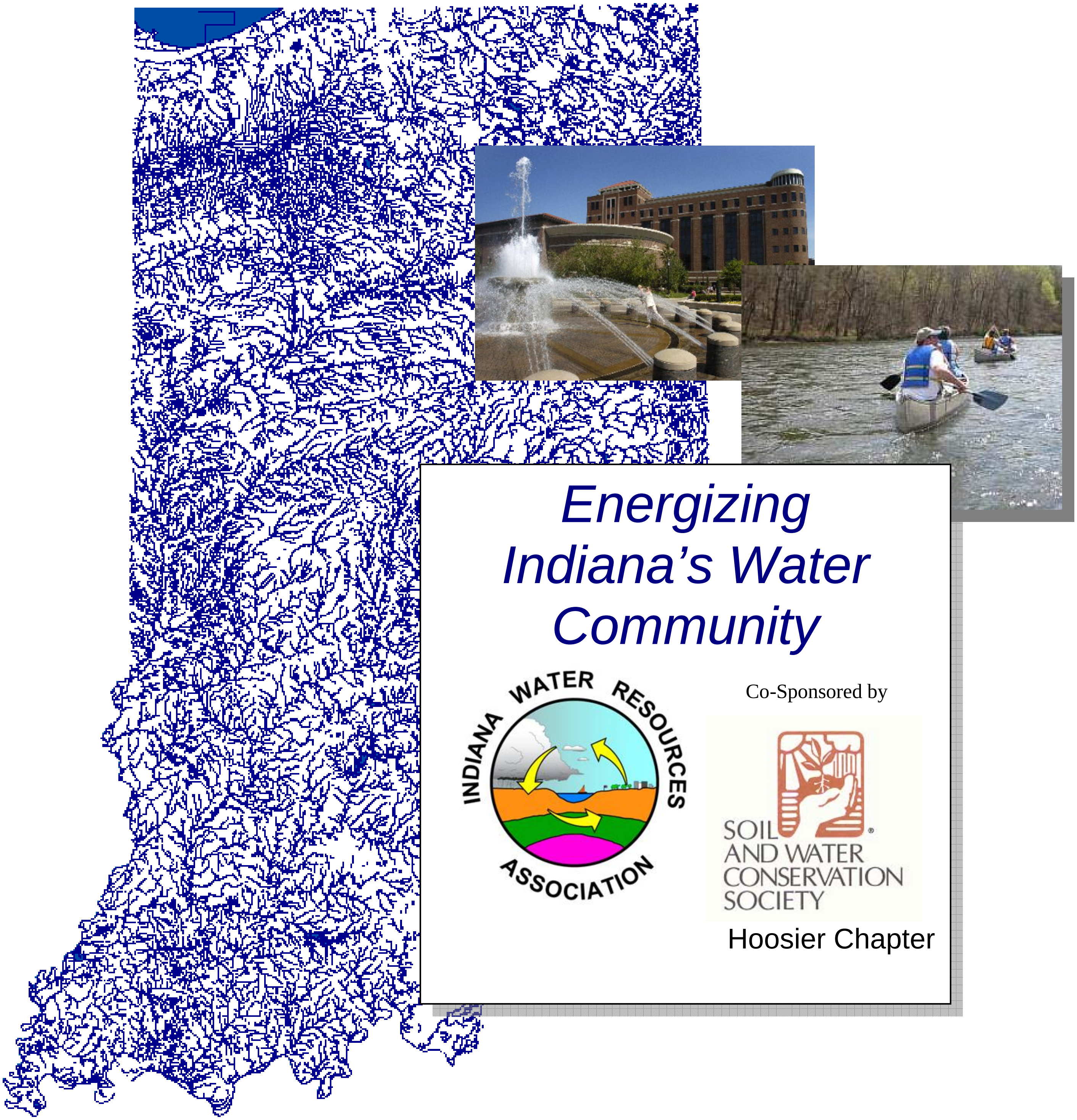
2006 27th Annual Symposium

Indiana Water Resources Association



Energizing Indiana's Water Community

Indiana Water Resources Association

Co-Sponsored by

Soil and Water Conservation Society

Hoosier Chapter

Purdue University, West Lafayette, Indiana

June 21-23, 2006

PROCEEDINGS

of the 27th Annual Symposium

sponsored by the

Indiana Water Resources Association

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"Energizing Indiana's Water Community"

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Forward

The Indiana Water Resources Association (IWRA) is pleased to present the Proceedings from our 27th Annual Symposium. Presentations cover a wide variety of topics, reflecting the diversity of our membership's expertise and experience. The theme this year is "Energizing Indiana's Water Community", reflecting the strength of IWRA in bringing together professionals in water resources and related areas to meet, discuss, and exchange ideas pertaining to all aspects of water resources research and management.

This symposium is co-sponsored by the Hoosier Chapter of the Soil and Water Conservation Society, and I would like to thank **Jennifer Kipper**, Professional Development Committee Chair for her support in this effort. We extend a special welcome to SWCS members, and hope that getting to know each other better will lead to strengthening water management in Indiana.

I would like to thank the following IWRA people for helping plan this symposium: **Jeff Martin**, US Geological Survey (Registration and hospitality); **Jeff Frey**, US Geological Survey (Program, Moderator); **Rosy Hansell**, Marion County Health Department (Refreshments); **Art Garceau,** IDEM (Moderator and discussion leader). Thanks also to tour leaders **Eileen Kladivko** and **Brent Ladd**, Purdue University, and **Cyndi Wagner**, IDEM; those in charge of audio/visual **Mazdak Arabi** and **Mark Thomas**, Purdue University, and **Alison Goss** who organized the poster session.

Finally, thanks to all the presenters and you, the participants, for making this an exciting and energizing conference. We hope the information and contacts gained at the Symposium will be useful to all of us in our efforts to protect and improve Indiana's water resources.

Jane Frankenberger
Editor and President IWRA, 2006

Thanks also to our sponsor:

The Indiana Water Resources Association

The Indiana Water Resources Association (IWRA) was founded in 1979 as a state affiliate of the American Water Resources Association to promote water resources research, education, and communication in Indiana. The IWRA is an organization of several hundred professionals and students working in all aspects of water resources. Its members include scientists, engineers, regulators, educators, policy-makers, and students from government agencies, universities, industry, consulting firms, and other water related groups.

Over the years, the IWRA's forums have focused on the emerging and imminent water resources issues in Indiana - from the effects of coal mining in the southwest to hazardous waste sites in the northwest, from rising water levels in Lake Michigan to flooding along the Ohio River; plus statewide issues like wellhead protection, drought, acid rain, and water quality standards.

To exchange information and explain research on these and other issues, the IWRA holds a multi-day meeting each year in June at varying locations throughout the state. These annual meetings alternate between symposia and field trips. The symposia include presentations and short courses by members and nationally recognized experts; followed the next year by field trips to natural features, industrial sites, and cultural and historical locations. A meeting is also held each fall for election of officers and other business, followed by a short seminar or field trip.

2006 IWRA Officers

President	Jane Frankenberger	Purdue University	frankenb@purdue.edu	765-494-1194
President-Elect	Tim Kroeker	IDEM	tkroeker@idem.IN.gov	317-234-3312
Secretary	Art Garceau	IDEM	agarceau@idem.IN.gov	317-308-3381
Treasurer	Kathy Fowler	USGS	kkfowler@usgs.gov	317-290-3333 ext. 137

IWRA Volunteer Support Positions

AWRA Liaison	Harold Templin	IDEM		317/232-8711
Academic Liaison, Webmaster	Ken Luther	Valparaiso University	ken.luther@valpo.edu	219/464-5183
Membership Committee	Jeff Martin	USGS	jdmartin@usgs.gov	317/290-3333 x 148

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Posters

The Charles Harold Bechert Award

The Indiana Water Resources Association is very pleased to announce the awarding of the Charles Harold Bechert Award this year. The award was first established in 1981 to be presented to a member of the water-resources community who has contributed significantly to water-resources activities within Indiana.

Charles Bechert has been recognized as a major pioneer in Indiana's water-resources management programs. Following graduation with honors from Purdue University in 1929, he became the State's first sanitary engineer in the Department of Conservation. During his 36-year career with the Department, he served as Assistant Chief of the Division of Water, Department of Natural Resources and served in that capacity until 1970.

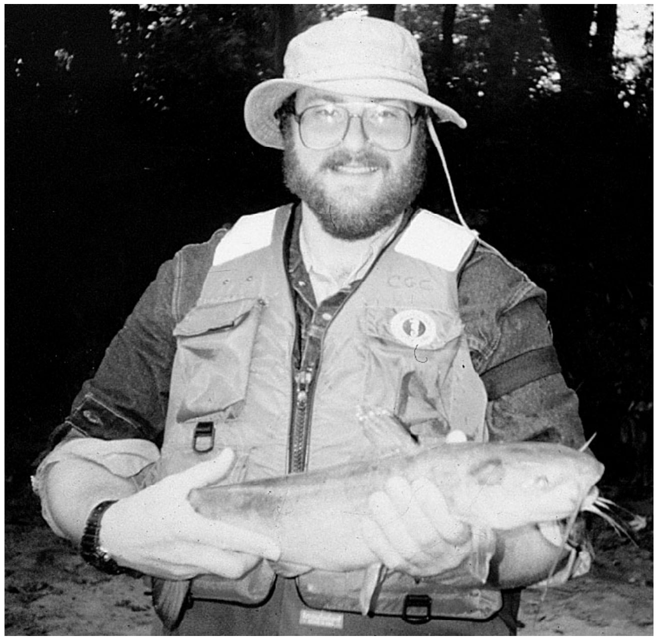
During his distinguished career, Mr. Bechert was officer and member of numerous water-related organizations. He served as president of the American Society of Civil Engineers and of the Indiana Division of the American Water Works Association. His membership in other organizations included, Indiana Society of Professional Engineers, Scientech Club, Indiana Academy of Sciences, and Tau Kappa Epsilon and Chi Epsilon honorary fraternities.

