago, IL. Paper No. 022224, ASAE, 2950 Niles Rd., St. Joseph, MI 49085-9659.

- Borah, D.K. and M. Bera. 2003. HSPF Model Evaluation Based on Formulations and Applications. Proceedings, American Water Resources Association 2003 Spring Specialty Conference on Agricultural Hydrology and Water Quality, Middleburg, VA, CD-ROM.
- Borah, D.K. and M. Bera. 2003. SWAT Model Background and Application Reviews. 2003 ASAE Annual International Meeting, July 27-July 30, 2003, Las Vegas, NV. Paper No. 032054, ASAE, 2950 Niles Rd., St. Joseph, MI 49085-9659.
- Borah, D.K., and M. Bera. 2003. Watershed Scale Hydrologic and Nonpoint Source Pollution Models for Long-Term Continuous and Storm Event Simulations. Second Conference on Watershed Management to Meet Emerging TMDL Environmental Regulations, American Society of Agricultural Engineers, November 8-12, 2003, Albuquerque, NM.
- Borah, D.K., M. Bera, and R. Xia. 2001. Hydrologic and sediment transport modeling of the Big Ditch watershed in Illinois. Proceedings of the International Symposium on Soil Erosion Research for the 21st Century, January 3-5, 2001, Honolulu, Hawaii, ASAE, St. Joseph, MI: 291-294.
- Borah, D.K., M. Bera, and R. Xia. 2002. Hydrologic and Sediment Transport Modeling in an Illinois Watershed for Planning Restoration. Proceedings of the 2002 Conference on Water Resources Planning and Management, May 19-22, 2002, Roanoke, VA. ASCE-EWRI, Washington, DC: CD-ROM.
- Borah, D.K., M. Bera, L. Keefer, M. Demissie, and S. Shaw. 2000. Watershed models analyzing agricultural watersheds in Illinois. Proceedings of the West North Central Region Soil and Water Conservation Society's Conference on the Watershed Approach to Improving Water Quality: Fact or Fantasy? March 28-30, 2000, La Crosse, WI: 70-72.
- Borah, D.K., R. Xia, and M. Bera. 2000. Hydrologic and water quality model for tile drained watersheds in Illinois. 2000 ASAE Annual International Meeting, July 9-12, 2000, Milwaukee, WI. Paper No. 002093, ASAE, 2950 Niles Rd., St. Joseph, MI 49085-9659.
- Borah, D.K., R. Xia, and M. Bera. 2001. DWSSM – A Dynamic Watershed Simulation Model for Studying Agricultural Nonpoint Source Pollution. 2001 ASAE Annual International Meeting, July 30-August 1, 2001, Sacramento, CA. Paper No. 01-2028, ASAE, 2950 Niles Rd., St. Joseph, MI 49085-9659.
- Borah, D.K., R. Xia, and M. Bera. 2001. Hydrologic and Sediment Transport Modeling in the Court Creek Watershed. 2001 Governor's Conference on the Management of the Illinois River System, October 2-4, 2001, Peoria, IL. Special Report No. 27, Illinois Water Resources Center, Urbana, IL: 178-188.
- Borah, D.K., R. Xia, and M. Bera. 2001. Hydrologic and Sediment Transport Modeling of Agricultural Watersheds. Proceedings of the World Water & Environmental Resources Congress, May 20-24, 2001, Orlando, FL. ASCE, Washington, DC: CD-ROM.

Borah, D.K., R. Xia, and M. Bera. 2001. Modeling Agricultural Nonpoint Pollution and Applying on an Illinois Watershed. Proceedings of Papers & Posters, 5<sup>th</sup> International Conference on Diffuse/Nonpoint Pollution and Watershed Management, June 10-15, 2001, Milwaukee, WI. Ed. C.S. Melching and E.A. Alp, IWA and Marquette University, Milwaukee, WI: CD-ROM.

Borah, D.K., R. Xia, and M. Bera. 2002. Watershed Model to Study Hydrology, Sediment, and Agricultural Chemicals in Rural Watersheds. International Conference on Water Resources Management in Arid Regions, March 23-27, 2002, Kuwait. In: Surface Water Hydrology Volume 1. Ed. V.P. Singh, M. Al-Rashed, and M.M. Sherif. A.A. Balkema Publishers, Lisse/Abingdon/Exton(PA)/Tokyo: 343-358.

Bullock, David S. "The Science of Precision Agriculture: Economics." Invited lecture at the NCR-180 meetings titled "The Science of Precision Agriculture," Madison, Wisconsin, January 5, 2001.

