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Illinois Water 2004 Staff

Water 2004 is coordinated by the Illinois Water Resources Center with Guidance from organizations and agencies in Illinois.

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Editor and Graphic Designer.....Susan White

Thank you..... members of the planning committee, moderators and speakers.

Agenda

Wednesday, October 13

8:00-9:00 a.m.	Registration (Conference Center Foyer)
9:00-9:10 a.m.	Welcome and Opening Comments (Salon E and F)
9:10-9:50 a.m.	Featured Speaker: Breathing New Life into the National Water Program – Roberta Savage (Salon E and F)
9:50 - 10:00 a.m.	Report from the Pre-conference Workshop: Water Monitoring Council (Salon E and F)
10:00-10:15 am	Break
10:15-12:15 p.m.	Themed Session I: (concurrent sessions) - Surface Water Use Designations – A Time for Change? (Salon A) - Glacial Aquifiers (Salon C)
12:15-1:30 p.m.	Lunch (atrium)
1:30-3:00 p.m.	Technical Session I: (concurrent sessions) - Effects of Phosphorus on Stream Systems (Salon A) - Watershed Management I (Salon C) - Groundwater Modeling and Monitoring (Salon E)
3:00-3:30 p.m.	Break and Exhibits
3:30-5:00 p.m.	Technical Session II: (concurrent sessions) - Research in Nutrients and Agriculture (Salon A) - Watershed Management II (Salon C) - Economics of Conservation Design and Stormwater (Salon E)
5:15-7:30 p.m.	Reception (Atrium) - Poster Session 5:15-6:15 p.m.
6:30-7:30 p.m.	Student Career Panel (Killarney Room)

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7:30-8:30 a.m.	Illinois Section of the American Water Resources Association Meeting (Salon C)
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8:30-10:30 a.m.	Themed Sessions II: (concurrent sessions) - Agriculture Drainage Management (Salon A) - Water Quality (Salon E)
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10:45-12:15 p.m.	Technical Session III: (concurrent sessions) - Water Quality (Salon A) - Watershed Planning and Economics I (Salon C) - Environmental Hydrodynamics (Salon E)
12:15-1:30 p.m.	Lunch (Atrium)
1:30-3:00 p.m.	Technical Session IV: (concurrent sessions) - Stream Hydraulics and Sediment Transport (Salon C) - Watershed Planning and Economics II (Salon E)
3:00-3:30 p.m.	Closing Comments (Salon C)

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10:00-10:15 a.m. Break

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Surface Water Use Designations – A Time for Change? (Salon A)

Moderator: Paul Terrio, U.S. Geological Survey, Champaign

The Federal Role in Assisting States To Define Designated Uses and Assess Use Attainability - Dave Pfeifer, U.S. Environmental Protection Agency Region V, Chicago, IL

The History Behind Illinois Designated Uses, IPCB Standards and State/Federal EPA's - Past, Present, and Future - Bob Mosher, Illinois Environmental Protection Agency, Springfield, IL

Stakeholder Panel Discussion :
Wastewater Community Perspective - Richard Lanyon, Metropolitian Water Reclamation District of Greater Chicago

Environmental/Conservation Community Perspectives - Beth Wentzel, Prairie Rivers Network

Agriculutural Community Perspective - Roger Sy, Illinois Corn Growers Association

Glacial Aquifers (Salon C)

Moderator: Don Keefer, Illinois State Geological Survey

A Regional Study of the Groundwater Quality in the Glacial - Deposit Aquifer System of the United States - Kelly Warner, U.S.Geological Survey

The Mahomet Aquifer: Recent Advances in Our Knowledge - Edward Mehnert, Illinois State Geological Survey

American Bottoms Aquifer of Southwestern Illinois - Robert Olsa, Illinois State Water Survey

Glacial Aquifers in Northern Illinois - Colin Booth, Northern Illinois University

Wednesday, October 13 (cont.)

12:15-1:30 p.m. Lunch (atrium)

1:30-3:00 p.m. Technical Session I (concurrent sessions)

Effects of Phosphorous on Stream Systems (Salon A)

Moderator: Dennis McKenna, Illinois Department of Agriculture

Seasonal Algal Dynamics and Potential Nutrient Limitation in Central Illinois Agricultural Streams - Krista Kirkham, Biological Sciences, Illinois State University

Statistical Relationships between Illinois Stream Nutrients and Aquatic Diversity - Timothy Smith, Center for Aquatic Ecology, Illinois Natural History Survey

Spatial and Temporal Relationships between Biotic Integrity of Illinois Streams, Dissolved Oxygen, and Nutrients - Mark David, Natural Resources and Environmental Sciences, University of Illinois

Strategic Research Initiative in Water Quality - George Czapar, Extension, University of Illinois

The Impact of Sediments on the Potential Bioavailability of Phosphorus in Illinois Streams - Michael Machesky, Watershed Science, Illinois State Water Survey

Watershed Management I (Salon C)

Moderator: William White, Illinois State Water Survey

Web Tool for Watershed Information Dissemination - Shen Wang, Department of Environmental Management, Kane County

Watershed-scale Geomorphic Assessment Approach for Evaluating Stream channel Stability: Case Study Southern Illinnois Region - Big Creek, Cache River Basin, Union and Pulaski Counties, Illinois - Laura Keefer, Illinois State Water Survey

Assessing Opportunities for Municipal Wastewater Reuse in the Metropolitan Chicago Area - Yi Meng, Chemical and Environmental Engineering, Illinois Institute of Technology

Wednesday, October 13 (cont.)

Watershed Modeling to Evaluate Water Quality at Intakes of Small Drinking Water Systems - Deva Borah, Illinois State Water Survey, University of Illinois

Groundwater Modeling and Monitoring (Salon E)

Moderator: Edward Mehnert, Illinois State Geological Survey

Effect of Land Usage on Groundwater Quality in McHenry County - Hue-Hwa Hwang, Illinois State Geological Survey

Analysis of Illinois Soil Moisture Data: Implications for ENSO Influence on Midwest Climates - Geremew Amenu, Civil and Environmental Engineering, University of Illinois

Glacial and Other Unconsolidated Aquifers of the Metroeast Region of Southwestern Illinois - Edward Smith, Illinois State Geological Survey

3:00-3:30 p.m. Groundwater Flow Models of Northeastern Illinois using MODFLOW and GIS - Yu-Feng Lin, Illinois State Water Survey

3:30-5:00 p.m. Break and Exhibits

Technical Session II (concurrent sessions)

Research in Nutrients and Agriculture (Salon A)

Moderator: Phil Mankin, Illinois-Indiana Sea Grant

Soil Water Nitrogen Leaching in Riparian Autumn Olive Stands in Southern Illinois - Christine Goldstein, Forestry, Southern Illinois University

The Effects of Turbidity and Sedimentation Changes on the Channel Border Fish Communities of the Middle Mississippi River - Diane Zeman, Zoology, Southern Illinois University

Using Compost to Enhance Soil Water Retention - Duane Friend, Extension, University of Illinois

Assessment of Agricultural Production Vulnerability in Central Illinois Under Global Climate Change - Romain Laurent, Civil and Environmental Engineering, University of Illinois

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Moderator: Rick Cobb, Illinois Environmental Protection Agency

Comparisons between NEXRAD Radar and Gage Rainfall Data in and Near Du Page County, Illinois - Elizabeth Murphy, U.S. Geological Survey

Wednesday, October 13 (cont.)

Changes in Flood-Frequency Estimates for Rural Illinois Streams - David Soong, U.S. Geological Survey

Brewster Creek, IL Dam Removal and Stream Restoration - Karen Kosky, Department of Environmental Management, Kane County

Monetary Valuation of the Floodplain Forest - Don Pitts, Construction Engineering Research Lab

Econmonics of Conservation Design and Stormwater Management (Salon E)

Moderator: John Braden, Agricultural and Consumer Economics, University of Illinois

Economics of Conservation Design and Stormwater Management - Douglas M. Johnston, Department of Landscape Architecture, University of Illinois

Comprehensive Research and Management of Impervious Surface Impacts on Watershed Hydrology - Hale Thurston, U.S. Environmental Protection Agency

Water Quality Impacts of Land Use Change: A Model for Functional Landscape Design Evaluation - Sangjun Kang, Urban and Regional Planning, University of Illinois

5:15-7:30 p.m. Reception (Atrium)

5:15-6:15 p.m. Poster Session

Chemical Fractionation of Phosphorus in Stream Sediment - Thomas Holm, Groundwater Section, Illinois State Water Survey

Mahomet Aquifer Consortium: Scientific Direction and Plans - Kelly Warner, U.S. Geological Survey

Gastrointestinal Microflora of Hatchery-Reared Rainbow Trout - Keith Johson, Biology, Bradley University

Stream Mobility in a Low-Gradient, Third-Order, Perennial Stream - Eric Peterson, Department of Geography-Geology, Illinois State University

Erosion by Submerged Plane Wall Jet Impinging on a Layer of Sewer Sediment Resting on a Fixed Boundary - Octavio Sequeiros, Civil and Environmental Engineering, University of Illinois

Tile Drainage Modeling Study with a Hydrologic Conjunctive Model - Feng Yue, Civil and Environmental Engineering, University of Illinois

Wednesday, October 13 (cont.)

Hydraulic Model Study of Chicago River Density Currents - Claudia Manriquez, Civil and Environmental Engineering, University of Illinois

Web Tool for Watershed Information Dissemination - Jodie Tate, Extension, University of Illinois

Variability in Illinois Streams - Keyur D. Pathak, Department of Chemical and Environmental Engineering, Illinois Institute of Technology

6:30-7:30 p.m. Student Career Panel – Killarney Room

Thursday, October 14

7:30-8:30 a.m. Illinois Section of the American Water Resources Association meeting (Salon C) See page 65 for more details.

8:00-8:30 a.m. Registration (Conference Center Foyer)

8:30-10:30 a.m. Themed Session II (concurrent sessions)

Agricultural Drainage Management (Salon A)

Moderator: Robert Holmes, U.S. Geological Survey

Overview Including Benefits - Mike Hirschi, Agricultural and Biological Engineering, University of Illinois

The Geomorphology of Drainage Channels: Implications for Maintenance - Bruce Rhoads, Geography, University of Illinois

Illinois Drainage Management Demonstration Project - Don Pitts, USDA, Natural Resource Conservation Service

Passive Subsurface Bioreactors: A Subsurface Solution to a Subsurface Problem - Richard Cooke, Agricultural Engineering, University of Illinois

Environmental Issues - Jean Flemma, Prairie Rivers Network

Drainage District Perspective - Jim Cottrell, Drainage Law Attorney

Water Quality (Salon E)

Moderator: Gary Clark, Illinois Department of Natural Resources

Surface Water Availability and Adequacy of Supply in Illinois - VernoN Knapp, Illinois State Water Survey

Thursday, October 14 (cont.)

Groundwater Availability in Illinois - A Statewide Perspective - Allen Wehrmann, Illinois State Water Survey

Annex 2001 and What It Means to Illinois - Daniel Injerd, Illinois Department of Natural Resources

Climate Aspects of Water Supply Planning - Derek Winstanley, Illinois State Water Survey

10:30-10:45 a.m. Break

10:45-12:15 p.m. Technical Session III (concurrent sessions)

Water Quality (Salon A)

Moderator: Phil Mankin, Illinois-Indiana Sea Grant

Arsenic Distribution and Speciation in the Mahomet and Glasford Aquifers, Illinois - Walton Kelly, Illinois State Water Survey

Soil and Groundwater Phosphorus and Nitrogen Levels Within Row-crop Agriculture and Adjacent Riparian Buffers in the Cache River Watershed- Chad Yocum, Forestry, Southern Illinois University

Influence of Bedrock Geology on Stream Nitrate Concentrations in Forested Watersheds in Southern Illinois - Roger Haschemeyer, Forestry, Southern Illinois University

Coupling of Hydrologic and Hydraulic Models For The Illinois River Basin - Yanqing Lian, Illinois State Water Survey

Watershed Planning and Economics I (Salon C)

Moderator: Jeff Wickenkamp, North East Illinois Planning Commission

Targeting Conservation Practices on a Watershed Basis - Jeff Beaulieu, Southern Illinois University

"Nab the Aquatic Invader! Be A Sea Grant Super Sleuth" Educational Web Site - Robin Goettel, Illinois-Indiana Sea Grant College Program, University of Illinois

Long-term Impacts of Land Use Change on Non-point Source Pollutant Loading for St. Louis Metropolitan Area - Woonsup Choi, Geography, University of Illinois

Detoxifying Waukegan Harbor: Attitudes and Economic Benefits - John Braden, Agricultural and Consumer Economics, University of Illinois

Thursday, October 14 (cont.)

Environmental Hydrodynamics (Salon E)

Moderator: Richard Lanyon, Metropolitan Water Reclamation District of Greater Chicago

Flow Turbulence Characterization in a Large Scale Bubble Plume - Carlos Garcia, Civil and Environmental Engineering, University of Illinois

Bank Erosion Control: CFD Modeling of Submerged Vanes - Jorge Abad, Civil and Environmental Engineering, University of Illinois

3D Numerical Modeling of Turbulent Flow in Hydraulic Structures - Xuejun Yang, Civil and Environmental Engineering, University of Illinois

High Resolution Simulations of Density Currents - Mariano Cantero, Civil and Environmental Engineering, University of Illinois

12:15-1:30 p.m. Lunch (Atrium)

1:30-3:00 p.m. Technical Session IV (concurrent sessions)

Stream Hydraulics and Sediment Transport (Salon C)

Moderator: Robert Holmes, U.S. Geological Survey

Design, Installation and Operation of an In-lake Sheet Pile Sediment Basin - Dennis Beyer, USDA Natural Resource Conservation Service

Impacts of Carlyle Dam and the Navigation Project on Kaskaskia River Morphology - Xizhen Du, Forestry, Southern Illinois University

Dredging Sediment to Restore Habitat and Water Supply Capacity While Providing Reclaimed Topsoil to Terrestrial Sites - John Marlin, Waste Management and Research Center

Development of a Graphical User Interface for the Dynamic Watershed Simulation Model (DWSM) - Jong Ahn Chun, Agricultural and Biological Engineering, University of Illinois

Watershed Planning and Economics II (Salon E)

Moderator: Timothy Feather, Planning and Management Consultants, Ltd.

The Waukegan River Section 319 National Monitoring Program Project - William White, Illinois State Water Survey

SDSS on the Soil Conservation Policy in the Big Creek Watershed -

Thursday, October 14 (cont.)

Seth Soman, Agribusiness Economics, Southern Illinois University

Optimal Control Approach for Cost-Effective Management Ecosystems in a Watershed - Elias Bekele, Civil and Environmental Engineering, Southern Illinois University

Watershed Management Planning for Rayse Creek in Southern Illinois - Elisa A. Grafford, Forestry, Southern Illinois University

3:00-3:30 p.m. Closing Comments (Salon C)

The following students will be competing for best paper and best poster awards. The paper awards are $200 and the poster awards are $175. Awards will be made during the closing session on Thursday, October 14. 2004

Please visit our poster session and the presentations to support these students.

PRESENTING PAPERS

(please see agenda for presentation times and topics)

Jorge Abad, Department of Civil and Environmental Engineering, University of Illinois
Amenu Geremew, Department of Civil and Environmental Engineering, University of Illinois
Elias Bekele, Department of Civil and Environmental Engineering, Southern Illinois University
Mariano Cantero, Department of Civil and Environmental Engineering, University of Illinois
Woonsup Choi, Department of Geography, University of Illinois
Xizhen Du, Department of Forestry, Southern Illinois University
Carlos Garcia, Department of Civil and Environmental Engineering, University of Illinois
Christine Goldstein, Department of Forestry, Southern Illinois University
Roger Haschemeyer, Department of Forestry, Southern Illinois University
Romain Laurent, Department of Environmental Hydrology and Hydraulic Engineering, University of Illinois
Yi Meng, Department of Chemical and Environmental Engineering, Illinois Institute of Technology
Seth Soman, Department of Agribusiness Economics, Southern Illinois University
Xuejen Yang, Department of Civil and Environmental Engineering, University of Illinois
Chad Yocum, Department of Forestry, Southern Illinois University
Diane Zeman, Department of Zoology, Southern Illinois University

PRESENTING POSTERS

(posters will be presented from 5:15-6:15 p.m. Wednesday, October 13)

Octavio Sequeiros, Department of Civil and Environmental Engineering, University of Illinois
Feng Yue, Department of Civil and Environmental Engineering, University of Illinois
Claudia Manriquez, Department of Civil and Environmental Engineering, University of Illinois
Keyur Pathak, Department of Chemical and Environmental Engineering, Illinois Institute of Technology

Speakers

Roberta H. Savage

Roberta "Robbi" Savage is the Executive Director and Secretary of the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), the professional organization for the State and Interstate surface and ground water protection program administrators. Having served in these positions since 1978, Ms. Savage is the Association's first and only Executive Director. As such, she is the organization's principal spokesperson, working with Congress, the Administration, and national stakeholders to achieve ASIWPCA's five primary goals:

• Fostering technical and management information exchange among States, Agencies, and Interstate Organizations

• Assisting the Nation's Governors in developing policy by providing technical analysis of the Clean Water Program;
• Informing Congress and the Administration about State water program issues and needs;
•Promoting workable national water policy; and
•Encouraging youth education and other public outreach efforts.