His professional abilities were recognized in 1963 by Governor Matthew Welch when Mr. Bechert was appointed Sagamore of the Wabash. He was also presented the George Fuller Award in 1955 by the American Water Works Association and is listed in Who's Who in the Midwest (1967-68).

Past recipients of the Charles Harold Bechert Award are Oral Hert (1981), Daniel Wiersma (1982), William J. Andrews (1984), William J. Steen (1986), Dennis K. Stewart (1990), Jacques W. Delleur (1992), Jim Barnett (1996), John Simpson (1998), Thomas Bruns (2002), and Mark Reshkin (2004).

Charles G. Crawford

Recipient of the 2006
Charles Harold Bechert Award



The Indiana Water Resources Association is pleased to present the eleventh Charles Harold Bechert Award to Dr. Charles G. Crawford in recognition and appreciation of his many important scientific contributions to the knowledge of water resources in Indiana.

Dr. Crawford received a Bachelor of Arts degree in Biology, magna cum laude, from the University of Indianapolis in 1976, and Master of Science and Doctorate degrees in Environmental Science from Indiana University in 1978 and 1996 respectively.

Dr. Crawford joined the U.S. Geological Survey as a hydrologist in 1978 and began his career modeling dissolved-oxygen concentrations and waste-load assimilation in thirteen Indiana streams. In the 1980's Charlie directed or participated in several studies of Indiana's water resources including assessments of the hydrology of coal-mined areas and the hydrologic effects of mining, a study to measure reaeration in the Wabash River, a study to evaluate municipal and industrial point-source effluent loadings to the Grand Calumet River, a study of the effects of advanced treatment of municipal wastewater in Indianapolis on the water quality and benthic invertebrate communities of the White River, and an analysis of sediment concentrations and loads for 71 stations in Indiana's suspended-sediment monitoring network.

In the 1990's Dr. Crawford moved into supervisory positions with the USGS serving as Chief of the Hydrologic Investigations Section and Chief of the National Water Quality Assessment Program (NAWQA), White River Basin Study. In these supervisory positions, he was responsible for recruiting and supervising staff and developing and managing hydrologic investigations. As Chief of Investigations, Charlie developed a study of the effects of urban runoff on small streams, a study of the water quantity and quality of the sole-source St. Joseph aquifer system, and a study to evaluate the potential for bridge scour at 5,000 bridges in Indiana. In addition, he was project chief of a study with NOAA to compute trace-element loads in 149 coastal rivers. As NAWQA Chief, Charlie was instrumental in the design of the study and had the primary responsibility for analysis, interpretation, and communication of the surface-water pesticide data and historical fish data. He wrote the computer program LOADEST2, software extensively used by USGS, NOAA, and other agencies for estimating constituent loads in streams.

In 2000, Dr. Crawford's geographic area of study expanded from Indiana's water resources to the Nation's water resources as he took positions on the NAWQA Pesticide Synthesis Team and, in 2005, became the NAWQA Surface Water Status and Trends Coordinator. As a member of the Pesticide Synthesis Team, Charlie worked closely with USDA, USEPA, and the American Crop Protection Association to use NAWQA pesticide data to help meet the goals of the Food Quality Protection Act. Charlie led the development of modeling efforts to estimate pesticide concentrations in streams throughout the U.S. As Status and Trends Coordinator, Charlie provided the technical leadership for redesigning NAWQA's surface-water monitoring efforts to better support modeling efforts to predict water quality in unmonitored areas.

Dr. Crawford served on the Indianapolis Department of Capital Asset Management Wet Weather Technical Advisory committee from 1996 through 2000 and has served as a technical reviewer for several professional journals including Environmental Science & Technology, Journal of the American Water Resources Association, and Water Resources Research. Dr. Crawford is the author or coauthor of more than 50 technical reports and journal articles and is a member of American Water Resources Association, the Indiana Academy of Sciences, and the Indiana Water Resources Association. Charlie served as the secretary of IWRA in 1980, vice president in 1982, and president in 1983 and has served on several IWRA symposium committees.

Dr. Crawford is well known for work that meets the highest scientific standards. Charlie is an outstanding statistician, programmer, manager, and multidisciplinary scientist. His thorough literature reviews often reveals techniques and approaches from other disciplines that can be applied to water-resource investigations. Charlie's quantitative and analytical skills are legendary in the USGS and he is a long-time instructor in the USGS statistical analysis training class. In addition to his many personal water-resource achievements, Charlie is a generous colleague, always willing to take time to advise, consult, and "crunch numbers" for those seeking help. In view of Charlie's outstanding record of achievement and service, IWRA is pleased to award the eleventh Charles Harold Bechert Award to Dr. Charles G. Crawford. Congratulations Charlie and best wishes for the future.

Technical Tours

The Tours were organized to allow Symposium attendees to see some of the interesting water-related activities and new research at Purdue University. All are invited to join one or both of these walking tours, which will take place in the cool of the early morning.

Tour groups will meet at 7:45 in the area between Purdue Memorial Union and Stewart Center. They will return to the meeting room in Stewart Center between 9:15 and 9:30, to allow time for coffee before the Symposium presentations begin at 9:40. A map is provided in the inside front cover.

Thursday Tour

Thursday's walking tour focuses on the southern portion of campus, where most of Purdue's agricultural and natural resources research and education take place.

- **Boiler Bug Barn**: The new Boiler Bug Barn houses live insect displays including Madagascar hissing cockroaches, mealworms and milkweed bugs; insect predators such as fish, tarantulas and crayfish; and a display on the "impact of insects on the history of the world". (Host: Outreach Coordinator Mike Mullis)
- **Soil Resource Center**: The soil monolith collection housed here is believed to be the largest at any U.S. university and possibly the largest in the world. (Host: Outreach Coordinator Sherry Fulk-Bringman)
- **National Soil Erosion Research Laboratory**: This USDA Agricultural Research Service facility is a national and international focal center for erosion research. Home of the Universal Soil Loss Equation (USLE), NSERL currently also conducts broad-based watershed scale soil and water quality research. (Host: Research Director Dr. Chi-Hua Huang)

We will also point out highlights like the newly renovated Pfendler Hall, the Office of the State Chemist which is a regulatory agency of the State of Indiana, and the Agricultural and Biological Engineering building.

	Group 1 Cyndi Wagner, leader Yinghui Sui	**Group 2** Eileen Kladivko, leader	**Group 3** Brent Ladd, leader
7:45	Walk to SOIL	Walk to SMTH 124	Walk to LILY 3-419
8:00	**Soil Erosion Lab**	**Boiler Bug Barn**	**Soil Resource Center**
8:15	Walk to SMTH 124	Walk to LILY 3-419	Walk to SOIL
8:25	**Boiler Bug Barn**	**Soil Resource Center**	**Soil Erosion Lab**
8:35	Walk to LILY 3-419	Walk to SOIL	Walk to SMTH 124
8:50	**Soil Resource Center**	**Soil Erosion Lab**	**Boiler Bug Barn**
9:05-9:15	Return to Stewart Center	Return to Stewart Center	Return to Stewart Center

National Soil Erosion Research Laboratory

Mission: *"To develop the knowledge and technology needed by land users to conserve soil for future generations."*

The history of National Soil Erosion Research Laboratory (NSERL) traces back to 1954 when USDA established National Runoff and Soil Loss Data Center on the campus of Purdue University at W. Lafayette, Indiana, under the leadership of Walter Wischmeier. Initial research focus was on **Universal Soil Loss Equation (USLE).** With the use of **rainfall simulator** and flume, erosion process research was also initiated and became the main thrust of the Laboratory. For almost 30 years, ARS erosion scientists were housed in University departments, fostering a strong ARS-University partnership. In 1982, NSERL was formally established with the opening of its current facility. With the maturity of USLE technology, NSERL scientists started the development of a process-based **Water Erosion Prediction Project (WEPP)** Model. For more than 50 years, NSERL has established itself as the national and international focal center for erosion research. Almost all erosion scientists in the world have been associated with NSERL through graduate studies, exchange visits and cooperative research. In 2001, NSERL shifted its long tradition of plot and field-based erosion sedimentation research into a broad-based **watershed scale soil and water quality research program**. NSERL currently has a state-of-the-art facility for watershed hydrology, water quality monitoring, soil quality and trace gas analyses. In addition, NSERL scientists are engaged in national leading edge research activities such as: Watershed-scale conservation effects assessment (CEAP); Greenhouse gas emission from agricultural productions (GRACEnet); Next-generation combined wind and water erosion assessment tool.
Web site: http://topsoil.nserl.purdue.edu/nserlweb/index2.html

The Boiler Bug Barn

The Boiler Bug Barn was established in January 2006 as a visitors' center for the Department of Entomology. It houses live insect displays including Madagascar hissing cockroaches, giant cave cockroaches, dermestid beetles, mealworms and milkweed bugs. Other living arthropods on display include millipedes and scorpions.

Living insect predators including fish, tarantulas and crayfish are present to illustrate the important role that insects play as food in the web of life. The impact of insects on the history of the world is also displayed and insect-related computer games are available.

A number of items from the Bug Bowl are featured including the original cockroaches in the first "All American Trot" and the "Old Open Can" trophy that is a part of the annual cockroach races at Roachill Downs.