Bullock, David S., Scott Swinton, and Jess Lowenberg-DeBoer. "Can Precision Agriculture Technology Pay for Itself?: The Complementarity of Precision Agriculture Technology and Information." Invited presentation at the Spatial Data Analysis Workshop of the American Agricultural Economics Association Meetings, Chicago, Illinois, August 4, 2001.

Bullock, David S., Donald G. Bullock, Germán Bollero, and Sally Officer. "Data Mining Issues in Precision Agriculture." Invited presentation at the American Statistical Association Meetings, Atlanta, Georgia, August 7, 2001. Presented by Donald Bullock.

Bullock, David S. "Yield Goals: the Economic Reality of Integrating Yield Goals into Whole-Farm Site Specific Management." Invited presentation at the American Society of Agronomists meetings, in the session "Yield Goals: Using Site-Specific Yield Goals for Agronomic Management." Indianapolis, November 11, 2002.

David, M.B., G.F. McIsaac, T.V. Royer, R.G. Darmody, and L.E. Gentry. 2001. Estimated historical and current nitrogen balances for Illinois. Oral presentation at the 2<sup>nd</sup> International Nitrogen Conference on Science and Policy, Potomac, MD.

Ellsworth, T. R. . 2000. The Chinese Agricultural Chemical Society and National Taiwan University, Taipei, Taiwan, Solute Transport in Unsaturated Soil.

Ellsworth, T. R. 2000. National Pingtung University of Science and Technology, Neipu, Pingtung, Taiwan, Scale Dependence of Solute Transport in Unsaturated Soil.

Ellsworth, T. R. Department of Civil Engineering, November 2000, Transport Process and Parameter Identification in Field Experiments: Case Studies

Ellsworth, T. R., C. M. Harbourt, and C. W. Boast. Illinois Water 2000 Conference, Solute Transport in a Tile-drained Watershed, November 2000

Harbourt, C. M., C. W. Boast, E. M. I. El-Naggar, and T. R. Ellsworth. 2001. Catchment scale dependence of subsurface tile effluent breakthrough curves. Soil Science Society of America Annual Mtg. Abstracts.

Harbourt, C. M., T. R. Ellsworth, C. W. Boast, and M. C. Hirschi. 2000. Flow and Transport Characterization in a Tile-drained Field. Agronomy Abstracts, p. 209.

Hill, D., A. Valocchi (2000) presented at 2000 Fall Annual Meeting of the American Geophysical Union, San Francisco, CA.

Holm T.R., J.R. Karny, E. Mehnert, W.S. Dey, H.-H. Hwang, D.A. Keefer, R.A. Sanford, and T.M. Johnson, 2003. Mass balance of nutrients in a tile-drained, agricultural watershed in central Illinois, in Program with Abstracts, 48th Annual Midwest Ground Water Conference, Grand Rapids MI, October 1-3, 2003, *in press* (presentation/abstract)

Holm, T.R., E. Mehnert, W.S. Dey, J.R. Karny. D.A. Keefer, and W.R. Kelly, 2001. Shallow groundwater flow and mass flux of nitrogen and phosphorus in the Big Ditch watershed, in Program with Abstracts, 46th Annual Midwest Ground Water Conference, Madison WI, October 22-24, 2001, p. 36. (poster/abstract)

Hudson, R., A. Valocchi, S. Wentz, D. Hill, F. Yue, J. Singh (2002) "Modeling Denitrification in Agroecosystems of Central Illinois: Investigations at Field and Watershed Scales," presented at 2002 Fall Annual Meeting of the American Geophysical Union, San Francisco, CA.

Hwang, H.-H., M. Wander, W.C. Beaumont, T.M. Johnson, and E. Mehnert, 2002. Denitrification as revealed by isotope ratios in tile-drained agricultural watershed in central Illinois, in Abstracts with Program of the Southeastern and North-Central Sections Annual Meeting, Geologic Society of America, Lexington, KY, April 3-5, 2002, Vol. 34, No. 2, p. A-113. (poster/abstract)

Isik, M., M. Khanna, and A. Winter-Nelson, "Sequential Investment in Site-Specific Crop Management Under Output Price Uncertainty," American Agricultural Economics Association Annual Meeting, Tampa, August 2000 and Heartland Environmental and Resource Economics Workshop, Iowa State University, Ames, September 2000.

Isik, M., M. Khanna, and A. Winter-Nelson, 2000, "Sequential Investment in Site-Specific Crop Management under Output Price Uncertainty," Fifth International Conference on Precision Agriculture, July 16-19, 2000.

Keefer, L. L., 2000-2003. Presentations to the "Upper Sangamon River Watershed Planning Committee" on data collection progress and preliminary findings. Decatur, IL.