In the course of managing the Association to accomplish these objectives, Ms. Savage makes certain that the interests and perspectives of the Association membership are considered in national decision-making. In addition to her work with Congress and the Administration, she is the national contact for the Nation's Governors and environmental commissioners, Federal and Local governments, and numerous environmental and industrial organizations. Ms. Savage has worked on three of the four Congressional reauthorizations of the Clean Water Act.

Among her areas of expertise are:

- Wet weather and storm water management (Ms. Savage was one of the principal drafters of the original storm water legislative proposal);State Revolving Fund (SRF) Loan Program (Ms. Savage was one of the principal drafters of the original SRF legislative proposal);
- Watershed protection and total maximum daily loads (TMDL's);
- Nonpoint source controls;
- Water quality standards and monitoring;
- Permitting, compliance, and enforcement; and
- Education and other public outreach programs.

Ms. Savage is also the President and Board Chair of America's Clean Water Foundation, a nonprofit education, outreach, and technical exchange organization, which she created in 1989. Ms. Savage studied at the University of Utah and Harvard University. Currently, she serves as an adjunct professor at the Lyndon Baines Johnson School of Public Policy at the University of Texas.

Breathing New Life into the National Water Program (abstract)

The nation's Water Quality Program is at a significant crossroads with increasing mandates, shrinking budgets, and the retirement of large numbers of seasoned professionals. State, Local and Federal program managers are being challenged to find new ways of doing business. Stepping back to look at the bigger picture, (as if dwindling fiscal and professional resources coupled with ever increasing responsibility isn't big enough) we can chart an effective pathway through the mire. The creativity, experience and wisdom exist within the water program to meet the challenges of the next decade, if we can muster the political and public commitment to work through some thorny issues. So it seems to me that we should be asking ourselves some very pointed questions:

- First among them, is it possible to continue to do more with less, or have we reached the end of our efficiencies campaign – can the belt get any tighter?
- We must then ask ourselves and the powers that be if we should invest the nation's resources to remediate to the level of detection.
- The public's cry for zero discharge of pollution is laudable and backed up by statute, but it is really achievable? If not, is it time to say so?
- Is it possible to successfully involve the public in a meaningful and productive manner? Can we identify and resolve our water pollution problems at the watershed level working across jurisdictions with many stakeholders?
- With the "States' Rights" approach to water management that has dominated the landscape since our nation's founding, is it possible to forge lasting relationships between water quality and water quantity and surface and ground waters constituencies?
- Can the Technology vs. Biology debate be resolved to provide a balanced approach using all the tools available?
- Can we upgrade our Water Quality Standards programs to provide the nation with a sound basis for water quality decision making?
- How can we provide the necessary collaboration between the State, Local and Federal water and air program officials to assure cooperation on air deposition into water bodies?
- Will the plethora of data and information collected and stored ever be arranged in a useable format to support environmental decision making?
- With the water program showing its age, more than 20 % of the water program workforce is expected to retire within the next few years, are we preparing for this transition and will there be trained professionals to take our places?
- How are we going to pay for the aging infrastructure for sewers, stormwater retention, advanced treatment technologies, nonpoint source remediation and so on?

So the question comes down to this: Can we breathe new life into the water quality program? Can we move beyond our parochial interest long enough to forge a Clean Water Bill that might actually be enacted by the Congress?

First we need to build some enthusiasm for our programs. I for one am tired of hearing about how the water program is mature, stable and boring. How can the protection of one of our earth's most precious resources be boring? How can such a crucial element of life be taken for granted?

The Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), America's Clean Water Foundation (ACWF) and I are doing our part to re-energize public support for clean water:

1) Together we created the Year of Clean Water National Water Monitoring Day and now World Water Monitoring Day.
2) ASIWPCA has set some very high standards for itself and for the water program.
   - Goal 1: Everywhere in the United States, everyone has clean water.
   - Goal 2: Base decisions on sound science.
   - Goal 3: Enhance citizen awareness and involvement.
   - Goal 4: Ensure pollution control and prevention for nonpoint sources as well as point sources.
3) ASIWPCA has been reaching out to the public, to environmental interest groups, to corporate leaders and

international professionals to identify ways to work smarter, be more creative and share program models that work.

4) ASIWPCA, working with NRDC, America's Rivers, NUCA, AMSA and others has built a coalition of support for increased Clean Water Funding.
5) ASIWPCA and ACWF are working together on two State Circuit Rider Programs designed to provide in-state training, technical support and long-term mentoring onTMDL and Water Quality Standards.
6) ASIWPCA sponsors monthly conference calls for State –
   - TMDL Managers,
   - Permit Writers &
   - CAFO Managers.
7) ACWF provides the agriculture community with On-Farm Environmental Assessments through the On-Farm Assessment & Environmental Review (OFAER) program.

More needs to be done:

- Government organizations need to create a very clean set of roles and responsibilities – who does what, who's accountable for what, who pays for what and what is the clean water story that we all can support and relate to the public.
- Government organizations should sort out the data and information needed to accurately portray the strengths and weakness of the program. Then only ask for what will be utilized.Research priorities at the Federal level should be tailored to support program decision makers, as well as to articulate long term and strategic program needs.
- States and EPA need to place increased priority on updating Water Quality Standards, using the best information possible and then striving to keep the Standards current.
- Congress needs to take action to support Clean Water Programs with adequate resources.
- Specific strategies and implementation plans need to be initiated to train incoming professionals, expose seasoned personnel to management techniques, share innovations and be prepared for the exodus of large numbers of retiring government workers.

If I were you, it is likely that I would be shaking my head thinking, Lady get a grip, there aren't enough hours in the day… True enough, but we aren't doing ourselves any favors by putting our heads in the sand or by passing the buck; e.g. Hey, I'll be retired so what do I care?

If you agree that ASIWPCA's Strategic Plan is a good start, perhaps your organization could share the vision and help us promote the importance of clean water to all living beings. Perhaps you could create other forums. This one is great and we need more local and regional events to share the message and share information and technologies. If we can work more cooperatively together the inevitable outcome will be:

- Increased public support for clean water initiatives.
- A renewed emphasis on Clean Water Act Reauthorization.
- Adequate funding for our nation's water program.

In closing, let me thank each of you for committing your time to this conference. The Agenda for this meeting, the Illinois Water 2004 Conference, highlights the important priorities for the Federal, State and Local governments. The Association is delighted to be a part of your deliberations. Now we need to move from talking to doing.

Surface Water Use Designations – A Time for Change?

Illinois currently has four "designated use" categories and associated standards: General Use Water Quality Standards, Public and Food Processing Water Supply Standards, Secondary Contact and Indigenous Aquatic Life Water Standards, and Lake Michigan Basin Water Quality Standards. Numeric and narrative standards designed to protect these various water uses were promulgated by the Illinois Pollution Control Board (IPCB) years ago and are generally enforced by the Illinois Environmental Protection Agency (Illinois EPA). Some would suggest that this current use classification system is non-protective of highly sensitive aquatic species; others would suggest it is overly protective and restricts social and economic development activities. However, all stakeholders generally agree that the current use classification system is outdated and too "one size fits all." This session will explore the current system in Illinois, and explore the question,

The Federal Role in Assisting States Define Designated Uses and Assess Use Attainability

Dave Pfeifer, U.S. Environmental Protection Agency Region V, Chicago, IL

The Clean Water Act requires states to adopt water quality standards that designate uses for the state's surface waters and the water quality criteria necessary to protect the uses. Consistent with the Clean Water Act, states' uses must consider aquatic life, recreation, public water, industrial and agricultural water supplies and navigation. Designated uses may be general and broad (i.e., "protection of aquatic life") or complex (i.e., "tiered" aquatic life designated use systems that account for differences in biological expectations for water bodies as a function of water body type, ecoregion, habitat quality, etc.). Although both approaches have merits, experience suggests that more refined, biologically-based designated uses are more effective in guiding monitoring design, data evaluation and management activities. Although there are higher start-up costs for the more refined approach to designating uses, these costs are made up by the way such an approach simplifies activities such as use attainability analyses and the increased accuracy afforded by such an approach.

The History Behind Illinois Designated Uses, IPCB Standards and State/Federal EPA's – Past, Present and Future

Bob Mosher, Illinois Environmental Protection Agency, Springfield, IL

Illinois water bodies range from glacial lakes to cypress swamps, high gradient rocky streams to stagnant, silt bottomed ditches with almost everything in between. These waters support a variety of uses – different types of aquatic life communities based on habitat, climate, etc., as well as other uses such as swimming, agricultural uses and drinking water supplies. Unfortunately, ever since water quality standards in Illinois were initially adopted in 1972, the regulations have lumped these uses for all water body types into a single "General Use" category. At that time, the framers of Illinois water regulations did not have the extensive data that we have now and as a result, our standards dictate that all our waters other than Lake Michigan and a few canals in the Chicago area have the same set of "designated uses". Unique features of some waters are ignored while other waters lacking the natural ability to support the full complement of uses are nonetheless subject to water quality standards commensurate with higher caliber aquatic communities. Along with the use designation comes water quality standards, equally applied to all these waters whether they were ever achievable or not. The stagnant ditch is expected to meet the same chemical and physical water quality standards as the high gradient rocky run. This condition stifles water quality standards development, hinders the proper assessment of the condition of our waters and leads to inappropriate conclusions in total maximum daily load (TMDL) determinations that may waste resources. Illinois needs to redefine designated uses and adopt a system that is less "general" and more accommodating of the true potential of individual systems. Other states have gone before us and have developed systems we can use as models. However, our waters are unique enough that the effort to tailor these to Illinois conditions will be substantial. In a time of dwindling resources, IEPA will need to partner with other governmental agencies, environmental advocacy groups and academia to redefine designated uses and build a strong foundation of water quality standards that will benefit many other regulatory and assessment programs far into the future.

Surface Water Use Designations – A Time for Change? (cont.)
Stakeholder Panel Discussion

Wastewater Community Perspective

Richard Lanyon, Metropolitan Water Reclamation District of Greater Chicago

Yes! It is time for change. The current Illinois use designations are reflective of the lack of scientific knowledge and understanding of river mechanics and morphology and of stream ecology prevalent in the 1960s. Although designed to meet the goals of the Clean Water Act (CWA), the General Use class does not. It is now generally known that water quality in streams designated as General Use waters do not always meet the current standards. The Secondary Contact use designation, designed for treated sewage effluent dominated canals in the Chicago area, is out-of-date with 21st Century wastewater treatment technology capabilities. The Public Water Supply use designation is little used and the Outstanding Resource Water use designation has no streams assigned to this class.

Over the past two or three decades, some neighboring states have developed their use designation systems to keep pace with the science of river mechanics and morphology and of stream ecology. Illinois must now do the same, but over a shorter time period. The one-size-fits-all General Use designation that lumps together agricultural drainage ditches, urban streams and federal navigation waterways must be replaced. More realistic would be a tiered system that recognizes the realities of aquatic life in natural streams, in disturbed/recoverable streams, in modified/irretrievable watercourses, in modified/habitat-challenged rivers and man-made/no-habitat channels. This tiered system should be based on the best science available. Illinois must also address the recreational uses as well in a more realistic manner than the unrealistic presumption that swimming occurs or should occur in all places in all streams. Primary contact uses must recognize human life-safety as well as human health protection.

Environmental/Conservation Community Perspectives

Beth Wentzel, Prairie Rivers Network

Agricultural Community Perspective

Roger Sy, Illinois Corn Growers Association

Glacial Aquifers

Groundwater furnishes nearly 60% of Illinois' water supply that does not come from Lake Michigan and is the water source for about 90% of the rural population. Groundwater pumped from more than 10,000 public supply wells and more than 440,000 household wells totals of about 925 million gallons per day. Some of the most productive aquifers in Illinois are composed of bedded sand and gravel deposited in bedrock valleys by the large volumes of glacial meltwater that flowed away from the continental ice sheets that periodically invaded Illinois during the last two million years.

This session focuses on the characteristics of Illinois' glacial aquifers and their importance to our state. It begins with an overview of a national program to examine glacial aquifers and then focuses on three areas of Illinois where glacial aquifers are especially important: east-central Illinois, which is underlain by the Mahomet aquifer; the St. Louis Metro East area, and Northeastern Illinois. Talks in this session will describe both the physical characteristics of the aquifers and issues related to managing them.

A Regional Study of the Ground-water Quality in the Glacial-Deposit Aquifer System of the United States

Kelly Warner, US Geological Survey

The U.S. Geological Survey through the National Water-Quality Assessment (NAWQA) program has collected water-quality data as part of the program on a national and local scale since 1991. Ground-water quality data has been collected at over 2,300 wells. A new initiative to synthesize water-quality data on a regional scale will begin to address water-quality issues in areas of similar hydrogeology. Data will be synthesized for 8 regional aquifer systems. The largest regional aquifer system is the glacial and alluvial aquifer system that includes ground water in all glacial material. Ground-water use from this regional aquifer is the largest in the country. Ground-water quality data for over 200 wells in the Illinois River Basin are part of this regional synthesis. The unconsolidated and generally unconfined nature of this aquifer system, plus the relatively high recharge rates compared to other aquifer systems, make the glacial and alluvial aquifer system susceptible to anthropogenic sources of contamination. Long-term monitoring of ground-water quality in these areas is, therefore, an important aspect of a ground-water-protection strategy for the glacial-deposit aquifer system. A regional water-quality framework has been developed that will help provide a link between regional synthesis, such as NAWQA, and State or local monitoring programs. Major water-quality issues that can be addressed on a regional scale have been identified and several studies have been initiated. For instance, one regional study will examine the distribution of arsenic in the glacial and alluvial aquifer system and determine the factors affecting the source and transport in this system.

The Mahomet Aquifer: Recent Advances in our Knowledge

Edward Mehnert, Illinois State Geological Survey

Since 1990, various local, state, and federal agencies have funded 29 projects to collect new data aimed at improving our knowledge of the Mahomet aquifer beneath 13 counties in east-central Illinois. Total funding for all of these projects exceeds $3.6 million. Through these projects, our understanding of the geology and hydrology of the Mahomet aquifer has been greatly enhanced since Kempton and others (Kempton et al., 1991) wrote their seminal paper on the Mahomet aquifer. In this paper, some of these projects will be discussed.

Unusual results from two groundwater flow models, coupled with water level data from the "throat" of the aquifer in Piatt and DeWitt Counties, led to additional studies near Allerton Park (Piatt Co.). Using new technology (high-resolution seismic reflection), test drilling, and long-term aquifer testing, scientists were able to explain these unusual results. A hydraulic window was identified in the glacial materials overlying the Mahomet aquifer, connecting the

Glacial Aquifers (cont.)

Mahomet aquifer to the Sangamon River. This connection allows Mahomet water to discharge to the river under normal conditions, but allows the Sangamon River to recharge the aquifer when the river is high or when the aquifer is pumped.

Our knowledge of the groundwater chemistry in the Mahomet also has improved tremendously in the last 10 years. Motivated by the need to assess the vulnerability of groundwater resources to contamination and to define the long-term sustainability of our aquifer, scientists have sampled and analyzed groundwater for many common and some unusual chemicals. These studies have shown that the age of the groundwater sampled in the Mahomet aquifer varies from less than 1,000 to about 12,000 years. Arsenic has also been found in the Mahomet aquifer, often above accepted drinking water standards. Recent research suggests its presence is currently unpredictable, but geochemically controlled.