The Boiler Bug Barn is a collection of the sights, sounds, and smells of the insect world and how humans have interacted with their six-legged competitors for centuries. This insect adventure is free of charge courtesy of the Department of Entomology of Purdue University

Friday Tour

Friday's tour takes you through the central campus and the Engineering Mall with the signature fountain. We will visit two unusual facilities:

- The **Purdue Rare Isotope Measurement (PRIME) Lab** is at the site of a particle accelerator constructed under the Engineering Mall in 1968. (Host: Lab Director Dr. David Elmore)
- The **Purdue Stable Isotope Facility** was just completed in 2006, and is used for the measurement of isotopes in water, carbon, and nutrient research. (Host: Dr. Greg Michalski)

	Group 1 (Eileen Kladivko, leader)	**Group 2** (Brent Ladd, leader)
7:45	Meet at Purdue Memorial Union; Walk to Physics 110	Meet at Purdue Memorial Union; Walk to CIVIL 3294
8:00	Tour of PRIME laboratory	Tour of Purdue Stable Isotope Lab
8:25	Walk to CIVL 3294	Walk to Physics 110
8:35	Tour of Purdue Stable Isotope Lab	Tour of PRIME laboratory
9:00-9:15	Walk to Stewart Center	Walk to Stewart Center

Purdue Rare Isotope Measurement Laboratory (PRIME Lab)

Installation of the tandem Van de Graaff accelerator under the Engineering Mall in 1968

The Purdue Rare Isotope Measurement Laboratory (PRIME Lab) is a dedicated research and service facility for accelerator mass spectrometry (AMS). AMS is an ultra-sensitive analytical technique for measuring low levels of long-lived radionuclides and rare trace elements. Purdue has a major national AMS facility centered around the Physics Department's tandem electrostatic accelerator. We are using the accelerator to measure both man-made and cosmic-ray-produced radionuclides such as ^{10}Be (half-life 1,600,000 years), ^{14}C (5730 years), and ^{36}Cl (300,000 years) in natural samples having isotopic abundances down to $1x10^{15}$. Although the instruments and detection methods are those of nuclear physics, research applications are concentrated in the Earth sciences and biomedical sciences. Earth science applications include radiocarbon dating, dating the exposure time of rocks on the surface of the earth in the range 10,000 to 300,000 years, measuring erosion rates of rocks and landscapes, dating and tracing of old ground water, and dating of meteorites recovered from the Antarctic ice sheet. (Information and photo from http://www.physics.purdue.edu/primelab)

Presentation Abstracts

Wednesday, June 21

Indiana's Combined Sewer Communities: Progress In Improving Water Quality

Cyndi Wagner, Chief, Wet Weather Section, Office of Water Quality, Indiana Department of Environmental Management

Indiana has over 100 communities with antiquated sewer systems that carry sanitary waste to wastewater treatment plants in dry weather and storm water and sanitary flow to our rivers and streams in wet weather. The presentation will outline both the water quality and use issues of our streams, design options for combined sewer overflow (CSO) treatment, and IDEM's plan to bring all CSO communities into compliance with the Long Term CSO Control Plan requirements of state and federal law by the end of 2009.

Contact: CWAGNER@idem.IN.gov

Environmental Restoration in Urbanizing Watersheds: A Case Study in Integrating Development and Water Management with Environmental Restoration

Joe Pfeiffer, Jr. PWS, KCI Technologies Inc.

As urbanization continues to advance, greater pressure is placed on the remaining ecological systems. Impacts are not restricted to direct conflicts with the infrastructure of development, but also include secondary impacts from storm water discharges. Recognition of the effects of development can lead to opportunities for environmental restoration that both protect and restore the environment and serve the water management needs of the development. This understanding was applied to the development of a 1,500,000 sf warehouse facility in a rapidly developing watershed of Plainfield, Indiana to integrate the relocation of 5,000 lf of stream channel, wetland mitigation, storm water management and water quality. The resulting hybridization achieved a net benefit for the environment and development while minimizing secondary impacts on downstream resources.

Contact: jpfeiffer@kci.com

Indiana's Storm Water Regulations: Construction and Post Construction

Randy J. Braun, CPESC, Storm Water Program Manager, IDEM, Office of Water Quality

Storm water can have a significant impact on Indiana's water resources. These impacts are often the result of pollutants that are associated with construction/land disturbing activities and the post construction land use. In 1992, Indiana adopted storm water rules. One of these rules, commonly referred to as Rule 5, specifically addressed sediment that results from land disturbing activities. In 2003, Rule 5 was revised to incorporate the National Pollutant Discharge Elimination Phase II requirements. At the same time, Rule 13 was also adopted to designate communities within Indiana as Municipal Separate Storm Sewer Systems (MS4s).

This presentation will focus on the current status of these regulations and outline differences in between Rule 5 and Rule 13. Local MS4 communities will become more involved in the permitting process and compliance issues as they begin implementing programs locally.

Contact: rbraun@idem.in.gov, Phone: 317-234-3980

Fits and Starts – Creating a Storm Water Quality Strategy in Monroe County

Todd Stevenson, Monroe County Highway Department

Monroe County has been attempting to put into practice a storm water quality management plan (SQMP) for over a year. Although research, discussion, and planning have accompanied this process, the actual implementation has been characterized by fits and starts. The "state of the art" in storm water quality management is a term used by structural BMP (best management practice) salespeople but few others. The challenge is not only to know in the first place what practices will work in the long term, but to understand how people with different perspectives will be encouraged to apply them.

Recognizing that communities are different, the Environmental Protection Agency (EPA) has required that each regulated entity come up with their own plan, according to a six point outline provided by them. Many jurisdictions have interpreted this as an engineering or public works program and have delegated responsibility accordingly. The water quality approach that results is invariably to add structural BMPs to otherwise unaltered development plans. The scope of the SWQP is limited, and the relevance of the first two measures in the EPA outline (public education and public participation) is essentially lost.

Storm water quality is affected by a variety of land use decisions and wastewater treatment options. It makes sense to consider these issues in the development of a SQMP. In light of suburban sprawl concerns (relating to natural resources preservation and pervasiveness of individual lot septic systems), along with aging, leaky sanitary sewer collection systems associated with existing urban wastewater utilities, a clean water initiative provides an opportunity to rethink land use issues in unincorporated Monroe County.

Contact: tstevenson@co.monroe.in.us

Impact of watershed development and forest management on watershed sediment yields

Keith Cherkauer, Agricultural & Biological Engineering and Laura Bowling, Agronomy, Purdue University

The relationship between erosion and land use in forested watersheds has been known in a qualitative sense for some time. Vegetation management, road construction and forest fires impact basin sediment yield by increasing the amount of sediment available for transport and the amount of surface water available to transport it. Recent paired watershed studies using statistical methods show general relationships between forest management practices and sediment yields. These approaches, while providing useful background information, are not derived from physical hydrologic and hillslope processes, and are therefore of limited use for prediction in a management context. Mixed ownership and land-use, including the construction of houses, yards and public roads in and around state forests, introduce further complexities to Indiana watersheds, which would be difficult to separate using statistical approaches.

An alternative approach for evaluating sediment movement in forested watersheds derives from spatially distributed, physically-based hydrologic models. The Distributed Hydrology-Soil-Vegetation Model (DHSVM) is a hydrological model that explicitly represents the effects of topographic and subsurface heterogeneities on the downslope redistribution of subsurface moisture. It was designed to provide a tool to address the hydrologic consequences, especially changes in flood potential, associated with forest disturbance (logging, fire, forest roads) in forested mountainous watersheds. Recently, DHSVM has been extended to address sediment delivery in mountainous forested watersheds via erosion from forest roads and trails, overland flow and in channel flow, as well as mass wasting.

The 133 acre Yellowwood Lake in Brown County, Indiana was created in 1937 with the damming of Jackson Creek. Approximately 80% of the 4,389 acre (18 km^2) surrounding watershed is comprised of the Yellowwood State Forest. In recent years, there has been mounting concern over water quality, in particular with regard to the sediment load into the lake. Typical of many state forest lands, there is currently insufficient information to evaluate sediment sources or causality in this mixed ownership and land-use environment. The purpose of this project is therefore to evaluate a distributed hydrologic and sediment model as a tool for watershed-based planning in the Yellowwood watershed.

Model simulations are run using historical meteorological forcing data over a variety of land cover scenarios. These include current land-use maps, changes due to recent harvest within the watershed and extreme changes in land-use to test the sensitivity of the model. Water and sediment fluxes from the watershed are compared between land-use scenarios to demonstrate the model's sensitivity to harvest practices and road construction. Rates of sediment input to Yellowwood Lake are compared with observed changes in lake depth. Results from this initial study will be used to identify significant areas for continued research and observation within the watershed and with DHSVM.
Contact: cherkaue@purdue.edu

Statewide Monitoring of Mercury in Surface Water, Precipitation, and Fish in Indiana

Martin Risch and Nancy Baker, USGS Indiana Water Science Center

The U.S. Geological Survey in cooperation with the Indiana Department of Environmental Management (IDEM) has operated statewide monitoring networks for assessing mercury concentrations and loads in surface water since 2002 and mercury concentrations and deposition from precipitation since 2001. In addition, IDEM has maintained annual fish sampling for mercury since 1993 in support of health-risk fish-consumption advisories. These monitoring data were examined for their capability to detect corresponding changes in mercury deposition, mercury loads, and mercury in fish in Indiana from 2002 through 2005. Also, mercury-monitoring data from the three programs was used to assess any spatial patterns or clusters with mercury-source inventories and environmental features in Indiana. Mercury-source inventories included stationary emissions to the air and discharges to surface water from wastewater treatment. Environmental features included land cover and land use. The monitoring data and source inventories were organized by watershed and mapped with the environmental features. Watersheds were identified where mercury in fish and mercury loads spatially coincided with mercury sources or certain land cover and land use. These spatial relations were used to evaluate advantages and limitations of the existing locations for mercury monitoring and to identify optimal locations for mercury monitoring.

Contact: mrrisch@usgs.gov

Pesticides in the Nation's Streams and Ground Water, 1992–2001

Jeffrey D. Martin, USGS Indiana Water Science Center

The use of pesticides to control weeds, insects, and other pests has resulted in a range of benefits, including increased food production and reduction of insect-borne disease, but also raises questions about possible adverse effects on the environment, including water quality. Water samples collected from 1992 through 2001 from 186 streams and rivers and from 5,047 wells in 51 of the Nation's major river basins and aquifer systems were summarized to provide the most comprehensive national-scale analysis of pesticide occurrence to date. At least one pesticide was detected in water from all streams studied and at least one pesticide was detected more than 90 percent of the time in water from streams draining agricultural, urban, or mixed land uses. Pesticides were less common in ground water than in streams but were detected in more than 50 percent of the sampled shallow wells beneath agricultural and urban areas. About one-third of the deeper wells sampled, which tap major aquifers used for water supply, contained one or more pesticides or pesticide degradates.