Kemp, M.J., J.L. Tank, T.V. Royer and M.B. David. 2003. Stream nutrient cycling in an agricultural landscape. North American Benthological Society Annual Meeting, Athens, GA. (<http://www.benthos.org/database/allnabstracts.cfm/db/Athens2003abstracts/id/224>)

- Khanna, M., "Incentives for Adoption of Precision Agriculture for Fertilizer Management," Missouri-Illinois Precision Agriculture Conference, Quincy, Illinois, February 21-22,2001.
- Kraft, S.E., C.L. Lant, J. Adams, J. Beaulieu, D. Bennett, L. Duram, J.B. Ruhl, 2000. Understanding the Social Context of Watershed Planning in Multiple-Ownership Watersheds. In Proceedings of the World Water Congress, Melbourne, Australia, March, 2000.
- Kraft, S., C. Lant, J. Beaulieu, L. Duram, J. Ruhl, D. Bennett, T. Loftus, J. Adams, and Schaller, J.L., T.V. Royer and M.B. David. 2003. Denitrification associated with algal mats in nutrient-rich agricultural streams. North American Benthological Society Annual Meeting, Athens, GA.(<http://www.benthos.org/database/allnabstracts.cfm/db/Athens2003abstracts/id/158>)
- Mehnert, E., W.S. Dey, H.-H. Hwang, D.A. Keefer, T.R. Holm, J.R. Karny, R.A. Sanford, and T.M. Johnson, 2002. Mass balance of nitrogen in a tile-drained, agricultural watershed in central Illinois, National Ground Water Association Midwest FOCUS Ground Water Conference, Chicago, IL, April 11-12, p. 10. (presentation/abstract)
- Mitasova, H., Mitas, L. 2000. Modeling Spatial Processes in Multiscale Framework: Exploring Duality Between Particles and Fields. Plenary Talk at GIScience 2000 Conf., Savanna, GA, October 2000.<http://www2.gis.uiuc.edu:2280/modviz/gisc00/duality.html>
- Muleta, M.K. and Nicklow, J.W. (2001). "Using genetic algorithms and SWAT to minimize sediment yield from an agriculturally dominated watershed." Proceedings of the 2001 Conference of the Environmental and Water Resources Institute, ASCE. Orlando, FL, May 20-24.
- Muleta, M.K. and Nicklow, J.W. (2002). "Artificial neural networks for efficient decision making in watershed management systems." Proceedings of the 2002 Conference of the Environmental and Water Resources Institute, ASCE. Roanoke, VA, May 19-22.
- Muleta, M.K. and Nicklow, J.W. (2002). "Genetic algorithms for automatic calibration of physically-based distributed watershed models." Proceedings of the 2002 Conference of the Environmental and Water Resources Institute, ASCE. Roanoke, VA, May 19-22.
- Nicklow, J.. 2001. "Ecological restoration in multiple-ownership watersheds: The case of the Cache River in Illinois – Insights from multidisciplinary research" 2001 Governor's Conference on the Management of the Illinois River System, Eighth Biennial Conference. The Illinois River: Partnerships for Progress, Restoration, and Preservation. Peoria, IL
- Nicklow, J.W. and Muleta, M.K. (2002). "Integrative decision making for watershed management using evolutionary algorithms." Proceedings of the 2002 Conference of the Environmental and Water Resources Institute, ASCE. Roanoke, VA, May 19-22.
- O'Brien, J.M. and K.W.J. Williard. November 12-15, 2001. Denitrification and nitrogen removal in a southern Illinois agricultural stream. AWRAs Annual Water Resources Conference, Albuquerque, NM.

O'Brien, J.M. and K.W.J. Williard. October 14-18, 2001. Effects of ambient conditions on microbial denitrification in a southern Illinois stream. Ecological Society of America Second International Nitrogen Conference, Potomac, MD.

O'Brien, J.M., and K.W.J. Williard. November 2000. The effects of sediment characteristics on denitrification in Big Creek. Illinois Water 2000 Conference, Urbana, IL.

Omonode, R.A., G.F. McIsaac, and M.B. David. 2002. Long term changes in soil carbon and nitrogen due to cultivation in Illinois. ASA, CSSA, SSSA Annual Meeting Abstracts and poster presentation.

Royer, T.V., J.L. Tank, and M.B. David. 2001. Denitrification rates and controls in agricultural streams in the Midwest. ASLO 2001 Aquatic Sciences Meeting, Abstract Book, p. 121.