American Bottoms Aquifer of Southwestern Illinois

Robert D. Olson, Illinois State Water Survey

The American Bottoms is an area in the Mississippi River lowlands of about 175 square miles located in southwestern Illinois that includes portions of Madison, Monroe, and St. Clair Counties. Also referred to as the East St. Louis area, and more recently as Metro East, this heavily populated, industrialized region also contains substantial areas devoted to agriculture, particularly production of specialty crops such as horseradish and vegetables.

The prolific sand and gravel aquifer underlying the American Bottoms was developed extensively into the 1960s for industrial, agricultural irrigation, and municipal use. Groundwater withdrawals in the Bottoms peaked at 111 million-gallons-per-day (mgd) during the 1950's and 1960's, far exceeding current pumpage but less than the estimated yield of 188 mgd. These withdrawals coupled with an extended drought caused localized record low groundwater levels during this time. As industries closed and remaining users switched sources to the Mississippi River, groundwater use declined and groundwater levels rapidly rose. Infrastructure built when usage was high became inundated; sewer breakages and flooded basements in portions of the area became common. As a consequence, IDOT currently pumps about 20 mgd to keep groundwater levels beneath several stretches of below-grade highway and extensive dewatering schemes have been proposed to alleviate problems caused by high groundwater levels elsewhere.

Glacial Aquifers in Northern Illinois

Colin Booth, Northern Illinois University

Most of northern Illinois is covered by sediments laid down by ice sheets and glacial meltwater during the Pleistocene Epoch (2 million to 10,000 years before present). These deposits hide a more mature landscape which had mostly developed before glaciation, of dolomite/limestone uplands cut by steep-sided valleys, and broader valleys on softer rocks - the type of landscape visible today in the unglaciated "driftless" area of Jo Daviess County in northwest Illinois. Across northern Illinois, the glacial drift cover varies in thickness from zero (bedrock exposed) to about 500 ft (where it has filled buried bedrock valleys). Much of it consists of poorly permeable, fine-grained material, clayey and silty sediments deposited in lakes or till laid down by the ice. However, it also includes permeable, coarse-grained sand and gravel deposited as "outwash" by meltwater streams. Where thick and extensive enough, these outwash deposits can form productive aquifers. These may occur as sheets or localized lenses inter-layered within the tills, or as near-surface bodies along major river valleys, or as deeper aquifers present in the lower and middle parts of filled-in bedrock valleys such as the Troy and St. Charles.

Glacial Aquifers (cont.)

Major water supplies in northern Illinois have largely been obtained from surface water (major rivers and Lake Michigan) and deep bedrock aquifers. The glacial aquifers have mostly been used for smaller supplies. However, the major sources have become over-committed, especially in northeastern Illinois, and the region's growing population is increasing the demand for water. Thus, the glacial aquifers, despite problems of vulnerability to contamination and to watershed stresses, are becoming increasingly important.

Shallow glacial outwash aquifers, often under water-table conditions, have historically been the most accessible and most readily exploited, but are also the most readily contaminated. With better mapping techniques, GIS, and more well data, we are now therefore more intensively delineating and exploiting the deeper sand-and-gravel aquifers, especially where these are localized within the buried bedrock valleys. These aquifers, generally under confined conditions beneath covers of till, are less vulnerable to contamination and drought than surficial aquifers. However, their long-term yields and recharge amounts and paths are more difficult to assess, and the effects of urbanization, changes in the overlying watersheds, and pumping stresses remain uncertain. Moreover, each individual aquifer unit cannot be treated in isolation. Future work in resource assessment and protection will increasingly deal with the continuous flow system involving the surface watershed, the various glacial units within this "Prairie Aquigroup", and the sub-cropping bedrock of the "Upper Bedrock Aquigroup" beneath the glacial aquifers.

Agricultural Drainage Management

Illinois contains some of the most productive soils in the world. Agriculture is the predominant land use in Illinois, with approximately 80 percent of the state being actively farmed. Throughout the last two centuries, Illinois lands have been altered in order make the land suitable for row crops, such as corn an soybeans. With an estimated 10 million acres being tile-drained cropland and over 4,000 stream miles either ditched or channelized , Illinois has one of the most anthropogenically altered hydrologic systems in the United States. These changes coupled with the advent of intensive crop production have presented challenges to balance economic viability of the producers with concerns over water quality and other environmental issues. This session will focus on both existing agriculture drainage research and policy issues s! urrounding agricultural drainage.

Overview of Agricultural Drainage and Related Issues

Mike Hirschi, Agricultural and Biological Engineering, University of Illinois

In many areas of the Midwest, excess water limits crop growth without artificial drainage. For more than a century, drainage has been used as a tool to increase agricultural productivity and reduce variability and risk. The infrastructure developed over those many decades has changed the land. Many believe the change has been for the betterment of agriculture and society. Many others believe it has been to the detriment of natural ecosystems. Still many others believe that there are benefits and costs and that there may be better methods available.

The Geomorphology of Drainage Channels: Implications for Maintenance

Bruce Rhoads, Deparment of Geography, University of Illinois

Drainage channels are ubiquitous features on the landscape of East Central Illinois. For the most part, the need for maintenance is determined based on visual assessment of ditch condition by drainage district commissioners and concerned farmers. In particular, attention has focused on the development of "silt bars" in the bottom of the channel, which are viewed as evidence of excessive sedimentation. Recent research in Illinois and Ohio has examined the development of silt bars, or benches (most of which consist of sand and gravel), from a geomorphological perspective. Although research is ongoing, initial results suggest that the development of benches represents a natural geomorphological adjustment to maintenance and that bench growth stabilizes over time, often at levels well below the outlets of tile drains. These results suggest that removal of benches will only result in redevelopment of these features and that drainage districts may want to consider whether removal of these features is cost-effective. Benches are important components of physical habitat for aquatic organisms and can greatly enhance the environmental quality of drainage channels. Future research to clarify relations among maintenance, geomorphological response, habitat quality, and fish-community structure will focus on a maintenance project in the Salt Fork of the Vermilion River, which will provide the opportunity to examine these relations within an experimental setting.

Illinois Drainage Management Demonstration Project

Don Pitts, US Deptartment of Agriculture, Natural Resource Conservation Service

Due to naturally high water tables and flat topography, there are approximately 4 million has (10 million ac) of farmland artificially drained with subsurface (tile) systems in Illinois. Subsurface drainage is practiced to insure trafficable field conditions for farm equipment and to reduce crop stress from excess water within the root zone. Although drainage is essential for economic crop production, there have been some significant environmental

Agricultural Drainage Management (cont.)

costs. Tile drainage systems tend to intercept nutrient (nitrate) rich soil-water and shunt it to surface water. Data from numerous monitoring studies have shown that a significant amount of the total nitrate load in Illinois is being delivered to surface water from tile drainage systems. In Illinois, these drainage systems are typically installed without control mechanisms and allow the soil to drain whenever the water table is above the elevation of the tile outlet. An assessment of water quality in the tile drained areas of Illinois showed that approximately 50 percent of the nitrate load was being delivered through the tile systems during the fallow period when there was no production need for drainage to occur. In 1998, a demonstration project to introduce drainage water management to producers in Illinois was initiated by USDA(NRCS). An initial aspect of the project was to identify producers that were willing to manage their drainage system to create a raised water table during the fallow (November-March) period. Financial assistance from two federal programs was used to assist producers in retrofitting the existing drainage systems with control structures. Growers were also provided guidance on the management of the structures for both water quality and production benefits. Some of the retrofitted systems were monitored to determine the effect of the practice on water quality. This paper provides background on the water quality impacts of tile drainage in Illinois, the status of the demonstration project, preliminary monitoring results, and other objectives.

Passive Subsurface Bioreactors: A Subsurface Solution to a Subsurface Problem

Richard Cooke, Agricultural Engineering, University of Illinois

Water flow and nutrient transport in many watersheds in the Midwest are influenced by the use of subsurface (tile) drainage systems, which often act as direct pathways, transferring leached nitrate to surface water bodies. For treatment practices to be effective, they should be designed to treat the water that passes through these tile systems. Researchers in the Midwest are in the process of developing design criteria for passive subsurface bioreactors. These bioreactors are essentially subsurface trenches filled with a carbon source, mainly wood chips, through which water is allowed to flow just before leaving the drain to enter a surface water body. The carbon source in the trench serves as a substrate for bacteria that break down the nitrate through the process of denitrification. These are particularly attractive for use with tile flow since they can be located below ground and they do not require external power sources or regular maintenance.

It appears that passive bio-reactors can reduce nitrate concentration in tile outflow to levels less than the EPA's safe limit of 10 mg/L relatively inexpensively, and without interfering with current field practices. Bioreactors provide many advantages over competing treatment systems: they use proven technology, they require no modification of current practices, no land needs to be taken out of production, there is no decrease in drainage effectiveness, and they require little or no maintenance.

Environmental Issues

Jean Flemma, Prairie Rivers Network

Rivers and streams in Illinois serve many functions, agricultural drainage being one of them. They also provide drinking water,serve as important habitat for fish and wildlife, and offer a wide range of recreational opportunities. The challenge is balancing those functions to provide drainage and the many other benefits these important resources have to offer.

Drainage District Perspective

Jim Cottrell, Drainage Law Attorney

Water Quality

Surface Water Availability and Adequacy of Supply in Illinois

Vernon Knapp, Senior Hydrologist, Watershed Science Section, Illinois State Water Survey

Although flow in Illinois streams is most times plentiful, major droughts have caused substantial reductions in the availability of flows for various uses, including public water supply. Determination of surface water availability and planning for adequacy in the surface water supply of Illinois requires three technical components which are described in this presentation: 1) analysis of the frequency of hydrologic droughts in Illinois, including an evaluation of long-term historical patterns in streamflow variability; 2) determination of flow characteristics for Illinois streams, such as now provided by the Illinois Streamflow Assessment Model (ILSAM), to quantify surface water availability; and 3) development of an inventory of the capacity and estimated yield of individual surface water supply systems. In recent decades, increased emphasis has been placed on maintenance of instream flows during drought conditions to avoid excessive adverse impacts to the health of aquatic ecosystems. The State Water Survey has identified five priority watersheds (the Fox, Sangamon, Kaskaskia, Kankakee and Kishwaukee River watersheds) that are most in need of water supply planning and instream flow evaluation. In each of these watersheds, projected development is expected to limit future availability of surface water for water supply and/or threaten instream flows, either by way of direct withdrawals from streams or through the likelihood that low flows may be adversely impacted by pumping from nearby shallow aquifers. In many of these priority watersheds, an improved understanding of the interaction between shallow groundwater use and low streamflow will be essential to water quantity planning.

Groundwater Availability in Illinois - A Statewide Perspective

Allen Wehrmann, Head, Groundwater Section, Illinois State Water Survey

Each day Illinois uses nearly one billion gallons of groundwater to meet supply needs for drinking water, agriculture, industry, and power generation. Although Illinois aquifers have an estimated combined potential yield of approximately 7 billion gallons per day, those aquifers are neither uniformly distributed throughout the state nor homogeneous in their physical and chemical properties from area to area. Recent aquifer use-to-yield analysis of Illinois' major aquifer systems (sand and gravel, shallow bedrock, deep bedrock) shows areas where groundwater availability problems may exist or could be pending, thus meriting attention. Such an analysis, coupled with a general historical perspective on the state's aquifers, and the potential for future demands on those aquifers, the State Water Survey has prioritized four aquifers or areas for further study. These four include the deep bedrock aquifer system of northeastern Illinois; the sand and gravel and shallow bedrock aquifers of northeastern Illinois; the Mahomet aquifer of east-central Illinois; and the American Bottoms aquifer of southwestern Illinois. The situation with the deep bedrock system beneath northeastern Illinois is especially critical. Lake Michigan allocations to the collar communities alleviated water supply concerns 20-30 years ago. As demand in the region continues to increase, withdrawals from the deep aquifers are again increasing. This time, however, additional allocations of Lake Michigan water are unlikely.

Annex 2001 and What It Means To Illinois

Daniel Injerd, Illinois Department of Natural Resources

On July 19, 2004 the Great Lakes Governors and Premiers announced the release of the Annex 2001 Implementing Agreements for public review. These agreements include a new standard that will be used across the basin to review proposals for new or increased withdrawals of Great Lakes basin water.

This presentation will provide an overview of the principles in the Great Lakes Charter Annex of 2001 that have been

Water Quality (cont.)

incorporated into the recently released Implementing Agreements, describe the decision-making standard that will be used to review water use withdrawal proposals and discuss how the Annex Implementing Agreements will be applied in Illinois. A brief overview and status of Illinois' diversion as allowed pursuant to a U.S. Supreme Court Decree will be included.

Climate Aspects of Water Supply Planning

Derek Winstanley, Chief , Illinois State Water Survey

Illinois withdraws about 19 billion gallons of water per day from Lake Michigan, reservoirs, rivers, lakes, and aquifers. All of this water starts as precipitation, which is the key climate element to consider in water supply planning. As populations grow, the economy expands, recognition of the needs of aquatic ecosystems increases, and water supply systems age, there is a need to look to the future to determine possible changes in water availability and water demand. Foresight and planning provide a sound basis for water supply management that includes consideration of constructing new reservoirs, expanding existing and constructing new water supply systems, water allocations, increasing withdrawals from surface waters and groundwater, and water conservation and reuse.

Using the water cycle as a framework, a water budget for Illinois has been updated. Examples will be provided of how variations and possible changes in precipitation and temperature may change the water budget and influence future water availability in Illinois. The historical climate records for the past 150 years and output from climate models provide the means to examine possible future climatic conditions and their impacts on surface water and groundwater availability. Special focus will be given to characterizing drought conditions and drought frequencies and their implications for water supply planning and management. Statistically, Illinois is due for a major drought, but are we prepared?

The Illinois Department of Natural Resources plays a lead role in water supply planning and management and this role will be explained.

Abstracts

Effects of Phosphorous on Stream Systems

Moderator: Dennis McKenna, Illinois Department of Agriculture

Seasonal Algal Dynamics and Potential Nutrient Limitation in Central Illinois Agricultural Streams

Presenting Author: Krista G. Kirkham, Department of Biological Sciences, Behavior, Evolution, Ecology, and Systematics, Illinois State University

Agricultural modification of headwater streams in central Illinois has led to extensive degradation. The implementation of Best Management Practices (BMPs) with farmer cooperation is critical in the restoration of these imperiled streams and the downstream ecosystems. For three years we have monitored the changes in water chemistry, fish, and macroinvertebrate assemblages in two agricultural headwater streams, Bray Creek and Frog Alley. We have documented declines in nitrate and increases in dissolved reactive phosphorous during late summer months which may limit algal production. Currently, we are examining seasonal algal biomass patterns and potential nutrient limitation in these two headwater streams using nutrient diffusing substrata (NDS) monthly for a year. NDS consist of agar amended with 0.5M N, 0.5M P, controls, and 0.5M N + 0.5M P deployed for 21-26 days. Preliminary results examining mean chlorophyll-a and biomass suggest nutrient limitation in Bray Creek by nitrogen in August and November, and phosphorus in September ($P<0.05$). Frog Alley has shown no significant nutrient limitation at any month thus far. The seasonal decline in nitrate concentrations and increase in dissolved reactive phosphorous concentrations was not as strong as previous years reducing the nutrient limitation observed. Using algae as an indicator of changing nutrient loading rates we hope to have a rapid indicator of changing water quality in agricultural landscapes. Eventually we hope to be able to better understand the relationship between nutrient loading and algal biomass dynamics which leads to degraded water quality.

Statistical Relationships between Illinois Stream Nutrients and Aquatic Diversity

Presenting Author: Timothy B. Smith, Illinois Natural History Survey. Center for Aquatic Ecology.