Concentrations of pesticides in streams and ground water were typically below water-quality benchmarks for human health. Only 11 of 186 streams had pesticide concentrations (usually atrazine or cyanazine) greater than a human-health benchmark (benchmarks are annual average concentrations). Only about 1 percent of the 2,720 domestic-supply and public-supply wells sampled had pesticide concentrations (usually dieldrin) greater than a human-health benchmark. Concentrations of pesticides in streams were typically above aquatic-life benchmarks (benchmarks are single sample concentrations or moving average concentrations). One or more pesticides exceeded benchmarks for aquatic life in 83 percent of urban, 57 percent of agricultural, and 42 percent of mixed-land-use streams. The insecticides diazinon, chlorpyrifos, and malathion were frequently above benchmarks for aquatic life in urban streams whereas chlorpyrifos, azinphos-methyl, atrazine, *p,p'*-DDE, and alachlor were frequently above benchmarks in agricultural streams.

Results of the assessment show that pesticide use is a major determining factor in pesticide occurrence, particularly for streams. Concentrations of atrazine, metolachlor, simazine, acetochlor, 2,4-D, chlorpyrifos, and diazinon in streams directly correlate with areas where they are used on crops. As use changes through time, concentrations in stream-water samples also change. National-scale models of pesticides in streams also show that pesticide use is the most important explanatory variable for predicting concentrations.

The national assessment serves as a foundation for improving water-resource assessment and management, but major gaps in critical information about pesticides still persist and continue to present challenges to scientists, managers, and policymakers. Some of the most important steps needed to fill gaps are: (1) improve tracking of pesticide use, particularly in urban areas; (2) add assessments of pesticides not yet studied; (3) improve assessment of pesticide degradates, including their distribution and potential effects; (4) evaluate toxicities of pesticide mixtures and their potential to affect humans and aquatic life; (5) evaluate the performance of pesticide-management practices; (6) improve methods for prediction of pesticide concentrations in unmonitored areas; and (7) sustain and expand long-term monitoring for trends.

Information for this presentation was taken from U.S. Geological Survey Circular 1291 "*The Quality of Our Nation's Waters—Pesticides in the Nation's Streams and Ground Water*, *1992–2001*." The report and supporting information are available at http://ca.water.usgs.gov/pnsp/pubs/circ1291/

Contact: jdmartin@usgs.gov

Potential Water Quality Impacts of Asian Soybean Rust Fungicide Applications in Indiana

Leighanne Hahn, Tong Zhai, K.J. Lim, Hugo Ochoa-Acuña and Bernie Engel, Purdue University

Soybean Rust (*Phakopsora pachyrhizi*) is a serious disease that has inflicted substantial crop losses throughout the world and recently has spread to states within the continental United States (U.S.). The recent introduction of Soybean Rust into the U.S. has prompted the Environmental Agency (EPA) to issue emergency exemptions for use of several fungicide active ingredients (11) to treat this virulent soybean pest. Since 11.3 million acres of corn and soybeans are grown in Indiana and runoff is the primary means of surface water contamination, a potential exists for adverse ecological effects to be associated with the increased use of fungicides. Fungicide losses via runoff, leaching, and sediment transport were estimated using the National Agricultural Pesticide Risk Analysis (NAPRA) WEBtool. This model was designed to assess risk of pesticide loss to ground or surface water as a result of various crop-tillage-management practices. NAPRA WEBtool is Indiana specific with web interfaces and databases that provided soil type and climatic based probabilities of off-site pesticide loadings by using Groundwater Loading Effects of Agricultural Management Systems (GLEAMS). Other model parameters and assumptions include the number of applications, the product rate (highest labeled rate), and the chemical properties of the product (Koc, solubility, and soil-half life). Probabilities of off site movement of fungicide concentrations were calculated for a simulation period of 40 years. Our results show that potential loadings and runoff concentrations vary greatly among the active ingredients approved for use to combat soybean rust and therefore the implication of these impacts needs to be further assessed.

Contact: hahnl@purdue.edu

Preferential Flow Estimates to an Agricultural Tile Drain with Implications for Glyphosate Transport

Wesley W. Stone and John T. Wilson, USGS Indiana Water Science Center

Agricultural subsurface drains, commonly referred to as tile drains, are potentially significant pathways for the movement of fertilizers and pesticides to streams and ditches in much of the Midwest. Preferential flow in the unsaturated zone provides a route for water and solutes to bypass the soil matrix and reach tile drains faster than predicted by traditional displacement theory. This paper uses chloride concentrations to estimate preferential flow contributions to a tile drain during two storms in May 2004. Chloride, a conservative anion, was selected as the tracer because of differences in chloride concentrations between the two sources of water to the tile drain, preferential and matrix flow. A strong correlation between specific conductance and chloride concentration provided a mechanism to estimate chloride concentrations in the tile drain throughout the storm hydrographs. A simple mixing analysis was used to identify the preferential flow component of the storm hydrograph. During two storms, preferential flow contributed 11 and 51% of total storm tile drain flow; the peak contributions, 40 and 81%, coincided with the peak tile-drain flow. Strong positive relations between glyphosate [N-(phosphonomethyl) glycine] concentrations and preferential flow for the two storms suggest that preferential flow is an important transport pathway to the tile drain.

Contact: wwstone@usgs.gov

Glyphosate Concentrations in Various Hydrological Compartments of a Small Watershed in East-Central Indiana

Nancy T. Baker, USGS Indiana Water Science Center and Michael T. Meyers, USGS Kansas District Organic Geochemistry Research Lab

Glyphosate is a widely used herbicide in the cropping of genetically modified herbicide resistant soybeans and corn. In 2004 in Indiana, approximately 94 percent of the soybeans were glyphosate resistant. Glyphosate has a very high organic carbon adsorption coefficient, which allows it to be readily bound to soil particulates on the land and in the water. To investigate the occurrence and transport of glyphosate in the agricultural environment, the U.S. Geological Survey collected samples from various hydrological compartments (precipitation, soils, soil water, shallow ground water, tile drain effluent, field surface runoff, and ditch water) in a small watershed in east-central Indiana. Glyphosate was detected more than 50 percent of the time in each of the hydrological compartments and 100 percent of the time in soils and field surface runoff. The highest glyphosate levels were also seen in soils, 476 parts per billion (ppb), and field surface runoff (427 ppb). As expected, the maximum glyphosate concentration in soil water (0.14 ppb), shallow ground water (0.13 ppb), tile drain effluent (4.71 ppb), and precipitation (1.09 ppb) were low; however, glyphosate was detected frequently in these compartments, 59, 100, 87, and 92 percent of the samples, respectively. The soil-binding properties of glyphosate strongly affect the hydrologic movement of this compound; transport pathways that move sediment and soil particulates also are the most important pathways for glyphosate transport. However, some glyphosate does move through the soils to tile drains. This is likely secondary to preferential flow pathways (macropores, shrink-swell fissures, and biota-created channels) during larger rainfall events.

Contact: ntbaker@usgs.gov

Thursday, June 22 – Morning

Raysville Dam Decommissioning: A Case Study into Dam Removal in Indiana

Brian McKenna, P.E., Earth Tech, and Terri Price, IDNR, Division of Water

The Raysville Dam was originally constructed as a railroad embankment sometime in the late 1800's. A natural stream was able to pass uncontrolled through a stone arch conduit under the embankment until the 1920's when a concrete control structure was constructed at the upstream end of the arch. The control structure and embankment created a 6 acre impoundment with the stone arch conduit serving as the sole outlet for the lake. Development took place in the vicinity of the lake with several homes and a major US highway being constructed just below the dam. The embankment was eventually abandoned by the railroad and was used as a roadway until the deteriorating condition of the arch prompted the closure of the roadway.

The deterioration of the arch posed a significant threat to the safety of the dam. Several portions of the arch outlet conduit showed signs of weakening while one portion of the conduit had already experienced a partial collapse of the stone wall supporting the embankment. A total collapse of the arch would have cut off the only outlet for the lake and would have likely resulted in a catastrophic failure of the dam, possibly causing significant damage to the structures located downstream. The embankment itself showed signs of potential weakness that could have also led to a failure. Areas of standing water thought to be the result of seepage through the dam embankment were observed at the downstream toe of slope. In addition, the dam embankment was covered with trees, further increasing the opportunity for seepage and accelerating the possibility of a failure.

Ownership of the dam and outlet conduit is unknown due to its age and numerous changes of ownership over the years. Consequently, the Indiana Department of Natural Resources (IDNR) initiated an evaluation to determine the feasibility of draining the impoundment and removing the outlet conduit and a section of the dam embankment to remove the potential for a dam failure. Earth Tech was retained by IDNR to design a solution for the decommissioning of the dam, provide detailed plans and specifications, and assist with construction engineering and on-site observation services during the construction of the project which took place in the fall of 2004.

The main objective of the decommissioning design was to improve the overall safety of the structure by reducing the potential for a catastrophic failure of the embankment. Several other considerations for the design were also established through coordination with IDNR as well as other regulatory agencies and stakeholders. These considerations included minimizing construction and long term maintenance costs, maintaining flood storage properties of the dam to protect downstream structures from severe rainfall events, minimizing the amount of sediment released during and after construction, and staging of the demolition sequence of the dam and arch outlet conduit. Key lessons were learned during the design and construction phases of this successful dam decommissioning project. After a year and a half since construction, this project has also provided valuable insight into the response of sediment in the lake bed following the removal of a dam.

Contact: Brian.McKenna@earthtech.com, tprice@dnr.IN.gov

Recent IDNR Lake Level Outlet Control Structure Repair and Reconstruction Projects.

David Nance, Engineering Geologist, IDNR, Division of Water

Over the past year, IDNR has completed four lake level outlet control structure projects in a relatively small geographic area north east of Warsaw, Indiana. These four projects represent a cross section of typical lake level outlet control structure repair projects. The outlet control for a natural lake is often as unique as are the lakes. As a result, the outlet setting, the outlet structure, or a problem with the outlet structure is usually anything but typical. This presentation will provide the highlights of the four projects, with emphasis on the setting, authority, importance, and unique challenges associated with the activity. Some project history will be presented for the projects. The goals of the project will be discussed along with the structural improvements and approximate cost.