Royer, T.V., J.L. Tank, and M.B. David. 2001. Is denitrification a major sink for nitrate in agricultural streams? North American Benthological Society Annual Meeting, Lacrosse, WI. (<http://www.benthos.org/database/allnabstracts.cfm/db/LaCrosse2001abstracts/id/273>)

Royer, T.V., J.L. Tank, and M.B. David. 2002. Energy flow in a stream ecosystem: an assessment of denitrification and oxygen metabolism. North American Benthological Society Annual Meeting, Pittsburgh, PA. (<http://www.benthos.org/database/allnabstracts.cfm/db/Pittsburgh2002abstracts/id/17>)

Royer, T.V., J.L. Tank, M.J. Kemp and M.B. David. 2003. Nitrate transport in agricultural streams: has denitrification been given too great a role? North American Benthological Society Annual Meeting, Athens, GA. (<http://www.benthos.org/database/allnabstracts.cfm/db/Athens2003abstracts/id/156>)

Royer, T.V., M.B. David, J.L. Tank, and L.C. Fitzgerald. 2001. Denitrification in streams, rivers, and reservoirs of Illinois: its role in the nitrogen mass balance. Poster presentation at the 2<sup>nd</sup> International Nitrogen Conference on Science and Policy, Potomac, MD.

Schoonover, J.E. and K.W.J. Williard. November 12-15, 2001. Nutrient and sediment retention in forest and giant cane riparian buffer strips. AWRA's Annual Water Resources Conference, Albuquerque, NM.

Schoonover, J.E., and K.W.J. Williard. March 7-9, 2001. Native riparian vegetation impacts on agricultural surface and subsurface water quality in Cache River watershed. Illinois Renewable Natural Resources Conference. Peoria, IL.

Schoonover, J.E., and K.W.J. Williard. November 2000. Native riparian vegetation impacts on agricultural surface and subsurface water quality in the Cache River watershed. Illinois Water 2000 Conference, Urbana, IL.

Schoonover, J.E., K.W.J. Williard, J.J. Zaczek, J.C. Mangun, and A.D. Carver. 2003. Soil water nitrate concentrations in giant cane and forest riparian buffer zones. In: Proceedings of the 13<sup>th</sup> Central Hardwood Forest Conference. April 1-3, 2002, Champaign, IL. (In Press)

Schoonover, J.E., K.W.J. Williard, J.J. Zaczek, J.C. Mangun, and A.D. Carver. April 1-3, 2002. Soil water nitrate concentrations in giant cane and forest riparian buffer zones. 13<sup>th</sup> Central Hardwood Forest Conference. Champaign, IL.

Sentupta, R., Loftus, T., and Beaulieu, J., 2002, Assisting decision-makers manage CRP payments in agricultural watersheds through modeling and simulation. Association of American Geographers Annual Meeting, Los Angeles, CA.

Shade, C.W., C.O. Moses, and R.J.M. Hudson (2000), Spatio-temporal variability of stream nitrate levels in a small agricultural “hill-land” catchment, American Geophysical Union 2000 Fall National Meeting, San Francisco, CA.

Shiffer, S., R. Sanford, T. Matos, E. Mehnert, D. A. Keefer, W. S. Dey and T. R. Holm. 2001. Natural attenuation of nitrate in the Big Ditch watershed, Illinois., *In Bioremediation of Inorganic Compounds*, A. Leeson, B. M. Peyton, J. L Means, and V. S. Magar eds., Proceedings from the Sixth International In Situ and On-Site Bioremediation Symposium, June, 2001. Vol. 6(9) p. 179-186. (presentation/proceedings paper)

Singh, J. and R. Hudson (2003), Automatic Calibration of a Subsurface Drainage and Water Quality Model, AWRA Spring Specialty Conference Agricultural Hydrology and Water Quality, May 12-14, 2003, Kansas City, Missouri

Singh, J., Hudson, R., Cooke, R., Hirschi, M., Ellsworth, T., and Gertner, G. (2002) “Simulating Hydrology and Water Quality at Unmonitored Tile-Drained Fields” Presented at 2002 ASAE/CIGR Annual International Meeting, Chicago, IL.

Singh, J., Hudson, R., Cooke, R., Hirschi, M., Ellsworth, T., and Gertner, G. (2002), “Automatic Calibration of a Subsurface Drainage Model,” Presented at 2002 ASAE/CIGR Annual International Meeting, Chicago, IL.

Stensland, G.J, V.C. Bowersox, B. Larson and R.D. Claybrooke. 2000: Comparison of Patterns of Ammonium Concentration in Precipitation to Ammonia Emission Estimates. 10<sup>th</sup> Annual USEPA Emission Inventory Conference. Conference Proceedings at <http://www.epa.gov/ttn/chief/conference/ei10/index.html#ses-1>. 17pp

Stensland, G.J., B. Larson, V.C. Bowersox, and R.D. Claybrooke. 2000. What a Difference Ten Years Has Made in Ammonium in Rain and Snow in the United States-The Changing Landscape of Ammonia Sources and Deposition (poster). Proceedings, NADP Technical Committee Meeting, Saratoga Springs, NY, p. 108

Stensland, G.J., V.C. Bowersox, B. Larson, and R.D. Claybrooke, 2001: “Comparison of Ammonium in USA Wet Deposition to Ammonia Emission Estimates”, Abstract Book for The

Second International Nitrogen Conference, Potomac, MD, Oct 14-18, 2001. p.50

Varsa, E. C., S. A. Ebelhar, T. D. Wyciskalla and C. D. Hart. 2002. Using historically established yield variability for the improved prediction of nitrogen fertilizer needs of corn. In R. G. Hoefl (Ed.) 2002 Illinois Fertilizer Conf. Proc., pp 35-44.