Authors: Timothy B. Smith, Walter Hill, Matthew Short, Roy Smogor

In this study, we seek to describe the general effects of nutrients on aquatic diversity in streams in Illinois using statistical models built from observational data. Statistical models can provide rigorous scientific support for water quality standards. However, analyses across streams typically show high variance in the relationship between nutrients and the algal growth they stimulate. The data best suited to describe the highly variable relationship among nutrients, algae and their effects on aquatic stream life across ecosystems encompasses long time periods and broad spatial scales. Thus, to achieve our goal, we used extensive datasets from the Illinois Environmental Protection Agency, the Illinois Department of Natural Resources, and the Illinois Natural History Survey.

Preliminary analysis of these data sets examined general patterns of species diversity and nutrient concentrations across the state of Illinois. To meet the statistical assumptions of independence between cases, analyses of nutrient effects on species richness were conducted on aggregate values for nutrients and species richness in non-overlapping subdrainages (N=84). Univariate and backward elimination multiple regression models showed strong relationships between nutrient concentrations and fish and mussel species richness. Both fish and mussels species richness declined with increasing average concentrations of ammonia, total phosphorus and orthophosphorus. The number of mussel species declined with increasing nutrients in a strong "L" shaped pattern. Mussel diversity was depressed in all streams with average ammonia concentrations greater than 0.3 mg/l and total phosphorus concentrations greater than 0.5 mg/l. The patterns we observed persisted when the analysis was constrained to the most abundant stream sizes in the AWQMN (spatially independent streams with catchments less than 250 and

Effects of Phosphorous on Stream Systems (cont.)

greater than 100 square miles), but were not apparent when smaller and larger streams were analyzed separately. As expected, numbers of fish and mussel species increased with stream size. Phosphorus and ammonia concentrations were correlated.

Trends from long term data sets maintained by state agencies show clear relationships between nutrient concentrations and fish and mussel species richness. As in all ecological systems, species distributions occur as a result of many processes. Additional work will seek to tease apart the effects of phosphorus, ammonia and other environmental variables and will further explore the interaction between stream size and nutrient effects.

Spatial and Temporal Relationships between Biotic Integrity of Illinois Streams, Dissolved Oxygen, and Nutrients

Presenting Author: Mark David, Natural Resources and Environmental Sciences, University of Illinois

Authors: M.B. David, L.E. Gentry, T.V. Royer, M.R. Whiles, C.A. Mitchell, K.M. Starks, A.M. Morgan, and T.N. Heatherly

The addition of nutrients, particularly phosphorus (P), to freshwater lakes generally leads to an increase in productivity and the occurrence of nuisance algal blooms, a process termed eutrophication. Streams and rivers are also susceptible to eutrophication from nutrient loading, although there are substantial differences from the patterns observed in lakes. Phytoplankton can be scarce in flowing waters and most chlorophyll-a is found in periphyton. The effects of riparian shading, turbidity, and hydrology also play a much greater role in flowing waters than in lakes. The general model thought to describe the predicted response of these systems to enrichment is increased nutrient loading leading to increased chlorophyll-a, which lowers nighttime dissolved oxygen, and impairs biota. How well this model applies to the streams of Illinois is unknown. Factors such as light availability, temperature, and hydrology could modify the cause-and-effect relationship implied in the above model. Furthermore, it is unknown if a single model will be applicable to all streams at all times.

Our project is quantitatively examining the assumptions that underlie the model on which Illinois EPA is basing their approach. We believe the outcomes of this project will provide a scientific and defensible foundation to guide the development of nutrient standards in Illinois. Our objectives are to: 1) determine relationships among nutrients, dissolved oxygen, and chlorophyll-a (including sestonic vs. benthic chlorophyll) for streams in Illinois, and relationships to biotic integrity (stream macroinvertebrates); and 2) quantify controls on P forms and amounts in Illinois streams, determining relationships to chlorophyll-a; and 3) examine the role of landscape and anthropogenic factors on these relationships, including shading, sewage effluent discharges, and sedimentation.

We are conducting state-wide sampling (extensive) to encompass the variability in stream and land use types that occur in Illinois during both late spring (high flow) and late summer (low flow) conditions (approximately 140 sites). All sites have complete water chemistry measured, chlorophyll-a in sestonic (all) and periphyton (where present), macroinvertebrates (from most wadeable sites), and related parameters such as turbidity, shading, and dissolved oxygen. At five sites each in southern, east-central, and northeastern Illinois we are making intensive (weekly to biweekly) measurements of nutrients, chlorophyll-a (benthic and sestonic), and dissolved oxygen either continuously or on 72 hour cycles monthly). We also are collecting sediment at all extensive sites and determining the equilibrium concentration of dissolved reactive P using isotherms, and also examining controlling sediment parameters. From all these data we hope to determine controls on P concentrations in Illinois waters, along with the

Effects of Phosphorous on Stream Systems (cont.)

Strategic Research Initiative in Water Quality

Presenting Author: George Czapar, Extension, University of Illinois

Water quality continues to be one of the biggest challenges facing agriculture. The State of Illinois has funded research through the Illinois Council on Food and Agricultural Research (C-FAR) to examine the impact of nutrients on water quality. The goals of the Strategic Research Initiative (SRI) in Water Quality 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).

As part of the SRI, an advisory team from the Illinois Environmental Protection Agency and the 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.

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. Since standards need to consider all sources of nutrients, the SRI is collaborating with 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 Impact of Sediments on the Potential Bioavailability of Phosphorus in Illinois Streams

Presenting Author: Michael Machesky, Watershed Science, Illinois State Water Survey

Authors: Michael L. Machesky, James A. Slowikowski, Thomas R. Holm, Josh Stevens, Kip Stevenson, and Ted Snider

In this CFAR-funded study we are clarifying the impact of suspended and bed sediments on the potential bioavailability of phosphorus. The Court Creek and Spoon River watersheds in West-Central Illinois are the focus of this study. The Illinois State Water Survey has collected extensive data on these watersheds over the last twenty years and is currently involved in monitoring the effects of the CREP program within the Court Creek watershed as well as with an extensive channel stabilization effort. Our efforts include intensive low flow and storm sampling of suspended and bed sediments to determine phosphorus forms and bioavailability. While these intensive data are being collected, important water quality parameters such as pH, temperature, dissolved oxygen, and chlorophyll a are also being monitored, through in situ sampling and the use of continuous water quality monitoring instrumentation. A principal outcome of this research will be to more clearly define the relationship between eutrophication and total phosphorus by determining what fraction of total phosphorus is potentially bioavailable, and how bioavailability varies with flow, stream order within the watershed, and between suspended and bed sediments.

Watershed Mangement

Moderator: William White, Illinois State Water Survey

Web Tool for Watershed Information Dissemination

Presenting Author: Shen Wang, Department of Environmental Management, Kane County

Authors: Shen Wang and Karen Kosky

The Watershed boundaries for Kane County, Illinois were redelineated in 2004 using new 2' topography data and ESRI's ArcInfo and the ArcHydro extension. Prior to redelineation, the watershed boundaries had been hand-delineated using 10' topography from hardcopy USGS quadrangle sheets. This paper will present the differences between the old and the new boundaries. Using the new watershed boundaries and other digital geographic data, a publicly accessible watershed information website has been developed. This website contains information on each of the county's ten main watersheds, and will present the information via pages developed using HTML and JavaScripts. The webpages contain information on each watershed's physical makeup, water quality/restoration projects occurring in the watershed, subwatershed boundaries, gage stations, active watershed groups, and other helpful links. The goal of this project is to disseminate information about water projects to the public in a more efficient manner. The watershed webpages are also expected to act as an educational tool, allowing the public to learn about watersheds in general as well as their local watershed boundaries and makeup. An ARCIMS site is created to include detailed data about watershed, subwatershed, soil and land use etc, which will facilitate environmental management in Kane County.

Watershed-Scale Geomorphic Assessment Approach for Evaluating Stream-Channel Stability: Case Study Southern Illinois Region - Big River Creek, Cache River Basin, Union and Pulaski Counties, Illinois

Presenting Author: Laura Keefer, Illinois State Water Survey

Natural stream channels are dynamic systems that adjust their form in response to changes in sediment supply and sediment transport capacity. Channel responses to indirect environmental influences are complex such that even under constant environmental conditions a channel can assume a variety of morphologic configurations. Direct influences, due to over a century of human intervention, are the dominant influences on the Illinois landscape. Channels in Illinois can respond to these changes either by increasing lateral rates of migration, downstream translation of meanders, or development of headward retreats of knickpoints in the channel bed; all resulting in increased rates of erosion and downstream sedimentation. An array of different methods for evaluating stream-channel stability is being utilized throughout the country to meet the demands of resource managers interested in stream restoration and management to reduce erosion and improve stream habitat. Most stream channel responses in Illinois tend to be more subtle than the dramatic response characteristics of streams in the Coastal Plains, mountain environments, and the desert southwest for which other approaches have been developed. Given that watershed assessments needed for stream restoration require non-trivial professional, as well as time and financial resources, an approach needs to be specifically developed for Illinois regional conditions. A watershed-scale geomorphic assessment approach adapted from existing "process-based" approaches developed around the United States will be presented. A case-study was performed in the Big Creek watershed of the Cache River Basin in the southern Illinois region. This approach includes systematic data collection protocols for two phases of characterization leading to an evaluation of the fluvial system for the purpose of determining past watershed

conditions, current geomorphic character, and potential for future channel adjustments using modest time and financial resources.

Assessing Opportunities for Municipal Wastewater Reuse in the Metropolitan Chicago Area

Presenting Author: Yi Meng, Chemical and Environmental Engineering, Illinois Institute of Technology

Authors: Yi Meng and Paul R. Anderson

Water use practices in the Chicago metropolitan area are inefficient and lead to frequent violations of the international treaty that governs water diversions from Lake Michigan. An alternative approach that encourages reuse of municipal wastewater could address many of the inefficiencies. Although wastewater reuse has been practiced in Illinois, it is rare in an urban setting.

Currently the regional planning has not addressed so much on water reclamation and reuse. The water balance model which addresses the water demand and water supply has not been established in this region yet, and such model is believed very important for the brand-new regional planning philosophy.

In 1990, Knight and Sokol made the first effort in the treated wastewater reuse in metropolitan Chicago area; they found only 2 percent of treated wastewater were reused. The effluent from WWTPs is the best source for different kinds of reuse application. The high quality of treated wastewater can be used in industrial process which need high water quality and for land irrigation which need lower water quality. Without knowing the water demand and water supply, economically feasible water reuse system can not be established.

The purpose of this project is to explore the potential for reusing municipal wastewater in the Chicago metropolitan area. Wastewater reuse could reduce the costs of raw water treatment, reduce the costs of wastewater treatment, and reduce the amount of water diverted from Lake Michigan. Potential wastewater reuse options include irrigation (public or private lands), flushing toilets, cooling water, and process water. In addition to these reuse options, treated municipal wastewater can provide a reliable source of heat energy for use in heat pump applications.

Incentives and barriers to municipal wastewater reuse can be separated into several broad categories, including existing regulatory issues, existing institutional or policy programs, potential human or ecological health concerns, technical requirements, and the economics of different approaches. The overall objective of this proposed project is to assess each of these categories and how they contribute to current practice. This information will be used to outline a plan to encourage municipal wastewater reuse.

Watershed Modeling to Evaluate Water Quality at Intakes of Small Drinking Water Systems

Presenting Author: Deva Borah, Illinois State Water Survey, University of Illinois

Authors: Deva K. Borah, Edward C. Krug, and Maitreyee Bera

Small public surface water supply systems of the Midwest are in need of watershed-scale hydrologic and nonpoint-source pollution models to support their water-supply needs. Such models can be developed into useful watershed management tools through assessment of distributed water quantities and qualities, and evaluation of best

Watershed Mangement (cont.)

management practices for protecting and improving water quantities and qualities, and the landscape of the watershed. As part of a Midwest Technology Assistance Center supported project, a combined watershed-scale long-term continuous and storm-event simulation model has been developed as a source-water protection assessment and management tool. Based on a recent review of eleven leading watershed-scale models, the long-term continuous model SWAT (Soil and Water Assessment Tool) was selected. This USDA-ARS model, part of the USEPA's BASINS, was developed to assist water resources managers in predicting and assessing the impact of management on water, sediment and agricultural chemical yields in large river basins. It is a conceptual model that operates on a daily time step. The model is intended for long term yield predictions and not for detailed single-event flood routing. Therefore, the model is being expanded with a storm-event component to simulate hydrology, soil erosion, and transport of sediment and agrochemicals during storm events with short time intervals (minutes or hours) to capture rapid changes, especially during intense or severe events causing most of the environmental damages, in addition to long-term simulations with longer time intervals (days, months, and years) while studying long-term impacts. The 3,200 mi2 (8,400 km2) Little Wabash River watershed in southeastern Illinois was selected for this study because of its favorable small drinking water supply and watershed attributes. It has seven small (population<10,000) and three large public surface water supply systems. It has many precipitation, stream flow, and water quality monitoring stations and many years of data. Using multi-year periods of stream flow and yields of sediment and water quality constituent data, the SWAT continuous component will be calibrated and validated. Established statistical indicators, coefficient of determination (r2) and Nash-Sutcliffe coefficient, will be used to measure and improve model predictions. Using storm event rainfall, flow, sediment, and water quality constituent data at smaller time intervals, less than a day, SWAT storm event component will be calibrated and validated. The calibrated and validated model will be used for both long-term (monthly yearly, and daily) and storm event (such as 10, 50, and 100-year design storms) water quantity and quality evaluations throughout the watershed, including at the intakes of small public water supply systems under existing conditions and under alternative land use and management practices to evaluate the effectiveness of those practices in alleviating potential water shortage, sedimentation, chemical contamination, and overall water quality. The storm-event results would be useful in designing flood and sediment control structures, and planning management practices for keeping concentrations of sediment, chemicals, and overall water quality at acceptable levels. Up-to-date results from this ongoing research will be presented.

Groundwater Modeling and Monitoring

Moderator: Edward Mehnert, Illinois State Geological Survey

Effect of Land Usage on Groundwater Quality in McHenry County

Presenting Author: Hue-Hwa Hwang, Illinois State Geological Survey

Authors: Hue-Hwa Hwang, Samuel V. Panno, and Keith C. Hackley

McHenry County, located near the Chicago metropolitan area, has the fastest growing population in Illinois. The majority of water supplies in the county come from shallow sand and gravel aquifers, which are vulnerable to contamination. Nitrate levels higher than the U.S. EPA drinking water standard (10 mg-N/L) have been detected in many shallow wells in the county. The main objectives of this research were to evaluate the change of groundwater quality in McHenry County during the last few decades and identify the sources of nitrate in the groundwater. Historical groundwater quality records for McHenry County were obtained from the Illinois State Water Survey and the McHenry County Health Department. Temporal analysis of the database revealed that total dissolved solids, chloride, and nitrate concentrations in the groundwater increased after the mid 1960s, indicating deterioration in groundwater quality. This timing coincides with that of population growth in the county and the onset of utilization of artificial fertilizer and road salt. A good correlation was established between high nitrate concentration and cropland, as well as a few areas adjacent to lakes and rivers on a land cover map. Groundwater was collected for chemical and isotope analyses from selected shallow wells with historically high nitrate concentration as well as from farms with livestock. Chemical data indicated that most of the sampled groundwater was of the Ca-Mg-HCO_3 type water. Groundwater from urban areas showed greater Na and Cl content than rural areas, which reflected more extensive applications of road salt. Higher nitrate concentrations were found in groundwater from rural (croplands) areas. Groundwater near livestock farms displayed higher nitrate, sulfate, and total N concentrations. Delta N-15 and delta O-18 values of dissolved nitrate ranged from +2.7 to +40.1 and +4.1 to +16.7 permil, respectively. Isotope data indicates that fertilizer and soil nitrogen are the predominant sources for nitrate in shallow groundwater in McHenry County. Animal waste was also a source for nitrate in the vicinity of farms with livestock. Spatial analysis of historical nitrate data revealed a reverse relationship between nitrate levels and depth, suggesting that the source of nitrate in the groundwater was from the surface. An aquifer sensitivity map showed a strong correlation between large nitrate concentrations and areas with greater leaching potential. The permeable soils, and near surface sand and gravel aquifer in many areas of McHenry County provide unobstructed pathways for surface contaminants such as nitrate and road salt to migrate from surface to shallow groundwater.