Contact: dnance@dnr.IN.gov

Hurricane Katrina and the Great Mississippi River Flood of 1927: The President, Congress, Corps of Engineers, ASCE and the World VS. New Orleans and Louisiana in Water Disasters

J. Darrell Bakken, P.E., D.E. E., Environmental Engineer

Contact: jdarrellb@sbcglobal.net

Evaluation of Flow Augmentation in the Whitewater Canal, Metamora, Indiana

Paul A. Johnson, LPG, Jeffrey Spicer, Andrew Cochrane, PE and Robert E. Hittle
American Consulting, Inc.

The Whitewater Canal is a State-designated historical site managed and operated by the Indiana Department of Natural Resources (IDNR). The canal was a part of the statewide canal system and provided a distribution and transportation link for goods and services between the Ohio River region and southeastern Indiana. Today, the Whitewater Canal is a cultural and tourist attraction for the Metamora area.

The original Whitewater Canal stretched from Lawrenceburg to Connersville and was constructed during the period 1839-1844. The canal operated for approximately two decades, but became unprofitable as a transportation route due to the onset of the railroads. Flow in the canal was maintained by a series of low-head ("feeder") dams. Presently, the Whitewater canal has flow from southeast of the Town of Laurel through Metamora and down to Brookville. The Laurel Feeder Dam is the primary supply of water in the present canal. Decades of sedimentation at the Laurel dam and intake structure limit flow in the canal. Moreover, on-going sedimentation in sections of the canal in Metamora limit operation of the canal tour boats, requiring frequent dredging and maintenance.

The IDNR contracted with American Consulting, Inc. to evaluate the causes of the sedimentation and design structural controls to minimize the on-going maintenance issues. In addition, the IDNR wishes to operate a grist mill wheel within Metamora using the flow within the canal. The present flow within the canal is insufficient to turn the grist wheel and provide sufficient flow to operate the tour boats. American Consulting is also investigating the potential to augment the canal flow through construction of wells, an infiltration gallery or a reconfigured feeder dam/channel near the existing Laurel feeder dam.

Preliminary results from this study indicate the existing canal cross-section may not have sufficient capacity to supply the needed flow from Laurel through Metamora without impacting adjacent properties. Alternates to supplying the needed canal flow without increasing erosion and sedimentation within the historic canal will be presented. These alternates include installation of wells along the canal near Metamora, as well as options for an infiltration gallery or Ranney-style well, or a supplemental diversion from Duck Creek.

Contact: amypauljohnson@comcast.net

Water Resources Protection and Conservation Toolkit

Reggie Korthals, Northwestern Indiana Regional Planning Commission; Sarah B. Nerenberg, Water Resources Consultant

The three counties in Northwestern Indiana are predicted to see greater growth in areas not currently receiving Lake Michigan water as the population declines in the urban core along the Lake Michigan shoreline. Because of this change and the unknowns in future water quality and quantity in the three-county region, NIRPC is taking the lead in the region to educate local governments on the availability, protection, and conservation of its water resources.

Under a grant from the Joyce Foundation, NIRPC produced a Water Resources Protection and Conservation Toolkit. The toolkit provides background on water resources and methods to best protect critical water resources in and near the Great Lakes watershed.

These tools are intended to help communities in these areas to most effectively protect and conserve water resources and protect the natural water cycle. The toolkit is intended to assist communities meet part of the major goal of the Great Lakes Charter Annex of 2001 - to protect, conserve, restore, and improve the water and water dependent natural resources of the Great Lakes.

The toolkit consists of a series of fact sheets that provide overviews of the key issues and identify a series of resources saved on a CD that will assists homeowners, local governments, water utilities, and developers in making choices that better protect, conserve, and sustain local water resources. To-date, 500 toolkits and 1000 CDs have been distributed throughout the Lake Michigan Watershed. Currently, NIRPC is assessing the future water supply planning needs of the region and strategizing on an approach.

This presentation will frame the water resources issues in Northwestern Indiana, present the challenges, provide an overview of the key players, and summarize the content and intention of the toolkit.

Contact: rkorthals@nirpc.org; URL: http://www.nirpc.org/

A First Water Resources Class at Valparaiso University

Kenneth Luther, Valparaiso University ,

The course ENVS 340: Water Resources Science and Management was offered at Valparaiso University for the first time. I will present an overview of the course, including student activities, student feedback, reviews of the three texts we used, and comments on things I learned from the course. Audience input will be requested regarding the content of the course as well as the structure of the entire Environmental Science program at Valpo.

Contact: ken.luther@valpo.edu

Thursday, June 22, Afternoon

Incorporating Social Indicators into a Regional Evaluation Framework for NPS

Shorna Broussard, Linda Prokopy, Department of Forestry and Natural Resources, Purdue University

Rivers and streams in the Great Lakes Region (USEPA Region 5) face significant impairment from nonpoint sources (NPS) -- nutrients, siltation, habitat alterations, and related issues are among the most frequently cited causes of impairment. Recognizing the influence of individual management and behavioral decisions on NPS, state and federal programs fund projects that directly address environmental management, such as the installation of various best management practices, as well as more socially oriented projects that increase individual and community capacity to manage water bodies to meet designated uses. Many involved with NPS projects in Region 5 have expertise and knowledge necessary to plan, implement, and evaluate their projects' physical and environmental components, yet addressing and evaluating the social and human-dimension components presents new challenges.

In response to this situation, EPA Region 5, state environmental agencies, and the CSREES Great Lakes Regional Water Quality Program (GLRWQP) have initiated a project to incorporate a social component into NPS project planning and evaluation for the region. The effort involves an inter-organizational team drawing from EPA, state environmental agencies, land grant universities in the CSREES Great Lakes Region, and others. The team is developing a framework for tracking indicators of individual change, such as knowledge, awareness, and behavior, as well as broader social indicators related to communities, organizations, and other contextual factors that can influence NPS water quality efforts. States NPS programs in the region plan to use the framework for evaluating Section 319 NPS and related projects.

This presentation will describe this regional project, its components, and considerations for designing a NPS evaluation framework that spans regional, state and project scales.

Contact: broussar@purdue.edu, lprokopy@purdue.edu

Continuous nitrate concentration data from a small agricultural ditch in Indiana: Relationship to stream flow and inferences to biological processes affecting nitrogen cycling

Timothy R. Lathrop, USGS Indiana Water Science Center

Typical surface-water quality sampling regimes collect samples for nutrient analysis on a daily, weekly, monthly, or less frequent basis. Nutrient concentrations, specifically nitrate, can vary hourly in streams, however as a result of changes in stream flow (runoff) and biological process. The U.S. Geological Survey worked with YSI, Inc. to collect continuous nitrate data in water in a small agricultural ditch in east central Indiana during 2004 using an in-situ nutrient analyzer. Concurrent water samples were collected and analyzed for nitrate by an off-site laboratory to assess the accuracy of the continuous nitrate data. Nitrate concentrations during the study period rose with increased ditch flow, which reflected contributions from nitrate sources in the watershed. In addition, nitrate concentrations in the ditch fluctuate diurnally during lower flow conditions. The diurnal nitrate concentration changes were small, less than one milligram per liter; however, the pattern was consistent throughout the study period, being highest during the day and the lowest at nighttime. In-stream photosynthesis and respiration can produce diurnal fluctuations of dissolved oxygen. Specifically, photosynthesis during the day produces higher dissolved oxygen levels, while nighttime respiration consumes oxygen. If in-stream biological processes dominate a system, then nitrate fluctuations should inversely follow the dissolved oxygen diurnal changes. However, the small diurnal nitrate changes found in this stream appear to be the opposite of what would be expected of an in-stream process dominated system. These small changes in nitrate concentrations in the ditch suggest that benthic processes dominate nitrogen cycling in this ditch during low flows.

Drainage Water Management Impacts on Nitrate Leaching, Soil Quality, Crop Yield, and Profitability

Eileen Kladivko, Laura Bowling, Brad Carter, Sylvie Brouder, Department of Agronomy; Jane Frankenberger, Barry Gutwein, Roxanne Adeuya, Department of Agricultural and Biological Engineering; James Lowenberg-DeBoer, and Jason Brown, Department of Agricultural Economics, Purdue University

Subsurface "tile" drainage is a common water management practice in agricultural regions with seasonally high water tables. The practice of subsurface drainage provides many agronomic and environmental benefits, but may also contribute substantial nitrate-N loads to surface waters. Drainage water management (also known as controlled drainage) can reduce nitrate losses from drained fields while maintaining drainage intensity during critical periods of the crop growth cycle. Drainage water management systems have control structures that raise the effective height of the drain outlet, which raises the water table level at which drainage first occurs. By reducing the amount of subsurface drainage from a field, the nitrate-N losses through drainage waters are also reduced. Controlled drainage has been included as one of the BMPs for nutrient management in North Carolina for many years, and more limited data from Midwestern sites show the potential for large reductions in nitrate loads in this region as well. Impacts of the practice on nitrate loss, soil quality, and farm profitability are being studied through paired-field trials on three private farms and a Purdue University farm. Drain flow and nitrate concentration are being monitored in each paired field to quantify nitrate load reductions due to drainage water management. Potential impacts on agricultural sustainability are also being assessed by measuring management practice impacts on soil physical properties, earthworms, plant growth, plant N content, yield, and profitability of both conventional and managed drainage for each paired site. This paper presents site selection, design and installation of the flow monitoring system and an overview of soil and crop measurements being made. A companion paper gives preliminary results of drainflow and water table measurements.