Wall, L.G., J.L. Tank, T.V. Royer, M.J. Kemp and M.B. David. 2003. Can a reservoir act as a nitrogen sink? The role of denitrification in NO<sub>3</sub>- retention within an agriculturally influenced reservoir. North American Benthological Society Annual Meeting, Athens, GA.  
(<http://www.benthos.org/database/allnabstracts.cfm/db/Athens2003abstracts/id/155>)

Wente, S., R. Hudson and G. Gertner. 2001. An Inverse Model for Determining Agricultural Watershed N Balances from Stream Nitrate Data. National Nonpoint Source Monitoring Workshop, Indianapolis, IN

Wente, S., R. Hudson and G. Gertner. 2000. Estimating Allowable Agricultural Fertilizer Application Rates to Meet N Water Quality Standards. Illinois Water 2000 Conference, Urbana, IL

Wente, S., R. Hudson and G. Gertner. 2000. U.S. Environmental Protection Agency, Region 5 Nutrient Criteria Workgroup. Chicago, IL

Wente, S., R. Hudson and G. Gertner. 2001. Watershed-scale Nutrient Mass-balance Models as an Integral Part of Monitoring and Managing Water Quality. U.S. Environmental Protection Agency, Region 5 Nutrient Criteria Workgroup. Chicago,

Westervelt, James D. and M. Shapiro (2000) Reviewing Approaches for Linking Spatial Simulation Models, Integrating GIS and Environmental Modeling: Problems, Prospects, and Research Needs, Banff, Canada. Sept. 2-8, 2000.

Westervelt, James D. and R. Farnsworth (2000) Designing a Citizen-Oriented Watershed Simulation environment, ASCE Watershed Management 2000 Conference, Fort Collins, Colorado. June 21-24, 2000.

Williard, K.W.J. November 14, 2002. Effects of riparian buffer zones on water quality in agricultural watersheds. Illinois Council on Food and Agricultural Research Day. Carbondale, IL.

Williard, K.W.J. and J.J. Zaczek. April 16, 2002. Quantifying the water quality benefits of riparian buffer zones. U.S. Fish and Wildlife Service Upper Mississippi River/Tallgrass Prairie Ecosystem Team Meeting. Herrin, IL.

Williard, K.W.J., C.R. Blattel, and S.G. Baer. May 12-14, 2003. Attenuation of nutrients in groundwater by giant cane and forested riparian buffers in southern Illinois agricultural watersheds. AWRA's Spring Specialty Conference on Agricultural Hydrology and Water Quality. Kansas City, MO.

Williard, K.W.J., J.C. Mangun, J.J. Zaczek, and A.D. Carver. 2000. Nutrient uptake and sediment filtration by riparian buffer zones in the Big Creek watershed. *Watershed Management Briefs* (Illinois Department of Natural Resources) 2(4):6.

Williard, K.W.J., J.E. Schoonover, and J.J. Zaczek. 2002. Nitrogen, phosphorus, and sediment attenuation in giant cane and forest riparian buffer zones. *AWRA's Annual Water Resources Conference*. Philadelphia, PA.

Williard, K.W.J., J.E. Schoonover, J.J. Zaczek, J.C. Mangun, and A.D. Carver. October 29, 2002. Water quality benefits of riparian vegetation in southern Illinois. 2002 Annual Meeting: The North Central Region Association of Agricultural Experiment Station Directors, Technical Committee on Riparian Management in Midwest Agricultural and Forest Ecosystems (NC-230). Carbondale, IL.

Williard, K.W.J., J.E. Schoonover, J.M. O'Brien, and J.A. Webber. March 7-9, 2001 Water quality benefits of native riparian vegetation in the Cache River watershed. *Illinois Renewable Natural Resources Conference*. Peoria, IL.

Xia, R., D.K. Borah, and M.Bera. 2001. Modeling Agricultural Chemical Transport in Watersheds. *Proceedings of the World Water & Environmental Resources Congress*, May 20-24, 2001, Orlando, FL. ASCE, Washington, DC: CD-ROM.