Analysis of Illinois Soil Moisture Data: Implications for ENSO Influence on Midwest Climates

Presenting Author: Geremew Amenu, Department of Civil and Environmental Engineering, University of Illinois

Authors: Geremew G. Amenu and Praveen Kumar

Soil moisture is a key component of terrestrial hydrology, and yet one of the least understood hydrologic variable. Being long memory and low-pass filter, it is responsible for modulating land-atmosphere interaction. It regulates the exchange of water and energy between the atmosphere and the earth's surface. It controls the partitioning of radiation into sensible,

latent, and ground heat fluxes and the partitioning of precipitation into runoff, infiltration, and evapotranspiration. Thus, proper understanding of soil moisture dynamics and variability is crucial for accurate prediction of climate and water resources of a region. Of special interest are long-term predictions of floods and droughts, which are critical for water resources management.

One of the challenges in the study of soil moisture is the lack of appropriate data. Satellite observations are ineffective over vegetated surfaces and, at the same time, suffer from inability to capture deep-layer soil moisture profiles. On the other hand, ground observations are very limited in spatial extent and are of poor quality. An exception to this is the soil moisture data of Illinois, which is the most comprehensive, continuous, long-term, and best quality dataset of its kind available in the United States. The Illinois State Water Survey has been collecting this data since 1981 at 19 stations, which forms the Illinois Climate Network (ICN) stations, distributed across the State of Illinois. Biweekly soil moisture profile observations have been obtained for the top 2m depth at each of the ICN stations. Analysis of this historical data is very essential for basic understanding of the soil moisture characteristics in the Midwest, in general, and in Illinois, in particular.

This study uses the soil moisture data of Illinois to investigate (i) the spatio-temporal variability of soil moisture, (ii) depth-wise variability of soil moisture amplitude, phase-shift, and persistence, and (iii) the dominant signals of soil moisture and their linkage to ENSO signals. Simple statistical techniques as well as advanced techniques, such as Singular Spectrum Analysis (SSA) and Maximum Entropy Method (MEM) of spectral estimates, are used for the study. Results of the analysis will be presented and implications to the land surface and climate models will be discussed.

Glacial and Other Unconsolidated Aquifers of the Metroeast Region of Southwestern Illinois

Presenting Author: Edward Smith, Illinois State Geological Survey

Authors: Smith, E. C., D. A. Grimley, A. C. Phillips, and R. C. Vaiden

Sand and gravel aquifers of Wisconsin, Illinois, and pre-Illinois episode age and post-glacial origin in three southwestern Illinois counties, Madison, Monroe and St. Clair, are being studied as part of a regional evaluation of groundwater resources. Regional mapping is being conducted at small scale (1:100,000). Coincident with this mapping project, a comprehensive large scale (1:24,000) quadrangle mapping program is also being conducted statewide.

Thick sand and gravel underlie the Mississippi River floodplain. The Mississippi River Valley aquifer is a source of groundwater to high yielding, large capacity water wells. On the uplands to the east, shallow and relatively discontinuous sand and gravel deposits are found underneath modern stream valleys and overlying buried bedrock valleys. Here, the sand and gravel aquifers, until recently, have been poorly delineated and considered poor potential aquifers. Large-scale mapping has identified areas where these sand and gravel aquifers are more contiguous than previously known. Also, within the buried bedrock valleys in the west toward the Mississippi River, sand and gravel deposits can be relatively discontinuous. Bedrock valleys in the east have minor, though more continuous sand and gravel.

To better understand the geology and hydrology of a portion of the mapping area, a comprehensive study of post-

Groundwater Modeling and Monitoring (cont.)

Groundwater Flow Models of Northeastern Illinois using MODFLOW and GIS

Presenting Author: Yu-Feng Lin, Illinois State Water Survey

Authors: Yu-Feng Lin, Doug Walker and Scott Meyer

The population of Kane County, Illinois, in the Chicago metropolitan area, is predicted to grow to nearly 700,000 residents by the year 2030, an increase of over 70 percent above the population in 2000. This growth has prompted a study of the groundwater resources in the area conducted jointly by the Illinois State Water Survey and Illinois State Geological Survey, and in cooperation with the United States Geological Survey and Wisconsin Geological and Natural History Survey. The study, funded in part by Kane County, Illinois, includes groundwater-flow modeling on two scales: high-resolution models of groundwater flow in Kane County and its adjacent areas in northeastern Illinois, which are nested within a lower-resolution, regional scale model covering parts of Illinois, Wisconsin, Michigan and Indiana. This modeling effort has required the organization, quantification, and interpretation of large quantities of geological and hydrological data. Geographic Information System (GIS) software has been used for the interpolation and transfer of information from geological models and hydrological models into the advanced numerical groundwater models. A computer model of groundwater flow, MODFLOW, has been used to simulate the groundwater flow field.

The aquifers in northeastern Illinois present several challenges to hydrogeologists. The deep aquifers are extensive and influenced by pumping centers that are widely separated, while the shallow aquifers consist of discontinuous, unconsolidated glacial aquifers and the weathered, lithologically variable upper surface of the shallow bedrock. The multiple layers of this system interact with each other and with surface water resources, each of which is managed for different objectives. Studies documenting the use and status of these aquifers stretch back over 150 years, with varying methods, degrees of accuracy, and levels of documentation. This history and the extent of the system have resulted in data collection, analyses and archives dispersed over several states and many agencies in a variety of formats. The credibility of the present groundwater modeling studies requires that the models be based on the available data, inferred parameters, and conceptual models of the system, in a thoroughly documented fashion.

In addition to the complexities of the system, managers and policy makers require a study that accommodates a long-term perspective. Long-term management requires baseline studies that establish a framework permitting follow-on analyses and model updates to account for unanticipated physical, social and economic changes. Simultaneously, modeling technology will continue to improve, permitting a degree of resolution and sophistication that exceeds current tools. In short, the management of groundwater resources in northeastern Illinois demands more than a single analysis based on current conditions and a static, final report. Meeting this demand requires, in addition to the present analyses of groundwater resources using computer models of groundwater flow, establishing a series of GIS coverages and databases that will serve as a baseline and a framework for future studies.

Research in Nutrients and Agriculture

Moderator: Phil Mankin, Illinois-Indiana Sea Grant

Soil Water Nitrogen Leaching in Riparian Autumn Olive Stands in Southern Illinois

Presenting Author: Christine Goldstein, Undergraduate Research Assistant, Department of Forestry, Southern Illinois University

Authors: Christine L. Goldstein and Karl W. J. Williard

Autumn Olive is a N fixing invasive, exotic shrub that has become naturalized in the eastern United States. Our study objective was to determine whether excess nitrogen (nitrate and ammonium) was leaching below riparian autumn olive stands, potentially contributing to stream N loads. To achieve this objective, we installed six tension lysimeters in both autumn olive and open field plots at three riparian sites in southern Illinois. Beginning in February 2004 soil water samples were collected monthly and analyzed for dissolved nitrate, ammonium, pH, and specific conductivity in the Forestry Laboratory of Watershed Research at Southern Illinois University Carbondale (SIUC). In-situ measurements of soil net nitrogen mineralization and net nitrification was conducted in summer 2004. Preliminary results (February through July) show that soil water ammonium concentrations were relatively low and were similar between autumn olive (Mean: 0.1006, StDv: 0.1645) and open field (Mean: 0.0993, StDv: 0.1782) plots. Soil water nitrate concentrations were relatively high under autumn olive stands (Mean: 4.8194, StDv: 14.328) and were significantly higher than open field plots (Mean: 0.0879, StDv: 0.1158). This high soil water initiate could potentially contribute to non point source N pollution of streams, and the presence of autumn olive in riparian areas may convert these ecotones from net N sinks to net sources of N.

The Effects of Turbidity and Sedimentation Changes on the Channel Border Fish Communities of the Middle Mississippi River

Presenting Author: Diane Zeman, Zoology, Southern Illinois University

Anthropogenic activity has severely compromised the ecological integrity of the Mississippi River during the past 50 years. However, few long-term studies have examined the impact of changes in river flow, turbidity, and siltation on non-commercial and non-sport fishes. A master's thesis represents one of the few detailed studies on the shoreline fish communities of the Middle Mississippi River near Grand Tower, Illinois (Klutho 1983, Southern Illinois University, Carbondale). I examined long-term changes in these communities by conducting a companion study to compare water quality, species abundance and community composition between two decades. I sampled fish biweekly between 1 March and 1 December 2003 and recorded date, time of day, substrate type, water temperature, discharge, and guage height. A total of 17,921 shoreline fishes comprising 14 families, 32 genera, and 53 species were collected. I found a dramatic change in community composition that includes an increase in the abundance of invasive species, sight-feeding planktivores, insectivores, and picivores, and a decrease in species specialized for turbid, silty backwaters.

Research in Nutrients and Agriculture (cont.)

Using Compost to Enhance Soil Water Retention

Presenting Author: Duane Friend, Extension, University of Illinois

Adding organic matter to soils in the form of compost has been shown to improve soil water retention. It is believed to decrease the amount of irrigation necessary, especially in coarse soils.

This presentation will review research that examines using compost to change water-holding capabilities of soils, and will discuss a study being conducted in Mason County, Illinois (currently in the 3rd year of a 4 year project). In this study, two rates of compost are being applied to an irrigated, sandy loam soil in replicated plots, which grow popcorn and soybeans in alternate years. Results of soil moisture tests done during the last two growing seasons will be presented. Implications for improving irrigation efficiencies will also be discussed.

Assessment of Agricultural Production Vulnerability in Central Illinois Under Global Climate Change

Presenting Author: Romain Laurent, Civil and Environmental Engineering, University of Illinois

Authors: Romain Laurent and Ximing Cai

Climate change impact assessments at the local scale are subject to large uncertainty. Former studies have assessed the range of the possible outcomes in specific regions but a systematic approach for the quantification of uncertainty in climate change remains a largely unexplored topic with interesting applications to policy making. We develop an approach to quantify the uncertainty of climate change and to transfer the information to local climate prediction in central Illinois; then we use the prediction as an input to an agronomic model to assess the possible, most negative impacts on the corn production in the region.

We combine a Monte Carlo simulation and a weather generator to quantify uncertainty in the generation of daily series of climate variables. For each source of uncertainty considered – emission scenarios, climate sensitivities, types of General Circulation Models – appropriate distributions are chosen. A Monte Carlo simulation samples from the three distributions and generates hundreds of sets of the monthly regional changes in temperature (DeltaT), precipitation (DeltaP) and solar radiation (DeltaRAD) for a specific time horizon (e.g. the 2050's). The results from the iterations are used to develop a joint probability density function (PDF). Next, based on the PDF, twenty representative sets of { DeltaT, DeltaP, DeltaRAD } with particular probabilities are extracted and used as inputs to LARS-WG, a stochastic weather generator whose parameters are first adapted to the specific chosen location of the case study. For each selected set of { DeltaT, DeltaP, DeltaRAD }, LARS-WG generates 100 years of daily local climate variables for the chosen time horizon. The resulting 2000 years are taken as a representative sample of the possible realizations of a year of daily climate variables in central Illinois for the chosen time horizon.

The set of samples is applied to an agronomic model, which simulates crop production taking crop water requirement and supply as variables. Statistical analysis on the outputs of the samples is conducted to display the risk and vulnerability of corn production in central Illinois.

Watershed Management II

Moderator: Rick Cobb, Illinois EPA

Brewster Creek, IL Dam Removal and Stream Restoration

Presenting Author: Karen Kosky, Department of Environmental Management, Kane County

Authors: Karen Kosky, Tim Straub, Don Roseboom, Gary Johnson

The goal of the YWCA/ Brewster Creek Dam Removal & Stream Restoration project was to restore a significant portion of Brewster Creek, a tributary to the Fox River in Illinois, to a natural condition, improving the environment and removing liability from the YWCA for a failing dam structure on their Camp Tu-Endie-Wei property. Camp Tu-Endie-Wei is an outdoor education facility owned and operated by the YWCA of Elgin, IL. Camp's ability to function was threatened by a 74 year old dam which created a lake for canoeing. It was designated by the Illinois DNR as a Class I structure, meaning that the dam had a high probability of causing loss of life and/or substantial economic loss in the event of a failure. In addition, the lake had lost much of its depth due to sediment deposition. The dam was lowered incrementally during 2003 and 2004, allowing a naturalized channel to cut through the impounded sediments and opening a large stretch of Brewster Creek to fish passage. The approach used to remove this dam is new to Illinois. An intensive monitoring effort led by the USGS began one year prior to dam removal to collect survey, flow, sediment load, dissolved oxygen, fish population, and mussel population data. The effort has continued through the construction phase, and will be continued for one year post construction. Monitoring results to date have shown that sediment loads during notching events (one to two day events where the dam is lowered by approximately 18") were, for the first three (of five) notches, less than the loads transported by two pre-notch storm events. At no time were dissolved oxygen levels downstream of the dam during notching events less than 7 mg/l. This paper will highlight other monitoring results including vegetation response, fish and mussel populations, and overall channel formation response.

Comparisons between NEXRAD Radar and Gage Rainfall Data in and Near DuPage County, Illinois

Presenting Author: Elizabeth Murphy, U.S. Geological Survey, Illinois District, Urbana, Illinois

Authors: E. A. Murphy, T. M. Over, T. W. Ortel, and A. L. Ishii

The ability to use radar-based rainfall estimates either alone or as a supplement to rain-gage data in real-time or historical rainfall-runoff simulations or other hydrologic applications would be valuable because of the sparseness of available rainfall data and possible missing data. To check this ability, the U.S. Geological Survey, in cooperation with the DuPage County Department of Environmental Concerns, has commenced an inter-comparison study between rainfall estimates from the National Weather Service (NWS) Next Generation Radar (NEXRAD) and a data set collected from tipping bucket rain gages, which include the 26 rain-gages in the DuPage County rain-gage network and two Automated Surface Observing System (ASOS) gages operated by the Federal Aviation Administration in northeastern Illinois.

NEXRAD data are available in a variety of forms; Multisensor Precipitation Estimator (MPE) (formerly Stage III) data provided by the NWS North Central River Forecasting Center were used in this comparison. MPE data have undergone a number of processing steps, including re-mapping from polar to Cartesian coordinates, conversion from reflectivity to rain rate using a Z-R relation, correction for range-dependence, and, finally, mean-field and localized corrections based on selected rain-gage data available in real-time (for example, the ASOS tipping-bucket gages.) The DuPage County gage network currently (2004) is not available to the NWS in real-time. Therefore, data from this network provide an independent test of the accuracy of the NEXRAD rainfall estimates.
Three types of comparisons were made: (1) maps of total rainfall summed over different periods, including the entire

period of study (1997-2001), individual years, and individual seasons; (2) double-mass curves comparing cumulative rainfall at a gage and the corresponding NEXRAD cell; and (3) scatterplots of daily rainfall depths, also between a gage and the corresponding NEXRAD cell. All comparisons were done for a common time period, with periods of missing or frozen precipitation excluded. NEXRAD data from December 1994 through October 2001, O'Hare Airport ASOS gage from November 1996 through October 2001, DuPage County Airport ASOS gage from May 1997 through October 2001, and DuPage rain gage network data from July 1997 through October 2001 were used in the study.

Preliminary results of the study include: (1) NEXRAD generally under-estimated the DuPage rain-gage network totals; (2) the double-mass curves between the DuPage rain gages and the NEXRAD indicate NEXRAD annual precipitation totals generally are low in 1998 and 1999, with deficits relative to some gages as high as 20 inches annually, but then exceeding the rain-gage totals by as many as 8 inches in following years (this difference results possibly because of changes in NEXRAD processing during the study period); (3) maps based on the NEXRAD data indicate a region of high rainfall rates (approximately 5 inches higher than the DuPage gages) along a line between O'Hare Airport and DuPage Airport that is not present in results from the gage data. Overall, these findings indicate that, at least in this region and during the study period, NEXRAD Stage III / MPE data should be used with caution in rainfall-runoff simulations or other hydrologic applications.