Contact: kladivko@purdue.edu; http://www.agry.purdue.edu/staffbio/ejkbio.htm

Drainage Water Management Impacts on Field Hydrology

Roxanne Adeuya, Jane Frankenberger, Department of Agricultural and Biological Engineering; Eileen Kladivko, Laura Bowling, Department of Agronomy, Purdue University

Four research sites were instrumented to conduct controlled drainage research in Indiana. The goal of the project was to assess the impact of controlled drainage systems on crop yield and nitrate load to surface water in Indiana watersheds, through the application of paired field studies. Continuous monitoring and field calibration techniques were applied

to quantify flow exiting subsurface drains from controlled drainage (treatment) and uncontrolled (control) drainage fields at each research site. Paired statistical analysis was conducted on the flow to identify hydrologically relevant statistical differences between the application of controlled and conventional subsurface drainage systems, and quantify the impact of the practice.

Contact: rmitchel@purdue.edu

Nutrient Losses in Tile-Fed Drainage Ditches in the St. Joseph River Watershed

Douglas R. Smith, Chi-hua Huang, Stan Livingston, Elizabeth Warnemuende, Gary C. Heathman, and Dennis Flannagan USDA-ARS, National Soil Erosion Research Laboratory

Nutrient losses from agricultural watersheds result in degraded water quality. Recently, the city of Defiance, OH issued an order for elderly and young children to drink bottled water, due to high nitrate levels in the Maumee River, the city's drinking water source. The objective of this work is to evaluate nutrient losses from a tile drained agricultural watershed. Twelve watersheds arranged in a nested, paired watershed design, and ranging from 2 to 19,000 ha have been monitored during the growing season (April to November). In 2005, for 7 of the sites that are nested within one of the ditches, no daily samples had NO_3-N concentrations greater than the 10 mg/L EPA drinking water standard, and only 57 of the 402 runoff event based water samples contained NO_3-N concentrations greater than 10 mg/L. Weather conditions in 2005 were relatively dry, resulting in very little discharge in these watersheds. In 2006, a series of heavy rainfall events occurred soon after many producers planted and fertilized corn. NO_3-N concentrations in excess of 30 mg/L were observed at several sites during runoff from these storms. Following these storms, NO_3-N concentrations were in excess of the 10 mg/L standard for at least 9 days in one of the drainage ditches, and 6 days in the receiving stream (Cedar Creek). Tile inlets between two of the nested sites on ditch A were shown to have a large impact on NO_3-N and dissolved P concentrations during this period. Further research will assist in identifying practices that result in a greater susceptibility of nutrient losses from agriculture in these settings, and how best to mitigate these potential losses.

Contact: Chihua@purdue.edu; drsmith@purdue.edu

Nitrate Leaching Through A Tile Drained Watershed Using SWAT

Yinghui Sui, Earth and Atmospheric Science, Jane R. Frankenberger Agricultural and Biological Engineering, Terry R. West Earth and Atmospheric Science, Purdue University

Nitrate leaching from tile drains is an environmental concern in downstream waters. The objective of this study is to simulate the effect of tile drainage on nitrate in the Sugar Creek watershed, a poorly-drained agricultural watershed within the White River basin in central Indiana. The Soil and Water Analysis Tool (SWAT) is a continuous time model that assists water resource managers in assessing the impact of management and climate on nonpoint source pollution in watersheds. A new function in SWAT predicts the dynamic ground water table and tile flow by setting a restrictive soil layer at the bottom of the soil profile. A sensitivity analysis identified the parameters that have the most influence on nitrate load, such as nitrogen percolation coefficient, soil organic N, and depth to the impervious layer. Daily flow and monthly nitrate load have been calibrated by the auto-calibration method in SWAT. SWAT will be run for a long period (30-50 years) to calculate long-term nitrate-N contribution from the tile drains.

Contact: ysui@purdue.edu

Remote Sensing of Phytoplankton Using Optically Active Pigments, Chlorophyll *a* and Phycocyanin

Kaylan Randolph, Graduate Student, Department of Geography, Research Assistant-Department of Geology and Center for Earth and Environmental Science, IUPUI
Lin Li, Assistant Professor of Geology;
Lenore Tedesco, Associate Professor of Geology and Director of the Center for Earth and Environmental Sciences;
Jeffrey Wilson, Associate Professor and Chair, Department of Geography;
D. Lani Pascual, Research Scientist, Center for Earth and Environmental Science;
Indiana University-Purdue University, Indianapolis
Dan Moran, Veolia Water Indianapolis, LLC.

Nuisance blooms of blue-green algae are seasonally prevalent in Indianapolis' three drinking water reservoirs: Geist, Morse, and Eagle Creek Reservoir. These blooms can lead to aesthetic degradation of drinking water resources (e.g., surface scums on the water and taste and odor in drinking water). Some blue-green algae are able to produce hepatotoxins (e.g., microcystin-LR) and neurotoxins (anatoxin-a), which can lead to adverse human health effects. Current methods for detecting blue-green algae are both costly and time consuming, which can lead to delayed management decisions. However, remote sensing techniques that utilize the optical properties of blue-green algal pigments (chlorophyll *a* and phycocyanin) can meet the need for rapid detection and assessment of blue-green algal distribution. On September 6, 2005, *in-situ* field reflectance spectra were collected at 87 sampling sites on the three Indianapolis reservoirs (~30/reservoir) using ASD Fieldspec (UV/VNIR) and Ocean Optics USB2000 (V/NIR) spectroradiometers. Ground truth samples were taken at each site and analyzed for Chlorophyll *a*, phycocyanin, and other water quality constituents such as turbidity, Secchi depth, conductivity, total dissolved solids (TDS), total suspended solids (TSS), total Kjehldahl nitrogen (TKN), total phosphorus, and organic carbon. Chlorophyll *a* and phycocyanin concentrations were measured flourometrically and spanned a range of 20 to 120 ppb and 2 to 150 ppb, respectively. Previously developed algorithms by Mittenzwey *et al.* (1992), Gitelson *et al.* (1994), Schalles *et al.* (1998), and Simis *et al.* (2005) were applied to field reflectance spectra to predict the phytoplankton pigment concentrations. Algorithm applicability was tested through a least squares regression and residual analysis across all reservoirs and stratified by reservoir. Using data collected by the ASD Feildspec, preliminary results show that, when stratified by reservoir, the Mittenzwey and Gitelson and algorithms yielded high coefficients of determination for estimation of chlorophyll *a* concentrations, 0.802 and 0.797, respectively. Application of the Schalles and Simis algorithms for estimation of phycocyanin concentrations for Morse reservoir resulted in r^2 values of 0.514 and 0.918, respectively. While these algorithms are robust, data will be analyzed to further optimize their applicability to Indianapolis' water reservoirs, thus, providing water quality managers with a survey tool for the rapid delineation and quantification of nuisance phytoplankton.

Contact: klrandol@indiana.edu

Spatial and temporal trends of algal biomass in small and large streams in Indiana, 2001-4

Jeffrey W. Frey, B. Scott Lowe, and Donald R. Leer, USGS Indiana Water Science Center

One area of limited data in the U.S. Environmental Protection Agency's development of Nutrient Criteria has been chlorophyll a in seston and periphyton. Typically, correlations between nutrient concentrations and biological community attributes are low because nutrient concentrations in streams are not linked directly to biological communities. It is thought algal growth associated with excessive nutrients is an important variable in explaining the effects of nutrient enrichment on biological communities. Between 2001 and 2004, samples were collected by the Indiana Department of Environmental Management and U.S. Geological Survey at 224 sites throughout Indiana to help the State of Indiana derive refined Nutrient Criteria for streams. Samples were analyzed for algal biomass (chlorophyll *a* and ash-free-dry-mass in periphyton, and chlorophyll a and particulate organic carbon in seston), nutrients, habitat, and fish- and invertebrate-community attributes. Samples were collected in spring, summer, and fall to measure seasonal variability. Additionally, several samples were collected each year at selected National Water-Quality Assessment Program sites to measure annual and temporal variability. Sestonic chlorophyll *a* concentrations ranged from less than 1 to 250 micrograms per liter, with a median concentration of 2.68 micrograms per liter. Periphyton chlorophyll *a* concentrations ranged from less than 1 to 1,550 milligrams per meter squared, with a median concentration of 45 milligrams per meter squared. The frequency and magnitude of storms affected periphytic chlorophyll a concentrations, as the increased flow and sediment tend to scour the periphyton and reset the substrates for recolonization. Concentrations in low-flow years were higher than in wet years, and depending upon the number and timing of storms within the basins, the highest concentrations for periphyton were in low-flow periods in August to October. Seston chlorophyll a concentrations tended to be higher in the larger rivers than in the smaller streams.

Contact: jwfrey@usgs.gov

Evaluation of water quality benefits of selected conservation practices in the EQIP program using GLEAMS-NAPRA

Mark Thomas, Graduate Research Assistant

Bernie Engel, Tong Zhai, Jane Frankenberger, and Mazdak Arabi, Agricultural and Biological Engineering, Purdue University

The goal of this study is to assess the impact of the USDA Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) on nutrient loss within Indiana. A modeling framework is presented for evaluating water quality benefits of nutrient management practices in the USDA NRCS EQIP program within Indiana. The modeling framework is composed of a nonpoint source pollution model (GLEAMS-NAPRA), a GIS interface, and a method of estimation of the nutrient losses to surface and shallow groundwater. The GIS interface is utilized to parameterize the NPS model based on the STATSGO database soil characteristics, NASS 2000 land use, and precipitation data for the state of Indiana. The NPS model (GLEAMS-NAPRA) is applied to estimate statewide nutrient losses to surface water and shallow groundwater before and after implementation of nutrient management plans (NRCS practice code 590). Finally, the GIS interface is used to display the nutrient loss potential for the entire State of Indiana.

The results can help quantify the benefit from implementing nutrient best management practice (BMP) at both field- and watershed-scales. The quantified nutrient benefit results will better assess NPS water pollution compared to the current EQIP empirical scoring system. The resulting modeling approach from this project will aid the NRCS in better targeting EQIP applicants in critical areas for implementation of BMPs to maximize environmental benefit.