### **Theses and Dissertations**

One of the most important outcomes of the water quality SRI has been the ability to support graduate education and research. The training of new scientists, that are able to conduct water quality research, has lasting impacts well beyond the life of the current SRI. Thirteen M.S. and Ph.D. students completed their graduate education as a result of the SRI (one Ph.D. project is still in progress).

Beaumont, W.C., 2003. Denitrification in a subsurface drained, agricultural watershed in central Illinois, M.S. thesis, University of Illinois at Urbana-Champaign, Department of Geology,

Blattel, Chris. 2003. Groundwater nitrogen and phosphate attenuation by giant cane and forest riparian buffers in the Cache River watershed. M.S. Thesis. Department of Forestry. Southern Illinois University Carbondale.

Hall, D. M.S. 2002. Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign.

Harbourt, C. M. 2002. A Vadose Zone Field Study: Subsurface Tile Drainage, Hydrology and Variability, Ph.D. Dissertation, UIUC, 220 pgs.

Kwon, H-Y. University of Illinois at Urbana-Champaign, Department of Natural Resources and Environmental Sciences. PhD in Progress.

McDonald, J.M., 2003. Determination of in-situ nitrate reduction rates in east central Illinois using single well push-pull testing, MS Thesis, University of Illinois at Urbana-Champaign, Department of Civil and Environmental Engineering, August 2003.

O'Brien, Jon. 2002. Factors affecting denitrification in a southern Illinois stream. M.S. Thesis. Department of Forestry, Southern Illinois University Carbondale.

Schaller, J.L. 2003. Substrate effects on denitrification in nutrient enriched streams in east central Illinois. M.S. thesis, University of Illinois. 62 p.

Schoonover, Jon. 2001. Attenuation of nutrients and sediment in agricultural surface and subsurface runoff by giant cane and forest riparian buffer zones. M.S. Thesis. Department of Forestry. Southern Illinois University Carbondale.

Shiffer, S. M., 2001. The microbial denitrifying activity in the groundwater of the Big Ditch watershed, IL. MS Thesis, University of Illinois at Urbana-Champaign, Department of Civil and Environmental Engineering.

Singh, J. 2003. Department of Agricultural Engineering, University of Illinois at Urbana-Champaign. (Ph.D. Dec. 2003).

Starks, K.M. 2002. Water quality in three central Illinois watersheds. M.S. thesis, University of Illinois. 117 p.

Wander, M., 2001. Development and implementation of an isotopic model for quantifying groundwater denitrification, M.S. thesis, University of Illinois at Urbana-Champaign, Department of Geology, August 2001.

Yue, F. 2003. Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign. (M.S. Dec. 2003).

### **Initial Objectives that were not Accomplished**

One of the challenges facing the Water Quality SRI was the broad diversity of projects. Although an initial objective of the SRI was to have all the research programs fully integrated, with 28 different projects this became extremely complicated. The mass balance group is actively pursuing an integrated report for their projects, but integrating the BMP and Modeling groups may be more difficult.

## **Strategic Research Initiative (SRI) in Water Quality: Outreach**

In order to make SRI information readily accessible at all times, a comprehensive web site (<http://web.aces.uiuc.edu/sriwq>) was developed. The site detailed individual projects, budgets, progress reports, and outcomes. The SRI also supported an educational outreach website on nitrogen cycling (<http://www.sws.uiuc.edu/nitro/>).

In addition to sharing information on web sites, researchers have communicated their results in a number of other ways. The extensive list of conference proceedings, book chapters, posters, reports, journal articles, seminars and workshops can be found in the products section of this report.

In order to foster a direct exchange between researchers and the public, a Water Quality Forum was held in Springfield on March 1, 2001 (See Appendix A for agenda). The intent of this water forum was to provide details on the types of projects being conducted, and to give the public a chance to become involved and offer suggestions from their local perspectives. This exchange gave researchers some immediate feedback, and helped identify areas of water quality research that are needed. Following the Water Quality Forum, all of the presentations were posted to the project web site.

Research teams provided updates on BMP, Mass-Balance, and Modeling efforts to an audience of about 160 people representing C-FAR, the state legislature, and agribusiness. Audience evaluations after the water quality forum were very favorable. When asked if their understanding of water quality research being conducted through SRI increased after the meeting, the average response was 8.4 (1 = lowest, 10 = highest).

Several research teams met with individual watershed groups and worked with local Soil and Water Conservation Districts to share their results and explain where additional information could be found.

Results of SRI projects have been widely distributed at several University of Illinois Extension meetings including the Illinois Corn and Soybean Classics, the Illinois Fertilizer and Seed Dealer Clinics and Agronomy Day. Approximately 3000 farmers, crop advisers, and agricultural retailers attended these meetings.