Changes in Flood-Frequency Estimates for Rural Streams in Illinois

Presenting Author: David T. Soong, U.S. Geological Survey

To provide up-to-date flood-frequency estimates for the State of Illinois, the U.S. Geological Survey, in cooperation with the Illinois Department of Natural Resources, Office of Water Resources, the Conservation 2000 Ecosystem Program, and the Illinois Department of Transportation, began a study in 2000 to analyze flood-frequency estimates for rural Illinois streams. Statewide flood-frequency estimates have been updated from 1987 estimates with additional peak-flow discharge data through September 1999 (the end of water year 1999) and geographic information system (GIS) derived basin characteristics. Modifications completed in the present study include redelineating hydrologic regions for Illinois, flood quantiles estimated with both Annual Maximum Series (AMS) and Partial Duration Series (PDS), and updated regional skew coefficients for Illinois in the AMS analysis. The purpose of this paper is to discuss changes from the 1987 work, in terms of magnitude and regional equations, in the AMS flood-frequency estimates for the State.

Comparisons are illustrated with at-site flood quantiles $\underline{Q}_2$ and $\underline{Q}_{100}$ between the two (2004 and 1987) studies. It is apparent that food frequencies have changed noticeably at many stations between the 2004 and 1987 estimates: the $\underline{Q}_2$ varied between –12 and +17 percent, and $\underline{Q}_{100}$ varied between –24 and 48 percent. In the present study, seven hydrologic regions were delineated using physiographic and hydrologic characteristics of drainage basins. Comparisons of $\underline{Q}_2$ and $\underline{Q}_{100}$ in each region show that:

Region 1: decreases in Q_2 but increases in Q_{100} resulted at most streamflow stations
Regions 2, 3, 4, 5, and 6: increases in both $\underline{Q}_2$ and $\underline{Q}_{100}$ at most stations
Region 7: Q_2 and Q_{100} decrease at most stations.

The occurrences and distributions of major flood events during the 1990's are the primary reason for increases in higher flood quantiles in different regions. The additional flood records also have more effect on reducing the width of confidence intervals than the updated generalized skew coefficients.

Watershed Management II (cont.)

The general form of updated AMS regional equations are

$$Q_T = a(TDA)^b (MCS)^c (PermAvg)^d \boldsymbol{R}^{(N)}$$ [for hydrologic regions 1, 3, and 5]

$$Q_T = a(TDA)^b (MCS)^c (\%\ Water + 5)^e \boldsymbol{R}^{(N)}$$ [for hydrologic regions 2, 6, and 7]

$$Q_T = a(TDA)^b (MCS)^c (\boldsymbol{B})^f$$ [for hydrologic region 4],

where TDA is the basin drainage areas in square miles, MCS is the main channel slope in feet per mile, PermAvg is the average soil permeability in inches per hour, %Water is the percentage of area classified as open water and herbaceous wetland in a watershed, BL is the basin length in miles, and a, b, … f are coefficient and exponents of the regional equations. Examining the exponents b and c on TDA and MCS shows that regional floods follow simple scaling for all regions except region 4. Region 4 includes the entire Galesburg Plain Region, Lincoln Hills Region, and Upper Salem Plateau Section. General characteristics of river basins in region 4 include steeply sloping channels and sharply incised valleys. This study also identified the lack of updated streamflow data for small drainage basins (drainage area less than 5 square miles was used in this study) throughout the state.

Monetary Valuation of the Floodplain Forest

Presenting Author: Don Pitts, Construction Engineering Research Lab

Direct benefits and externalities of floodplain forests were examined using both economic and appraisal methods, blending the two methods to devise a judicially defensible valuation of most services of floodplain forests. Services included phytoremediation, flood control, water quality (turbidity and pollutants), carbon sequestration, habitat, recreation and endangered species. Applications in urban, agricultural and natural regions were presented. In most scenarios the floodplain services were symbiotic, greatly adding monetary value when compared to single use applications. The end products are judicially defensible methods usable by field personnel with a working knowledge of a bachelors' degree. An additional product was showing that in many situations, the highest and best use of a floodplain in the eastern United States is as a hydrologically functioning floodplain forest, in that the forests have the highest monetary value to society and often the landowner.

Economics of Conservation Design and Stormwater

Moderator: John Braden, Agricultural and Consumer Economics, University of Ilinois

The Downstream Economic Benefits from Conservation Design Practices

Presenting Authors: Douglas M. Johnston, Department of Landscape Architecture, University of Illinois

Authors: Douglas M. Johnston, John B. Braden, Thomas H. Price

This paper evaluates the downstream hydrologic and economic impacts of conservation development strategies that promote greater on-site storage of storm water runoff. Conservation development provides the same gross density of conventional residential and commercial development, but through techniques such as clustering, permits more land to be used for such functions as storm water management. Storm water management strategies employed typically include wetlands, vegetated swales, and porous paving among others.

We apply benefits transfer techniques to quantify the downstream economic consequences of urban development strategies related to storm water runoff. This information is important in quantifying benefit-cost tradeoffs associated with storm water management policies and design standards for new development. Estimates of the downstream costs can inform developers about the value of preventive measures and help public officials determine the appropriate balance between those preventive measures and downstream mitigation.

The best estimate of total benefits to property owners is three to five percent of property value on average for all properties in the flood plain. The public sector realizes additional benefits through smaller bridges, culverts, and other drainage infrastructure and through increased aquifer recharge. Cities and industries may avoid costly upgrades to waste water treatment facilities if low flows increase. It is difficult to generalize about the economic value of the latter effects.

We take the next step toward usefulness by applying the benefits transfer methodology to a specific case study in a suburban Chicago watershed. The case study emphasizes the effects of flood risk reduction on property values, and the costs of storm water drainage infrastructure. The estimates are at a first level of approximation, based on generally available data. We use widely accepted simulation models to compare alternative development scenarios.

The results indicate that implementation of upstream conservation design practices should have substantial off-site benefits in addition to any on-site economic benefits. Using very conservative benefit estimation methods, our case study reveals downstream flood mitigation benefits and infrastructure savings ranging from $744 to $1,684 per upstream developed hectare ($301 and $681/ developed acre). Clearly, downstream economic impacts should be included in any evaluation of on-site practices.

Comprehensive Research and Management of Impervious Surface Impacts on Watershed Hydrology

Presenting Author: Hale Thurston, U.S. Environmental Protection Agency

Authors : Thurston, H.; Shuster, W.D.; Mayer, A.

Impervious surface is one of the primary agents of hydrologic change in urbanizing watersheds, and its impacts on hydrologic cycles and terrestrial ecological regimes are multifold. The mechanisms through which these impacts are manifested are not well understood, hampering effective management of these impacts. Here at the USEPA National Risk Management Research Laboratory, Sustainable Environments Branch, we are concerned with

promoting multidisciplinary approaches to sustainable environmental management systems through the integration of hydrologic, ecological, economic, and legal perspectives. One way that we articulate this mission is through the examination of storm water runoff regimes in urban ecosystems and how these might be better managed. We have identified two areas of focus, the first is in-situ assessment of the alteration of hydrologic cycle in response to urbanization; and secondly systemic, low-cost participatory approaches to managing storm water runoff at the watershed scale. There are few or no studies that we are aware of which determine the underlying mechanisms and extent of these impacts over the course of landscape alteration through the incremental addition of impervious surfaces over time. The USDA-ARS and USEPA-ORD-NRMRL have initiated a pilot program to study the impacts of different extents and geometries of simulated impervious surface on 1.5 ha experimental watersheds located at the North Appalachian Experimental Watershed, Coshocton OH (USA). As a complement to the experimental investigation of fundamental processes in urban hydrology, we explore distributed stormwater management practices that may mitigate the deleterious impacts of stormwater flows in a previously developed 150 hectare residential neighborhood where impervious surface impacts are typically left unmitigated. Here, we use an urban watershed as a pilot study to determine whether parcel-level Best Management Practices (BMPs; e.g., rain gardens) can be implemented throughout the residential areas, and on the basis of an economic incentive program, which centers on inducing landowner participation in reducing excess stormwater runoff volume with infiltration and temporary detention BMPs, and through incentive programs and unique auction approaches. We have implemented an before-after/control-impact experimental design and initiated hydrologic and ecological monitoring at five stations distributed across the various land uses and impacted areas to determine whether the placement of BMPs at the parcel level in the residential area have effected an improvement in hydrologic and ecological status for tributaries draining urbanized areas of the watershed. In this talk, we focus on economic aspects of these projects that comprise our research program.

Water Quality Impacts of Land Use Change: A Model for Functional Landscape Design Evaluation

Presenting Author: Sangjun Kang, Urban and Regional Planning, University of Illinois

Authors: Sangjun Kang, Changwoo Ahn, David Kovacic, and Douglas M. Johnston

Urban development has significant influences on flooding and nonpoint source pollution problems in watersheds. Buildings, roads, and compacted soils reduce absorptive capacity. In suburban areas, 20 to 50 % of the land is impervious to precipitation. In inner cities and commercial zones, imperviousness can exceed 80 %. According to Schueler (1994), the hydrologic functions of streams change with as little as 5 to 10 % imperviousness, and they change profoundly when imperviousness approaches 25 %.

The increased runoff exacerbates flooding and increases conveyance requirements. Less water is left in the soil to recharge aquifers, replenish wells, and maintain base stream flows. Faster run-off increases erosion, scours stream banks, and entrains more sediment, landscape chemicals, petroleum residues, pet wastes, and other anthropogenic detritus. The net effect is surface water quality that is less amenable to beneficial use.

Numerous strategies have been developed to manage storm water. More recently, landscape architects and urban planners have moved to implement low-impact or conservation planning and design strategies (Arendt, 1996; Hager, 2003; Coffman, 2000). Conservation design provides the same gross density of conventional residential and commercial development, but through techniques such as clustering of development and more land set asides as conservation zones or buffers, permits greater use of land for such functions as storm water management.

Most conservation design practices are based on relatively local (parcel or subdivision) interventions focusing on decreasing impervious surfaces, employing bioremediation via such devices as constructed wetlands or bio-swales,

Economics of Conservation Design and Stormwater (cont.)

to name just a few. However, relatively little research has been undertaken regarding the aggregate effects of widespread implementation of Best Management Practices (BMP)'s on flooding or water quality impacts

In this paper, we examine the watershed level effects of increased urbanization on stream flows and water quality measures of water temperature, nitrite plus nitrate and orthophosphate for the Blackberry Creek watershed near Chicago, Illinois. Blackberry Creek is an urbanizing area predicted to undergo rapid development over the next several decades. The county government is implementing its 2020 Land Resource Management Plan (LRMP) (Kane County, 1996) that calls for substantial conservation of stream corridors, wetlands, and other water resources, in part to reduce the negative impacts of development on flooding and water quality. We modeled the impacts of the 2020 LRMP using current (2000) conditions. Results indicate that the propose land use strategy decreases baseflow, interflow, and increases overland flow. However, with respect to water quality there is no significant difference ($P > 0.2$) between the base condition and the 2020 strategy for sediment, nitrite/nitrate and orthophosphate. Water temperature was reduced. Calibration of the model of nitrite/nitrate was not successful. This study suggests that the Kane County 2020 LRMP is, through landuse planning strategies alone, insufficient to achieve its goals of water quantity and quality benefits. To reduce the negative water quantity and water quality impacts, the implementation of specific land use management practices may be desirable.

Water Quality

Moderator: Phil Mankin, Illinois-Indiana Sea Grant

Arsenic Distribution and Speciation in the Mahomet and Glasford Aquifers, Illinois

Presenting Author: Walton Kelly, Illinois State Water Survey

Authors: Walton R. Kelly, Thomas R. Holm, Steven D. Wilson, George W. Roadcap, Jonathan L. Talbott, and John S. Scott

A total of 176 wells in the Mahomet and Glasford sand-and-gravel aquifers in central Illinois were sampled for arsenic and other chemical parameters. The wells were primarily located in three areas: (1) Tazewell County, an area with known arsenic contamination, (2) Champaign County, an area for which relatively little arsenic data were available, and (3) the deep part of the Mahomet Aquifer in Piatt, Macon, and DeWitt Counties, an area where the aquifer is being recharged by saline water from the bedrock. Roughly equal numbers of the wells in Tazewell and Champaign Counties were finished in the shallow (near the upper confining layer), intermediate, and deep (near the bedrock) parts of the Mahomet Aquifer. These results were combined with archived and published data from several hundred well samples to characterize the spatial distribution of arsenic and determine the potential geochemical controls on its solubility and mobility.

Elevated arsenic concentrations in the Mahomet Aquifer were found in Tazewell County and in the deep parts of the aquifer along bedrock valley walls in DeWitt, Macon, and Piatt Counties. Approximately 44% of the wells in Tazewell County were above the arsenic maximum contaminant level of 10 µg/L, while only 8.3% of the wells in Champaign County were above this level. The Glasford Aquifer had a number of wells with elevated arsenic throughout the study area; 38% were greater than 10 µg/L. There was considerable spatial variability in the arsenic concentrations, and there did not appear to be any arsenic "plumes" at the scale of the sampling. There was no clear pattern of arsenic concentration vs. depth.

The predominant arsenic species was As(III); in most samples As(III) made up over 90% of the total arsenic. Arsenic solubility appeared to be controlled by oxidation-reduction (redox) conditions. Geochemical conditions in the Mahomet and Glasford Aquifers are typically reducing, but only in the most reducing waters does arsenic accumulate in solution. In wells in which sulfate was present, arsenic concentrations were low or below the detection limit (0.5 µg/L). Elevated arsenic concentrations were only found in wells where sulfate was absent or at low concentrations, indicating post-sulfate-reducing conditions. Methane was detected and organic carbon and ammonium concentrations were generally elevated in these wells. Iron is ubiquitous in the aquifer sediments, and iron reduction appears to be occurring throughout the aquifers. Arsenic is likely released from the solid phase as iron oxide is reduced.

Soil and Groundwater Phosphorus and Nitrogen Levels Within Row-crop Agriculture and Adjacent Riparian Buffers in the Cache River Watershed.

Presenting Author: Chad Yocum, Forestry, Southern Illinois University

Authors: Chad M. Yocum and Karl W.J. Williard

Riparian buffers have long been recognized as important attenuation areas for incoming nutrients, specifically nitrogen (N) and phosphorus (P). The primary objective of our study was to compare groundwater and soil phosphorus and nitrogen levels within row crop communities and adjacent riparian buffers of giant cane (Arundinaria gigantea) and deciduous forest along three streams in the Cache River watershed in southern Illinois. Groundwater well transects were installed at successive distances from the row crop field edge (0, 1.5, 3, 6, 9, and

12m) in three riparian study areas each containing giant cane and deciduous forest. Soil cores will also be taken from each site, from the field through the riparian buffer, to determine soil P, N, and carbon (C) levels and test for soil phosphorus adsorption rates. We hypothesize that groundwater phosphorus and nitrogen levels will be reduced in the riparian area from the field edge to the stream. Beginning in January 2004, groundwater samples have been collected from each well. The samples are being analyzed for dissolved orthophosphate, nitrate, ammonium, pH, and specific conductivity at the Forestry Laboratory of Watershed research (FLOW) at Southern Illinois University Carbondale. Preliminary results will be presented at the conference in October 2004.

Influence of Bedrock Geology on Stream Nitrate Concentrations in Forested Watersheds in Southern Illinois

Presenting Author: Roger Haschemeyer, Forestry, Southern Illinois University

Authors: Roger D. Haschemeyer and Karl W.J. Williard

The purpose of our study was to investigate the impacts of bedrock geology on stream nitrate concentrations in unglaciated forested watersheds within the Shawnee National Forest, in southern Illinois. A study in the mid-Appalachians identified bedrock geology as an important factor that can help determine stream nitrate concentration through its control on soil fertility in unglaciated forested watersheds. Twenty-three forested watersheds with no recent disturbances were identified, eleven containing limestone bedrock and twelve containing sandstone bedrock. We hypothesized that the limestone watersheds will have greater stream nitrogen concentration than the sandstone watersheds due to greater soil fertility and enhanced soil nitrogen cycling. Monthly sampling of stream water at baseflow conditions, began on May 2003 and continued for one year. The samples were analyzed for dissolved nitrate, ammonium, organic N, pH and specific conductivity in the Forestry Laboratory of Watershed research (FLOW) at Southern Illinois University Carbondale. Preliminary results showed that stream nitrate, ammonium, organic N, pH, and specific conductivity were greater in watersheds containing limestone bedrock. Overstory vegetation and soil C:N ratio will also be assessed for each watershed.