Contact: thomasm@purdue.edu

Determining impacts of conservation practices using the SWAT watershed model

Mazdak Arabi, Jane Frankenberger, Bernie Engel, Agricultural and Biological Engineering, Purdue University

The results of modeling studies that evaluate best management practices BMPs) depend heavily on the numerical procedure used to represent BMPs. Herein, a method for representation of several agricultural BMPs with the Soil and Water Assessment Tool (SWAT) is provided. The representation procedure entails identifying hydrologic and water quality processes that are affected by BMP implementation, selecting SWAT parameters that represent the affected processes, performing a sensitivity analysis to ascertain sensitivity of model outputs to selected parameters, adjusting the selected parameters based on BMP function, and verifying the reasonableness of the SWAT results. This BMP representation procedure is performed for a case study in a small agricultural watershed in Indiana.

Contact: marabi@purdue.edu

Friday, June 23

Use of Two-Dimensional Resistivity Imaging to Optimize High Capacity Well Locations for Some of Indiana's New Ethanol Plants

Gregory B. Byer, Mundell & Associates, Inc., Indianapolis, Indiana

Recent demand for high groundwater yield at a number of Indiana's newest Ethanol Plant Sites has made it necessary to call on the use of extensive "deep" geophysical surveys to locate optimal water well locations in order to maximize groundwater yields. Principally two-dimensional resistivity imaging has been used to accomplish this task. A variety of geologic settings have been encountered and both unconsolidated and fractured bedrock aquifers have been considered. A high degree of success has been realized using this method. Perhaps an order of magnitude or better yield has been realized, and therefore both the cost of well drilling and the time required to locate adequate aquifer material have been greatly reduced.

Contact: GByer@mundellassociates.com

2D Flow Nets Displayed in 3D and 4D

Robert James Autio, President, Environmental Data & Consulting LLC

Two dimensional (2D) flow nets have been used to display ground-water flow systems in both map and cross-sections views. While valuable for understanding, the third dimension is lacking in both flow nets.

Using graphical software, a three dimensional (3D) flow net was produced by Kriging the 3D distribution of total heads in a monitoring well network. The total head values were positioned at the mid-point of the well screens. Iso-head surfaces are displayed which are the 3D equivalent of iso-head lines on a contour map.

The 3D dimensional flow net can be extended to four dimensions (4D) by adding the dimension of time through the movement of glyphs along flow lines that are perpendicular to the iso-head surfaces.

Contact: bautio@envdata.com
Web site: http://www.envdata.com
Mobile: 317-989-2018

Time series analysis of soil freeze and thaw processes in Indiana.

Tushar Sinha, Graduate Research Assistant and Keith A. Cherkauer, Agricultural and Biological Engineering Department, Purdue University

Seasonal freezing and thawing cycles influence surface energy and water cycle fluxes. Specifically soil frost can lead to a reduction in infiltration and increase in runoff response, resulting in a greater potential for soil erosion. Soil erosion potential may also increase through the weakening of soil bonds due to repeated soil freeze-thaw cycles. This study tests for the presence of significant trends in soil freeze-thaw cycles and soil temperatures at several depths and compares identified trends with other climatic variables including air temperature, snowfall, snow cover and precipitation. Data for the study was obtained for 3 research stations located in northern, central and southern Indiana that have collected soil temperature observations since 1967. Trends are tested at a significance level of 5% using autocorrelation, simple linear regression, cumulative deviation and Mann Kendall's tests. This analysis indicates that the soil freeze-thaw cycles, the number of days with soil frost and the mean maximum air temperature for winter months are increasing in northern, central and southern Indiana. Annual snowfall amounts are decreasing for northern Indiana while the annual number of snow covered days is increasing for southern Indiana. No significant trends are observed in the annual onset soil frost or annual and seasonal precipitation.

Contact: sinhat@purdue.edu

Indiana Watershed Leadership Academy: Strengthening the Capacity of Watershed Coordinators for Successful Watershed Management.

Brent Ladd, Indiana Watershed Leadership Program Coordinator, Jane Frankenberger, Agricultural & Biological Engineering; Shorna Broussard, Forestry and Natural Resources, Purdue University;

Developing and coordinating a local organization that promotes protection and restoration of watersheds is inherently challenging. Many key skills are necessary for watershed organizations to succeed in achieving their goals. A survey of these organizations in Indiana revealed high to very high needs for training in these skill areas. The Indiana Watershed Leadership Academy, new in 2006, has created a structure and forum for watershed leaders to pursue in-depth training in biophysical, social, and economic topics. A combination of distance education and group training sessions creates opportunities for peer-to-peer learning, together with training from experts. The development and structure of the academy, along with results from the class of 2006 will be presented.

Contact: Program Web site: http://www.purdue.edu/watersheds; laddb@purdue.edu

Posters

The Effects of Landscape Transformation in a Changing Climate on Indiana's Water Resources

Carrie Davis, Graduate Student, Alison Goss, Dibyajyoti Tripathy, and Jon Harbor
Earth and Atmospheric Sciences, Purdue University

Water resources are critically influenced by changes in land use and climate. As landscapes are converted from agriculture to urban and suburban development, natural hydrologic processes are altered. Impervious surfaces decrease the amount of water infiltrating into the soil to become groundwater and increase the amount of runoff reaching streams. Similarly, climate change that increases the frequency of large precipitation events alters the amount of runoff and groundwater, even if average annual rainfall remains constant. The Greater Indianapolis area has been experiencing increased urbanization in the past several decades, which affects the local water quality and quantity. As population increases, the stresses placed on water resources also increase. This project quantifies the impacts that past and future land use and climate change have on the water resources of Greater Indianapolis, providing critical information for local water resource planners and managers who are working to protect the water resources vital for the economic and environmental health of Indiana.

Contact: davis120@purdue.edu, 765.494.0258

Velocity-field and bathymetric survey of a reach of the Wabash River near New Harmony, Indiana

David C. Lampe and Scott E. Morlock, U. S. Geological Survey, Indiana Water Science Center,
David Nance, Indiana Department of Natural Resources, Indianapolis,

The U.S. Geological Survey and the Indiana Department of Natural Resources evaluated the rip-rap bank armoring along a reach of the Wabash River near New Harmony, Indiana. The rip-rap bank is for the purpose of protecting the town of New Harmony, Indiana. Water-velocity fields and bathymetric data were collected by the U.S. Geological Survey along a 5,000-foot reach of the Wabash River. The data were collected using an acoustic Doppler current profiler (ADCP) interfaced with a real-time differential GPS. Raw data files then were processed using ARC-GIS, and visualized, using the Environmental Visualization System (EVS) software package. Velocity profiles and their relationship to the existing armor along the reach of the Wabash River will be presented and discussed.

Contact: dclampe@usgs.gov, 317-290-3333 x 142

Introducing The Environmental Pathogens Information Network (Epi-Net)

Militza Carrero-Colón and Ron Turco, Agronomy Department, Purdue University

The challenges associated with managing microbial contamination of water resources and the roles that science plays in addressing those challenges are at the forefront of water policy discussions across the country. In a recent review of the literature Smith and Perdek, (2004) concluded, "a significant body of research is needed to understand the uncertainties in pathogenic [microorganism] processes at the watershed scale…" This recent study illustrates the knowledge gaps and evolving nature of our understanding of microbial contamination of surface water. We suggest that to maximize the effectiveness of such investigations, an informed and nationally oriented organizational unit for this important topic must be formulated. We proposed the development of a facilitation unit hosted at Purdue University entitled: The Environmental Pathogens Information Network (EPINet). The overarching goal of EPINet is to develop and then transfer the fullest possible understanding of how microbial pathogens enter into and then function in watersheds so that we can properly manage and prevent the spread of microorganisms (and the diseases they cause). The creation of a keystone organization will provide a stable, centralized resource of water related environmental microbiological contamination information, encourage information sharing, connect a network of stakeholders, regulatory officials, and technical experts, provide a reliable point of reference (methods and data interpretation) and increase our ability to develop a coherent national research agenda and good public policy. EPINet will serve as an important resource for state and local governments as they develop biocriteria Total Maximum Daily Loads (TMDLs). Furthermore, EPINet will function to better inform our citizens of the problems associated with pathogens in the environment and is ultimately organized to provide prevention approaches that forestall the need for TMDLs.

Contact: carreroc@purdue.edu phone: (765) 496-7737, http://www.epi-net.org

Mapping Concentration and Spatial Distribution of Cyanobacteria in Mesotrophic to Eutrophic Reservoirs Using Airborne Hyperspectral Remote Sensing Imagery

Rebecca, Sengpiel, Masters Student;

Lin Li, Assistant Professor of Geology;

Lenore Tedesco, Associate Professor of Geology and Director of the Center for Earth and Environmental Sciences;

Jeffrey Wilson, Associate Professor and Chair, Department of Geography;

D. Lani Pascual, Research Scientist, Center for Earth and Environmental Science; Indiana University-Purdue University, Indianapolis

Dan Moran, Veolia Water Indianapolis, LLC.

Cyanobacteria blooms contribute to the degradation of reservoirs by causing aesthetic problems, such as surface scum and unpleasant odors, changes in the taste of treated drinking water and potential toxicity. Monitoring of Cyanobacteria blooms and the conditions that foster bloom formation via *in-situ* water sampling is both time and labor intensive, and often limited to infrequent collections at a small number of stations within a reservoir. While Cyanobacteria blooms in Indianapolis's three drinking water reservoirs have been investigated intensively, water resource managers lack a tool capable of providing information about the spatial distribution and composition of blooms. Remote sensing techniques may provide a faster, more efficient method for mapping these Cyanobacteria blooms.