Finally, the water quality SRI is also developing short fact sheets to provide a non-technical overview of the project.

## **Strategic Research Initiative (SRI) in Water Quality: Components to be continued**

Water quality continues to be an important issue. According to a recent survey of Illinois homeowners conducted by the Illinois Natural History Survey (INHS), Illinois residents identified water quality as the most important issue in their communities.

The C-FAR Natural Resources Working Group recognized that water quality concerns are still a high priority and recommended that the WQ SRI be continued for an additional three years. The SRI focus, however, was slightly changed. The adjusted goals of the SRI are 1.) to help develop

the scientific basis for nutrient standards in the surface waters of Illinois, and 2.) to assist in the appropriate development and implementation of Total Maximum Daily Loads (TMDLs).

Water quality standards, based on the best available science, are necessary to help prioritize protection efforts. These standards consider run-off and drainage from agricultural fields, but they also include discharges from factories and sewage treatment plants. As a result, they directly affect both farm and urban residents.

This requires close collaboration with regulatory agencies in Illinois. As part of the SRI, an advisory team from the Illinois EPA and Illinois Department of Agriculture identified research needs, developed the request for proposals, and evaluated and selected projects. The final projects that were selected included scientists from the University of Illinois, Illinois State University, Southern Illinois University, the Illinois State Water Survey, and the Illinois Natural History Survey.

Since standards need to consider all sources of nutrients, the SRI has had discussions and offers of collaboration and support from municipalities including the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC). All have a goal of protecting water from nutrient over-enrichment without pursuing standards that are overly restrictive or unachievable.

The SRI is organized into four research teams, each with a slightly different focus. Project components include a detailed analysis of existing IEPA data, intensive sampling at fixed locations, and state-wide temporal sampling at 150 to 200 sites.

The four projects and research teams are as follows:

**Effects of phosphorus mediated through algal biomass in Illinois streams**

Walter R.Hill: Illinois Natural History Survey, Center for Aquatic Ecology  
Daniel Soluk: Illinois Natural History Survey, Center for Aquatic Ecology  
Roderick I. Mackie: University of Illinois, Department of Animal Science

**Spatial and temporal relationships between biotic integrity of Illinois streams, dissolved oxygen, and nutrients (including controls on dissolved reactive and particulate phosphorus)**

Mark B. David: University of Illinois, Department of Natural Resources and Environmental Sciences  
Matt R. Whiles: Southern Illinois University, Department of Zoology  
Todd V. Royer: Kent State University, Department of Biological Sciences  
Robert G. Darmody: University of Illinois, Department of Natural Resources and Environmental Sciences  
Gregory F. McIsaac: University of Illinois, Department of Natural Resources and Environmental Sciences

**Seasonal dynamics of nutrients, algae and dissolved oxygen in agriculturally dominated headwater streams: the link between land-use and water quality.**

William L. Perry: Illinois State University, Department of Biological Sciences

**The impact of sediments on the potential bioavailability of phosphorus in Illinois streams**

Michael L. Machesky: Illinois State Water Survey, Watershed Science Section

James A. Slowikowski: Illinois State Water Survey, Watershed Science Section

**Strategic Research Initiative (SRI) in Water Quality: Leveraged Funding**

Over the course of the Water Quality SRI, principal investigators have been very successful in securing additional funding from other sources to support and expand their work. While some of the projects were relatively modest, others were part of large, multi-state research efforts that have broad impacts well beyond Illinois. Researchers have leveraged funding and secured additional grants of approximately \$4,500,000. In addition, approximately, \$1,000,000 in grant proposals are currently under review from a wide range of external funding sources. Following is a list of additional grants secured:

Beaulieu, Jeff, Jane Adams, Dave Bennett, Leslie Duram, Steven Kraft, Chris Lant, and J.B. Ruhl. Understanding the Social Context of Ecological Restoration in Multiple Ownership Watersheds. 1999-2002. Funded by USDA/EPA, \$718,000.

Cooke, R.A. and P. Kalita. Development of design criteria for watershed-scale subsurface bioreactors. USDA CSREES Award # 2003-35102-13547, \$310,000.

Cooke, Richard and Prasanta Kalita. Flow and transport in shallow subsurface drainage systems. Timewell Tile and Springfield Plastic. \$30,000

David, M.B., G.F. McIsaac, D.C. White, M.C. Hirschi, and T.V. Royer. 2000-2004. Outcomes of N Fertilizer Management on Tile Drained Watersheds. USDA-CSREES 406 Water Quality Program. \$450,000.

Dey, J. R. The Effect of Land Use on Shallow Groundwater Quantity and Quality, Illinois Groundwater Consortium, 7/15/02 to 7/14/03, \$27,259

Hoelt, Robert. Evaluation of N management practices on the environmental fate of N and corn yield. Illinois EPA. \$163,490 for period June 1, 2003 through June 30, 2006.