Coupling of Hydrologic and Hydraulic Models for the Illinois River Basin

Presenting Author: Yanqing Lian, Illinois State Water Survey

Authors: Yanqing Lian and Misganaw Demissie, I-Chi Chan

A Hydrologic Simulation Program – Fortran (HSPF) model for the Illinois River Basin was developed by using the U.S. Environmental Protection Agency's (USEPA) Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) system. Values of the HSPF model parameters were based on the calibrations on three representative watersheds within the basin. Over the simulation period from 1985 to 1995, the monthly and annual mass balances agree satisfactorily with the observed discharges at three gaging stations along the Illinois River. However, the agreement for the daily flows is poor, largely due to the weakness of the HSPF model for routing the dynamic flow through the complicated Illinois River system. To address this problem, a one-dimensional unsteady state flow model (UNET) developed for the main stem of the Illinois River has been coupled with the HSPF model to perform the flow routing. Comparison of hydrographs showed that the coupled HSPF-UNET model simulated the daily peak flow and timing much more closely to the observations. The Nash-Sutcliffe efficiency of the coupled model for daily flow improved from 0.69 to 0.77 at Marseilles, from 0.35 to 0.78 at Kinston Mines, and from 0.17 to 0.82 at Valley City. However, as expected there is almost no improvement in simulating the monthly and annual flows. The development of the couple hydrologic and hydraulic model and the comparisons of simulations from the HSPF and the coupled

Watershed Planning and Ecomonics I

Moderator: Jeff Wickenkamp, North East Illinois Planning Commission

Targeting Conservation Practices on a Watershed Basis

Presenting Author: Jeff Beaulieu, Agribusiness Economics, Southern Illinois University

Authors: Jeff Beaulieu and Steven Kraft

The Illinois' Cache River, a conservation priority watershed, has afforded the opportunity to model and examine the linkages between private land use decisions and ecosystem management planning at the watershed scale. Watershed scale ecosystem management is designed to enhance or at least maintain the ecological integrity of the watershed. Conflicts with landowners or land users can occur if the ecosystem plan fails to reflect the economic uses to which the privately held land can be put. Merging the digital representation of the Cache landscape (ARC/INFO GIS) with farm enterprise optimization (linear programming), and sediment transport (AGNPS) has allowed the linkage between ecosystem management and the income generating stream of private land uses to be developed. The effectiveness of this approach is demonstrated in the Big Creek subwatershed of the Cache River.

ARC/INFO GIS allowed the representation of soil structure by type, slope, and location along different reaches of Cache tributaries. These soil characteristics determine crop productivity, and to a large degree, farm income and also the potential for sediment and chemical transport. Special tabulations of Censuses of Agriculture data on the returns from Cache River watershed farms resulted in land use statistics, in particular, farm size distributions (e.g., acres operated) and management resources (e.g. labor availability). These tabulations were useful in allocating the Big Creek landscape into individual farming units with an average acreage of 241 acres (range of 54 to 712 acres). In addition these tabulations, in turn, guided the development of farms modeled to maximize gross margin through linear programming (LP). Soil coverages generated by the LP, are introduced as input to the Agricultural Nonpoint Source model (AGNPS). Rain events can then be simulated. This coupling of models results in a more accurate depiction of sediment yield in the watershed and ultimately to the Big Creek-fed Buttonland Swamp, the northern most reach of native Cypress in the U.S.

The application of the model to be explored in this proposed paper concerns targeting versus random selection of farms for implementing conservation practices such as no-till. Scenarios will be developed and compared to an unconstrained soil loss scenario and a landscape that reflects current land use in the watershed. The targeted scenario is developed based upon aggregated farm level AGNPS estimated soil erosion. In a preliminary analysis, sediment yield at the mouth of Big Creek was estimated to be reduced about six percent when no-till practices are targeted from the current land use. As the model allows for the aggregate as well as distributional impacts on farm income to be explored, insight that decision-makers need when considering trade-offs between environmental quality and economic costs is provided.

"Nab the Aquatic Invader, Be a Sea Grant Super Slueth!" Educational Web Site

Presenting Author: Robin Goettel, Illinois-Indiana Sea Grant College Program, University of Illinois

"Nab the Aquatic Invaders! Be A Sea Grant Super Sleuth" engages students using a detective theme to investigate invasive species concepts such as biology, spread, impacts, and control measures. On the site, students learn about 10 invasive aquatic species such as silver carp, purple loosestrife, green crab, and nutria, and then they assist five detectives in solving cases of species invasion. After reading species "rap sheets," students have the knowledge necessary to understand how exotic aquatics affect the water environment and ways humans can help prevent the further spread of these organisms.

This session will describe how this education technology can be incorporated as a supplement to curriculum in

biology, geography, and environmental science. We will highlight features of the site to show the instructional methods used to encourage creative thinking and problem-based learning. We are interested in attendee input to enhance content. Results from the extensive Web site review will be shared to highlight effective methods for improving instructional Web sites.

Long-term Impacts of Land Use Change on Non-point Source Pollutant Loading for St. Louis Metropolitan Area

Presenting Author: Woonsup Choi, Department of Geography, University of Illinois

Authors: Woonsup Choi, Yun Wang, and Brian M. Deal

A land use change simulation model (LEAM) and a hydrological and non-point source (NPS) pollution model (L-THIA) were coupled in order to model the long-term impacts of urbanization on NPS total nitrogen (TN), total suspended particles (TSP), and total phosphorous (TP) loadings in St. Louis Metropolitan Area. With the future land use projection from year 2005 to 2030 under three economic growth scenarios (base, low, and high) and a long-term precipitation dataset, we predicted the mean annual surface runoff and mean annual NPS pollutant loadings. Mean annual TN was predicted to increase 0.21%, 0.13% and 0.14% in 2030 compared to 2000 under the base, high and low scenarios respectively. TSP and TP showed similar trends with different magnitudes. Corresponding changes in surface runoff are 0.55%, 0.92% and 0.51%. These much less changes compared to another study may be attributed to the conversion pattern between land uses and the relatively minute urbanization. When it comes to temporal changes, the surface runoff and pollutant loading under the base and low scenarios kept increasing and the two scenarios resulted in similar patterns. Under the high scenario, the surface runoff also kept increasing across time but at different rates and the pollutant loading showed more complicated pattern than the other scenarios. We attribute this result to the interactions between land-use-specific NPS event mean concentration and the magnitude of changes in acreage of various land use types.

Detoxifying Waukegan Harbor: Attitudes and Economic Benefits

Presenting Author: John Braden, Agricultural and Consumer Economics, University of Illinois

Authors: J.B. Braden, A.A. Patunru, S. Chattopadhyay, N. Mays, and A. Cangelosi

This study assesses community attitudes toward toxic contamination of Waukegan Harbor, Illinois, and estimates the economic value of cleaning-up the area. The modal responses to questions about the harbor's significance were neutral – no opinion. The non-neutral responses were roughly evenly split on whether the harbor enhances the quality of life, positive on balance about the harbor's economic importance and likelihood of redevelopment in the near-term, and negative on balance toward the harbor's environmental safety and attractiveness. As an influence on respondent's housing choices, the quality of the harbor environment was more important to residents of the City of Waukegan than to those living elsewhere in Lake County. Several different methods, all focusing on the value of owner-occupied homes, were used to estimate the economic value of clean-up. The estimated values ranged from $200 million to $800 million for Waukegan homeowners. This is equivalent to between 7 and 30 percent of the total value of Waukegan's owner-occupied housing stock. Survey-based methods produced lower estimates than did the analysis of home sales in the marketplace. All of the methods suggest that clean-up would also have considerable value to homeowners elsewhere in Lake County. In addition to the prospective property value enhancements, eliminating the contamination could also improve the Lake Michigan ecosystem and the edibility of Great Lakes fish.

Environmental Hydrodynamics

Moderator: Richard Lanyon, Metropolitan Water Reclamation District of Greater Chicago

Flow Turbulence Characterization in a Large Scale Bubble Plume

Presenting Author: Carlos M. García, Research Assistant. Ven T. Chow Hydrosystems Laboratory, Dept. of Civil and Environmental Engineering, University of Illinois

As part of the Chicagoland Tunnel and Reservoir Plan, the Metropolitan Water Reclamation District of Greater Chicago and the U.S. Army Corps of Engineers plan to build several reservoirs to store combined storm-water and raw sewage during large rainfall events. The objective of this action is to store the combined effluent, and hence to avoid any release to the waterways in the Chicago area. Then, the effluent can be pumped back into the treatment plants, once the storm has ended, at the rate that the plant is able to handle. To prevent the combined sewage in the reservoir from becoming anoxic (with the undesirable known effect of bad odors in a very populated area), different mechanisms are under study to incorporate air into the liquid.

One of the alternatives consists in installing an array of bottom bubble diffusers. Despite the vast literature about bubble plumes, the design of these systems of diffusers clearly poses new scientific and engineering challenges. In fact, since the mass transfer of oxygen and nitrogen to the effluent is of primary concern (the effects of vertical density stratification are of minor order in this case), an accurate knowledge of turbulence in bubble plumes becomes important. Unfortunately, detailed studies of turbulence in bubble plumes in large scale experiments are missing.

Bubble plumes can be created rather easily but they have a complex flow structure which makes their experimental observation a challenge. This paper presents an analysis of turbulence statistics in bubble plumes based on a set of water velocity measurements conducted in a large experimental tank (digester) at a wastewater treatment plant. Swinging motion of the plume (wandering) was observed. The low frequency oscillations of the meandering bubble plume as well as the noise contribution to the sampled signal were removed to obtain an accurate characterization of the flow turbulence.

The behavior of turbulence parameters such as turbulent kinetic energy, dissipation rates of turbulent kinetic energy, turbulent length scales and eddy viscosity, are analyzed for different air discharge of the air diffuser. The observations will help in the understanding of the bubble phenomenon, and will provide a basis for the validation of numerical models used to simulate the mechanics of combined-sewer-overflow reservoirs.

Bank Erosion Control: CFD Modeling of Submerged Vanes

Presenting Author: Jorge Abad, Graduate Research Assistant, Department of Civil and Environmental Engineering, University of Illinois

Authors: Jorge D. Abad and Marcelo H. García

Prevention of streambank erosion, protection of water intake and maintenance of navigatyion depths are the most common applications for submerged vanes along the cutbanks of meandering streams. In Illinois, such vanes, constructed of rock and referred to as bendway weirs have been rigorously evaluated for overall effectiveness. Key elements of design include the water depth-weir height ratio and the angle of attack of the flow relative to thw weir. The latter parameter is responsible for the direction of the vane-induced transverse flow component, which leads the increase or decrease of transverse bed slope.

This study attempts to clarify some concepts and improve the criteria for designing submerged vanes, especially

those related to fluid dynamics around weirs and the influence of these dynamics on sediment transport (near-field and far-field). A state-of-the-art three-dimensional CFD model (FLOW-3D) is used to simulate flow through meander bends in Illinois where 3D velocity measurements have been obtained to validate model predictions at low stages. The model is then used to simulate 3D fluid dynamics at high stage when the weirs are fully submerged. Results inducate that the weirs produce highly complex patterns of flow at high stage that restrict bedload transport but that can produce high shear stresses on the upper bank face.

In these numerical simulations, a multi-block gridding technique is used for the discretization of the physical domain (natural rivers). This technique allows fo rthe efficient usage of the computational resources and appropriate verification of grid independence. Both linked and nested blocks are used, the former are used for linking adjacent blocks and the latter one is used for improving the resolution of flow field near the benway weirs. For the turbulence closure a Renormalized-Group (RNG) model is used.

3D Numerical Modeling of Turbulent Flow in Hydraulic Structures

Presenting Author: Xeujun Yang, Research Assistant, Dept. of Civil and Environmental Engineering, University of Illinois

Authors: Xeujun Yang, Gustavo C. Buscaglia, Marcelo H. Garcia

To fully understand the flow behavior in a hydraulic structure is very essential for its design, operation, and maintenance. But it remains a challenge nowadays to numerically model the turbulent flow within the structure, which usually has a very complicated geometry, in phycial scale and three-dimensionally.

In this paper, two practices of such modeling are presented: the flow in the screen and borbay area in SEPA Station #3, and the flow in the wet well and suction condiuit of the Calument Pumping Station. Both structures are located in Chicago, Illinois. The first practice aims to obtaining the flow veloicty distribution and to identify the locations wehre dedimentation could happen, thus modifications on the structures or on the operation conditions could be made to improve the station's maintenance. The second one evaluates the proposed design of th epumping station, predicts potential hydraulic problems which could endanger its normal operation, and provides suggestions on further improvments of the design.

A finite element CFD code is employed to solve the flows with k-epsilon model as the turbulent closure. Very fine unstructured mesh is used in each case, in order to satisfactorily capture the flow pattern in the area where the geometry undergoes dramatic change. To enable the resulted intensive computation, parallel computing techniques are adopted.

The results show both the flow patterns are well captured. In the model area of SEPA-3 the flow velocity is relatively high, thus not allowing the sediment to settle down. The operating procedure can also be adjusted to further avoid the sedimentation in the lateral regions.

The result for Calument Pumping Station exposes that many flow phenomena, namely, air suction, flow seperation, and cavitation, could happen in the geometry of the orignial design, therefore cause potential failure of the pump operation. Modification of the design are suggested and reevaluated.

Environmental Hydrodynamics (cont.)

High Resolution Simulations of Density Currents

Presenting Author: Mariano I. Cantero, Ph.D. student, Ven Te Chow Hydrosystems Laboratory, Department of Civil and Environmental Engineering, University of Illinois

Authors: Mariano I. Cantero, James P. Ferry, S. Balachandar, and Marcelo H. García

When two fluids with different density are allowed to interact freely they manifest as a density current. In the most common environmental flows the difference in density is generated by temperature, salinity or the presence of particles in suspension. Density currents may be triggered by very small density differences and may turn into a very efficient mechanism for the transport of contaminants in rivers and lakes. Examples of this type of flow are the flow started by a sediment-laden river discharging into the ocean or into a lake, and the release of a contaminant in a lake or in the atmosphere.

Understanding the main features of these types of flows is very important to prevent engineering and environmental accidents or mitigate their consequences. In order to study the importance of interface instabilities in the evolution of density current flows very detailed numerical simulations have been performed with a spectral code. We have performed computations for saline and particulate density currents and focused our research in the contrast between the better-understood saline case behavior and the novel behavior introduced by the preferential concentration of inertial particles.

For the particulate density current computations we have developed a two-phase flow model based on an equilibrium Eulerian method for describing the particles velocity, which includes finite settling velocity effects, and the incorporation of volume fraction gradient and Faxén terms. The complete two-phase flow model is exact to O(ta+t2+a2) (where t and a are the particle response time and volume fraction, respectively) and has been implemented in a spectral channel flow code.

The simulations show clearly the dynamic of Kelvin-Helmholtz billows that are responsible for the mechanism of fluid entrainment for large Gr numbers. In addition, the 3D simulations not only show the Kelvin-Helmholtz billows, but also the existence of a fast instability at the front of the current in an unstable stratified region that develops into a complex lobe-and-clef pattern.

Steam Hydraulics and Sediment Transport

Moderator: Robert Holmes, US Geological Survey

Design, Installation and Operation of an In-lake Sheet Pile Sediment Basin

Presenting Author: Dennis Beyer, Natural Resource Conservation Service, United States Department of Agriculture

Authors: Thomas P. Book and Dennis F. Beyer

The paper/ presentation will cover the in-lake sediment basin and water control structure that was designed and installed at the upper end of Lake Taylorville in Illinois. It was positioned across the main river emptying into the lake, requiring a high flow capacity. A low profile dam design kept the area of ponded water upstream of the structure to a minimum, reducing land rights costs, at the expense of reduced sediment trapping ability. The structure is a 411 meter (1350 ft) long sheet pile weir, with a spillway elevation 1.2 m (4 ft) above the normal pool level. The downstream toe was armored with rock riprap. During construction, the structure site was under up to 1 m (3 ft) of water. This paper outlines the planning, design and construction phases of the work, and includes a report on the first year and a half of operation.