The primary objective of this research is to develop a more efficient survey tool which uses remotely sensed spectra as a proxy for *in situ* water quality data to allow for more rapid determination of Cyanobacteria concentration and spatial distribution in drinking water reservoirs. The approach utilizes the spectral characteristics of Chlorophyll *a* and Phycocyanin as captured by the Airborne Imaging Spectrometer for Applications (AISA) sensor. Water quality samples were collected in Indianapolis's three drinking water reservoirs (Geist, Morse, and Eagle Creek) on September 6, 2005 at approximately 30 sites on each reservoir concurrent with the imagery acquisition. Samples were analyzed for Chlorophyll *a*, Phycocyanin, total suspended solids, and other water quality constituents. Airborne spectra were collected with the AISA sensor by the University of Nebraska Lincoln's CALMIT laboratory. The image data have a spectral range of approximately 400 nm to 800 nm with 8.75nm – 9.61 nm bandwidth resolution which provide 5 million reflectance spectra for each reservoir at a spatial resolution of 1 m^2. After correcting for geometric distortion and spectral attenuation, spectral data from a subset of locations, that match GPS coordinates of ground truth samples, were retrieved to create a calibration data set. With reference to results from relating field spectra to Cyanobacterial blooms, an algorithm was applied to link the airborne spectra in the calibration set to Chlorophyll *a* concentration. The algorithm was then applied to the entire AISA image to generate a map of Chlorophyll *a* distribution for Geist reservoir (Marion County, Indiana). Preliminary results from this Reservoir indicate the development of a successful survey tool is dependent upon appropriate image processing techniques to account for the interfering factors that effect spectral reflectance. After being refined and finalized, this same technique will be used to develop additional Chlorophyll *a* maps and algorithms for the two other reservoirs.

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Contact: r_sengpiel@hotmail.com

Recreating Historical Land Cover Change for Hydrologic Impact Analysis, Muskegon River Watershed, Michigan

Alison Goss, Graduate Research Assistant, Earth and Atmospherica Sciences, and Laura Bowling, Department of Agronomy, Purdue University

The hydrologic impact of land use change has been well documented; however, the temporal and spatial scale of such studies is limited by the availability of quality remotely sensed land cover data and streamflow records. Also, the current temporal scale of land use change/water cycle research is frequently not extensive enough to fully capture water flux response to land use change, which may occur over ten to one hundred year timescales. A method for recreating land use/cover change in the Muskegon River Watershed, MI over the past 100 years will be presented. These decadal land cover "backcasts" served as inputs to a macroscale hydrologic model, Variable Infiltration Capacity (VIC), and impacts to streamflow and water fluxes such as evaporation and soil moisture will be presented. This novel type of long-term hydrologic impact assessment, which coincides with periods of widespread industrialization and land use change in a large watershed, enables the creation of mitigation strategies to lessen the negative impacts of development on critical water resources and informs assertions of how land use/cover change may impact water resources in the future.

Contact: agoss@purdue.edu, 765-494-0258; bowling@purdue.edu

Evaluating nitrate sources in nested agricultural sub-basins using nitrate stable isotopes

Kim, M.; Chang, C.C.Y; Frey, J.W.; and Kendall, C.

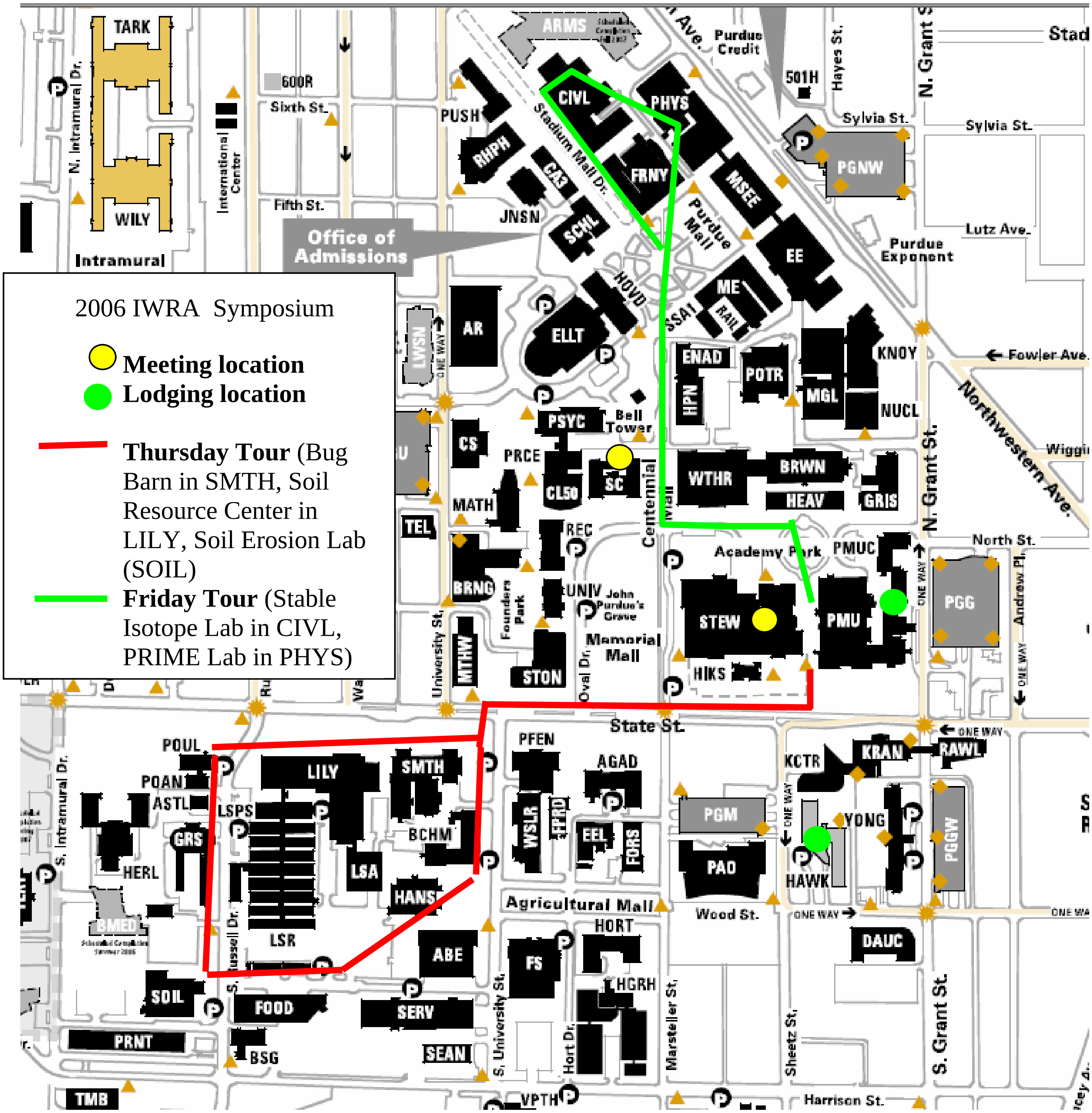
According to the U.S. Environmental Protection Agency nutrient enrichment is the second leading cause of impairment in streams in the United States. To provide environmental managers with nutrient source and transport information, the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program conducted a multi-component study in Sugar Creek Basin, Indiana, in which nutrients, major ions, and pesticides were analyzed. Land use at Sugar Creek (246 square km basin) is dominated by row crop agriculture, primarily corn and soybeans. The soils are largely heavy clay of glacial till origin, and require tile drains to move excess water and make the land farmable. Samples were collected most intensively from Leary-Weber Ditch, a 6.2.square km basin is nested within Sugar Creek Basin. Water samples were collected in 2003 and 2004 from major environmental compartments involved with the movement of nutrients into the ditch, (precipitation, tile drain, and overland flow). As one component of the study, stable isotopes of nitrate (N-15 and O-18) were used to examine nitrate sources and transport, and possible transformations of nitrate. Storm samples were collected bracketing four distinct periods of the agricultural cycle: pre-application of fertilizer, post-application of fertilizer, growing season, and post-harvest. Nutrient samples (dissolved nitrate, dissolved ammonia, orthophosphate, and total phosphorus) were also collected between storm events during baseflow conditions. Preliminary water-quality data indicate that tile drains are the primary pathway for nitrate movement to the ditch and little interaction occurs between the ground water and surface water interface. Nitrate stable isotopes will enable us to determine the relative contribution of nitrate sources, such as fertilizer, soils, and atmospheric deposition to tile drains, Leary-Weber Ditch and Sugar Creek. Initial results indicate that stable isotope analysis can track changes in these sources throughout a storm and over a growing season.

Automated Identification of Subsurface Drainage Systems of Agricultural Fields Using Image Processing Techniques

Bibi S. Naz, Graduate Research Assistant, Laura C. Bowling, Chris J. Johannsen, Agronomy Department, and Keith A. Cherkauer, Agricultural & Biological Engineering Department, Purdue University

This study focused on tile identification of subsurface drainage systems at the Agronomy Center for Research and Education (ACRE), West Lafayette, Indiana. The purpose of the study was to use image processing techniques for automatic detection of tile lines from multiple aerial photographs. A step-wise approach was developed to first identify potential tile drained fields by developing an algorithm using a decision tree classifier based on multiple data sets such as land use class, soil drainage class, soil potential for surface runoff and surface slope. Based on preliminary classification of potential tile drained area from decision tree classifier, image processing techniques such as directional edge enhancing filtering, density slice classification, Hough Transformation and automatic vectorization were used to identify individual tile lines from images of 1976, 1998 and 2002. Accuracy assessment of the predicted tile lines maps (Hough transformed and Untransformed) was accomplished by visually comparing the locations of predicted tile lines with the known tile line map created through manual digitization from historic design diagrams. The overall accuracies of Hough Transformed and Untransformed maps were 71 and 59%, respectively. The Hough Transformation provided the best results in producing a map without having any discontinuity between lines. The overall performance of image processing techniques investigated in this study shows that these techniques can be successfully used in identifying tile lines from aerial photographs over a large area.

Contact: Bibi Naz, bnaz@purdue.edu



Technical Tours

- **Thursday's walking tour** focuses on the southern portion of campus, where most of Purdue's agricultural and natural resources research and education take place. Stops include the Boiler Bug Barn, Soil Resource Center, and National Soil Erosion Research Laboratory.
- **Friday's tour** takes you through the central campus and the Engineering Mall with the signature fountain. We will visit two unusual facilities: The Purdue Rare Isotope Measurement (PRIME) Lab and the Purdue Stable Isotope Facility.