Hudson, R and A. Valocchi. Continue the development and application of both the 3-D modeling and automatic calibration work begun in this CFAR project. Funded by the US Geological Survey. \$110,000.

Kalita, Prasanta, Richard Cooke, Robert Hudson, and Mike Hirschi, Understanding hydrologic and water quality response of a tile drained watershed. \$290,000 (9/01 - 8/04) USDA- NRI

Kalita, P.K, and M.C. Hirschi. 2000-2005. DHARMA: Domain specific metaware for hydrologic application. National Science Foundation Grant (NSF Grant number IIS-0082667), total funding is \$510,614 (Collaborative project with Kansas State University).

Keefer, Laura. Watershed monitoring. City of Decatur: \$75,428 and Illinois Department of Natural Resources: \$47,850

McIsaac, G.F., D.S. Bullock, R.A.C. Cooke, D. Cavanaugh-Grant, Economic Analysis of Nitrate Reduction Effects in Drainage Water from Organic Farming Practices. 2000-2002. \$79,500 Illinois Department of Agriculture Sustainable Agriculture Program

Palm, H., Bullock, D. Suddurth, K., Kitchen, N., Wiebold, W., Hipple, J., Bollero, G., Reetz, H., 2001. Implementation and Validation of Sensor-Based Site-Specific Crop Management. (CSREES) Initiative for Future Agriculture and Food Systems (IFAFS) Grant Number: 2001-52103-11319; \$1,200,000 (Collaborative project with University of Missouri).

Tank, J.L., M.B. David, and T.V. Royer. 2001-2004. Factors Controlling Stream Denitrification in an Agricultural Landscape. USDA National Research Initiative Competitive Grants Program, Watershed Processes and Water Resources Program. \$315,000.

Vigue, Jerry. Increasing the Quality of Organic Food Grade Soybeans in Western Illinois. 2002. Western Illinois University Research Council Grant Program. \$4,190.

Vigue, Jerry. Pesticide-Free and Organic Crop Production on the Allison and Cooperating Farms. 2002-2003. Illinois Department of Agriculture, Sustainable Agriculture Grant Program \$85,628.

Williard, K.W.J. August 2000 – July 2004. Effectiveness of riparian buffer zones in attenuating nutrients and sediment from adjacent agricultural fields in southern Illinois. USDA McIntire-Stennis Cooperative Forestry Research Program \$80,000.

Winstanley, Derek. General Revenue Funds from the Illinois Department of Natural Resources. \$60,000

WATER QUALITY FORUM  
March 1, 2001

- 9:30 a.m. Introduction - George Czapar  
Illinois Department of Agriculture - Warren Goetsch  
SRI Overview - Jim Westervelt
- 9:45 a.m. Movement and Storage of Nitrogen in Illinois Watersheds – Mark David, moderator  
The Big Picture and the Research Needs (Mark David)  
Nitrogen in Rivers and Reservoirs (Laura Keefer)  
Fertilizer Use (Mark David)  
The Effect of Timing and Rate of N on Soil Transformations (Robert Hoefl)
- 10:45 a.m. Break
- 11:00 a.m. Movement and Storage of Nitrogen in Illinois Watersheds (cont)  
Nitrogen in Groundwater (Ed Mehnert)  
In-Stream Nitrogen Losses (Todd Royer)  
Panel Discussion
- 11:45 a.m. Lunch
- 1:00 p.m. Modeling to Support Economic and Ecological Decisions – Jim Westervelt, moderator  
Introduction (Jim Westervelt)  
Modeling Tile Drainage (Prasanta Kalita, Ben Yen)  
Modeling to Support Watershed Flood and Soil Loss Management (Deva Borah)  
Modeling Water Quality across Illinois (Steve Wente)  
Economic/Ecologic Decision Support System Modeling (Jean Mangun and Steven Kraft)  
Next Generation DSS (Jim Westervelt)  
Panel Discussion
- 2:30 p.m. Break
- 2:45 p.m. Developing and Testing Promising New BMP Strategies - Bob Hoefl, moderator  
Introduction (Robert Hoefl)  
Minimizing Nitrogen Loss from Tiled Fields (Robert Hoefl)  
Environmental and Economic Benefits of Precision Application of Nitrogen (Madhu Khanna, Stephen Ebelhar)  
New Strategies for Installing Tiles to Reduce Nitrogen Loss (Richard Cooke)  
Phosphorus Loss Under Alternative Application Strategies (Robert Hoefl)  
Panel Discussion
- 3:45 p.m. Final comments, Evaluation - George Czapar, moderator
- 4:00 p.m. Adjourn