Impacts of Carlyle Dam and the Navigation Project on Kaskaskia River Morphology

Presenting Author: Xizhen Du, Graduate Research Assistant, Department of Forestry, Southern Illinois University

Authors: Xizhen Du and Karl W. J. Williard

The morphology of the Kaskaskia River downstream from Carlyle Dam to Fayetteville, in southern Illinois, was investigated using aerial photographs of multiple date and river-gage information. The flow regime of this river reach has been altered by Carlyle Lake and the navigation project between Fayetteville and the mouth of the Kaskaskia River. Bankfull channel width was the primary variable used to assess pre- and post-dam and navigation project channel change. Ten cross-sections downstream from Carlyle Dam and another ten upstream from Fayetteville, the terminus of the navigation project, were selected. The channel widening rates were computed using 1938, 1949, 1955, 1962, 1968, 1978, 1988, 1993, and 1998 aerial photographs. River gage data from four stations were used to perform specific-gage analysis, a technique that holds discharge constant to observe tendencies in a series of parameters such as stage, cross-sectional area, flow velocity, or channel width. The impacts of vegetation removal and land clearing on channel morphology were also considered in this project. Preliminary results will be presented at the conference in October 2004.

Dredging Sediment to Restore Habitat and Water Supply Capacity While Providing Reclaimed Topsoil to Terrestrial Sites

Presenting Author: John Marlin, Waste Management and Research Center, Illinois Deptartment of Natural Resources

Authors: John C. Marlin and Robert G. Darmody

Decades of sediment deposit in reservoirs and Illinois River backwater lakes has severely impacted aquatic habitat and greatly diminished the water storage capacity of these water bodies. Sediment removal by dredging is an option for restoring depth; however, the placement of dredged material from such projects poses a problem. Finding ways to use sediment productively rather than view it as a disposal issue will facilitate projects to restore lost capacity.

Steam Hydraulics and Sediment Transport (cont.)

The agronomic characteristics of sediment dredged from a number of water supply reservoirs in Central Illinois was evaluated as was sediment from the Illinois River backwaters. The physical characteristics of the sediment were similar to those of native topsoil, particularly when the sediment had weathered for several years. Fields coved with sediment in prior years supported healthy crops.

Plans for removing millions of cubic yards of sediment as part of a multi-decade plan to restore the Illinois River ecosystem depend upon finding ways to handle the material. Research to that effect has been conducted in several locations in Illinois. Sediment was used as an amendment to sandy soil in Mason County where it increased corn and soybean yields. In greenhouse tests it performed as well as native soil with a variety of plants. Likewise sediment placed at a number of field sites developed good soil structure and supported vigorous plant growth.

A variety of methods of handling and transporting mechanically excavated river sediment were tested including concrete pumps, conveyors, and barges as well as a range of trucks. A pilot project transported 105,000 tons of Peoria Lake sediment 168 miles by barge to the old U.S. Steel South Works site in Chicago. The site is covered with slag and has no topsoil. The reclaimed topsoil from the lake will cover a portion of the site that is to be developed as a park.

In situations where needed topsoil is not readily available, reclaimed topsoil from water bodies may be a viable option. This is particularly true when economic benefits accrue at both the dredging and placement sites. Beneficial use of dredged material as reclaimed topsoil will facilitate projects to restore storage capacity while improving recreational and ecological value of both the water bodies and terrestrial sites.

Development of a Graphical User Interface for the Dynamic Watershed Simulation Model (DWSM)

Presenting Author: Jong Ahn Chun, Department of Agricultural and Biological Engineering, University of Illinois

Authors: Jong Ahn Chun, Richard A. Cooke, Bradley R. Tadlock, John S. Kinder, Geri L. Wellen

The Dynamic Watershed Simulation Model (DWSM) is an event-based model that simulates surface and subsurface storm water runoff, and sediment and nutrient transport from small watersheds. In this report we present the first phase of the development of a Graphical User Interface (GUI) for the model. This interface consists of modules for data input, sensitivity analysis, calibration, and graphical display of model output. Each module has interactive windows to support users' decisions. We present a case study in which the DWSM-GUI was applied to the Big Ditch Watershed in Central Illinois. In the next phase of the development of the GUI, we will add a pre-processing module in which a GIS (Geographic Information System) will be used for extracting and formatting input parameters for the model.

Watershed Planning and Economics II

Moderator: Timothy Feather, Planning and Management Consultants, Ltd.

The Waukegan River Section 319 National Monitoring Program Project

Presenting Author: William White, Illinois Department of Natural Resources, Illinois State Water Survey

Authors: William P. White, Don Roseboom, John Beardsley, Luong Duong, and Jon Rodsater

The Waukegan River Section 319 National Monitoring Program project was originally funded in 1994 and is located in Washington and Powell Parks in the City of Waukegan in northeastern Illinois. The river has two branches collectively about 12.5 miles long located about 35 miles north of Chicago and the watershed is heavily urbanized. The Waukegan River has a steep gradient and drains directly into Lake Michigan. Waukegan is an older community with comparatively few stormwater detention basins yet over 80% of the City of Waukegan lies within the watershed. Therefore, there is little control over the quantity and quality of stormwater discharge resulting in flashy runoff rates and heavy stormwater pollutant loads. Sediment was initially thought to be one of the main pollution concerns, however, in addition to severe streambank erosion and channel incision other impairments also exist including chemical pollutant runoff from lawns and streets, potential cross-connections between sanitary and storm sewers; potential leakage, hydraulic undermining, and overflow of sanitary sewer lines; and artificial channel lining. In addition to the physical destruction, the stream habitat and fisheries were highly degraded at the onset of this project and the system exhibited impairments due to lack of water depth in pools, limited cobble substrates, and limited stream aeration.

The objectives were to enhance habitat while specifically demonstrating that biotechnical streambank stabilization techniques can be more cost-effective than traditional armoring approaches alone and that these techniques work well in conjunction with an array of erosion control and habitat enhancement strategies (i.e., Lunkers, A-Jacks etc…) in providing additional water quality and in-stream habitat benefits. Another objective was to show that rock riffles and pools can be effective in reducing erosion of the streambed and streambank and improve stream stability and in-stream physical diversity while increasing water aeration; all leading to increased biodiversity and ecosystem sustainability.

A monitoring design was employed to document impacts of instream and streamside habitat restoration improvements. An upstream/downstream design was selected because urban water quality is more likely to uniformly affect biological conditions at both an upstream control and downstream rehabilitated station uniformly. Therefore, instream and streamside habitat improvements may provide biological benefits that are detectable if the water quality is not an overriding or limiting factor. Stream flow was monitored by using a Flow Logger which was installed during the spring of 1995. The urban fisheries and stream habitat were surveyed before implementation of the stream restoration techniques. Stream fisheries and in-stream habitat have been surveyed to provide post-restoration data. Monitoring also includes macro-invertebrate, physical habitat, and fish surveys during the spring, summer and fall seasons of the project period. In the fall of 2003 Sondes were installed to further investigate water quality impacts and now other water quality investigations continue because, in addition to peak discharges and hydraulic diversity, water quality has been determined to be a limiting factor with particular negative consequences.

SDSS on the Soil Conservation Policy in the Big Creek Watershed

Presenting Author: Seth Soman, Abribusiness Economics, Southern Illinois University at Carbondale

This study was to develop a Spatial Decision Support System (SDSS) to model changes in non-point source pollution and economic return given the different conservation policy scenarios. A geographical information system (GIS) platform was utilized to incorporate a linear programming analysis of landowner's objectives into a spatial evaluation

alternative policy scenarios in the Big Creek watershed. Linear programming (GEOLP) was used to assess economic impacts of changing conservation policy in Big Creek watershed. The objective of the linear programming model was to maximize the farm gross margin given crop prices and soil specific crop yields. The profit maximization function is constrained by available resources (labor and machinery) and by conservation policy T by 2000. And the resulting sediment yield from changes in land use due to soil specific conservation policies were assessed by using the hydrologic model SWAT. The results of this study showed that when the erosion constraints are tightened, farm practices tend to become more conservation oriented. The results indicated that when the soil loss is constrained to T from an unconstrained soil loss scenario, there is, on an average, a 4.8% loss in profit on a per farm basis. The study also helped to identify the hotspot areas for non-point source pollution (sediment) in the Big Creek watershed

Optimal Control Approach for Cost-Effective Management of Ecosystem Services in a Watershed

Presenting Author: Elias G. Bekele, Civil and Environmental Engineering, Southern Illinois University

Authors: Elias G. Bekele, M.Sc. and John W. Nicklow, Ph.D., P.E., P.H.

Ecosystem services such as sediment and nutrient load reductions, flood control, nutrient cycling, regulation of atmospheric gases, and expansion of wildlife habitat and biodiversity are increasingly recognized as essential to society and as having significant economic value. With the considerable successes that have been achieved in controlling industrial point source pollution, the target for improving ecosystem services in the U.S. and elsewhere is increasingly focused on landscapes. Control of non-point source water pollution, for example, is an issue that must be addressed by better managing landscapes.

Agricultural landscapes, which constitute about 50 percent of the land in the contiguous U.S., are distinct from other rural landscapes due to their simultaneous production of commodities and ability to produce ecosystem services, even if forest, prairie, wetland, riparian and other ecosystems were lost upon conversion to agriculture. Thus the potential to increase the production of ecosystem services lies greatly in private agricultural lands, especially grazing lands and croplands that are marginal due to wetness, dryness, steepness, or erodibility. As an example, the vast majority of areas best suited for wetland restoration are now farmland.

This paper focuses on three particular ecosystem service related objectives, namely reducing sediment, nitrogen and phosphorus loads to improve water quality in rivers and streams. These non-point source pollutants are transported from agricultural lands by soil weather and erosion processes, and in excessive amounts, make the receiving waters unfit for human and animal consumption. The study emphasizes load reductions through optimal management of land uses within the corresponding watershed. However, as to not discount the reality that agriculture is to a large extent an economically driven practice, a fourth, and conflicting, objective is the cost-effective production of agricultural commodities. Alternatively stated, this study aims to identify multi-seasonal land uses and tillage practices that most cost-effectively produce improved ecosystem services within a watershed and ultimately enable an examination of the tradeoffs between commodity production and generation of ecosystem services.

To solve this multi-objective problem, an optimal control computational model is developed by interfacing a widely used distributed watershed model, the USDA's Soil and Water Assessment Tool (SWAT), with a Pareto-based multi-objective evolutionary algorithm known as Strength Pareto Evolutionary Algorithm (SPEA2). Note that SPEA2 is an updated version of SPEA. The resulting model identifies the set of decision alternatives, consisting of land uses and respective tillage practices, that concurrently minimizes sediment, nitrogen and phosphorus yields and maximizes economic benefit at a farm-level scale. A three-year decision period is used, and the model operates within a user-friendly GIS framework. The model is applied to the Big Creek watershed, which is part of the larger Cache River

watershed in southern Illinois. The results demonstrate that the SPEA2 is capable of handling the complexities posed by the multi-objective watershed management problem. Furthermore, the overall integrative methodology is effective in identifying a set of optimal solutions and gives the user access to important information regarding the tradeoffs among competing objectives. Based on this information, decision makers are able to evaluate and choose alternatives which best meet their individual hierarchy of goals for watershed improvement. In addition, the model could be used to determine the most cost-effective means for meeting TMDL criteria. Future work will emphasize the inclusion of additional ecosystem services and the further investigation and comparison of alternative multi-objective search methods.

Watershed Management Planning for Rayse Creek in Southern Illinois

Presenting Author: Elisa A. Grafford, Department of Forestry, Southern Illinois University

Authors: Elisa A. Grafford, Karl W.J. Williard, Jean Mangun, and Kristin Floress

The Illinois Environmental Protection Agency (IEPA) and MWH have developed a Total Maximum Daily Load (TMDL) plan for the Rayse Creek watershed (RCW) in southern Illinois based on its inclusion on the 303d list of impaired waterways in Illinois. The listed causes of water quality impairment include: phosphorus, total suspended solids, and low dissolved oxygen resulting primarily from agricultural crop production and animal holding/management areas. Rayse Creek is located at the headwaters of the Big Muddy watershed in Jefferson and Washington counties and flows into Rend Lake. The overarching objective of our project is to work with the newly established Rayse Creek Watershed Planning Committee (RCWPC) to develop a comprehensive watershed management plan focusing on improving water quality. We plan to utilize and expand the Rayse Creek TMDL plan. The watershed planning effort will consist of a four step process: 1. assessment and problem identification (data inventory, data analysis, identifying problems based on the analysis, and developing management objectives), 2. planning (refinement of management objectives and developing strategies to meet the objectives, 3. implementation, and 4. evaluation (monitoring the success of implementation and subsequent plan revision). Problem areas within the watershed will be targeted and management suggestions, based on up-to-date research, will be presented to the RCWPC for implementation. Stakeholder involvement throughout the planning process will be vital to develop a sense of community ownership of the plan, which will be necessary for its successful implementation and evaluation.

Poster Session

Chemical Fractionation of Phosphorus in Stream Sediment

Presenting Author: Thomas Holm, Groundwater Section, Illinois State Water Survey

Authors: Thomas R. Holm, Michael L. Machesky, James Slowikowski

Phosphorus (P) occurs in many different chemical forms in sediments and is probably more bioavailable in some forms than in the others. In the SedEx procedure, which was developed by Ruttenberg [1] and modified by Anderson and Delaney [2], P is extracted by increasingly aggressive reagents. The SedEx procedure divides the sediment P into four operationally-defined fractions: 1. Iron oxide, 2. Carbonate, 3. Apatite, and 4. Organic P. We are applying the SedEx method to surficial sediments from the Court Creek and Spoon River watersheds in west-central Illinois. The results of extractions of sediments collected in the Spring of 2004 indicate approximately 80% of the sediment P is in the iron oxide fraction and 20% is in the apatite fraction. The P concentrations in the other two fractions are similar to the concentrations in the blank (reagents only, no sediment). The SedEx procedure will be applied to check for seasonal changes in surficial sediments. It will also be applied to suspended sediments. This research is part of the CFAR-funded project entitled "The Impact of Sediments on the Potential Bioavailability of Phosphorus in Illinois Streams."

1. Ruttenberg, K.C., Development of a Sequential Extraction Method for Different Forms of Phosphorus in Marine-Sediments. Limnology and Oceanography, 1992. 37(7): p. 1460-1482.
2. Anderson, L.D. and M.L. Delaney, Sequential extraction and analysis of phosphorus in marine sediments: Streamlining of the SEDEX procedure. Limnology & Oceanography, 2000. 45(2): p. 509-515.

Mahomet Aquifer Consortium: Scientific Direction and Plans

Presenting Author: Kelly Warner, U.S. Geological Survey

Authors: Kelly L. Warner, Allen Wehrman, and Edward Mehnert

Federal, State, and local organizations have supported scientific research and projects in the Mahomet aquifer in Illinois that amounts to more than 4.4 million dollars since 1994. These studies involved aquifer characterization, water-quantity, water-quality, and ground-water-flow studies on a limited regional or local scale. There has been little effort toward data compilation for a comprehensive assessment of the sustainability of the Mahomet aquifer. For more than 6 years, the Mahomet Aquifer Consortium (MAC) has sought support to conduct geologic mapping, water-quality monitoring, and ground-water-flow modeling to develop a comprehensive understanding of the Mahomet aquifer. Various studies (some at a local scale) have been done as part of the initial development of an aquifer-wide assessment. For example, Illinois State Water Survey (ISWS) scientists found water level and well log data that suggested the Mahomet Aquifer was directly connected to the Sangamon River along a short reach in Piatt County and performed aquifer tests to assess this connection. The Illinois State Geological Survey scientists conducted a 3-dimensional geophysical survey and drilled boreholes in Piatt County to assess the geology in the area where recent recharge into the Mahomet aquifer is likely. In other parts of the Mahomet aquifer, the U.S. Geological Survey has established a small network of domestic supply wells for sampling every two years for more than 200 chemical constituents. New and ongoing studies in the Mahomet aquifer in Illinois are helping the MAC fill gaps in information, but additional data collection and analysis need to be completed for the development of a detailed 3-dimensional model. Through integrated scientific planning, the MAC hopes to support and promote an aquifer-wide assessment to determine the capacity and sustainability of the Mahomet aquifer.

Gastrointestinal Microflora of Hatchery-Reared Rainbow Trout

Presenting Author: Keith Johnson, Biology, Bradley University

The gastrointestinal microflora of hatchery-reared rainbow trout are influenced through chemical exposure from the environment (e.g., mercury) as well as through diet. The effect of low levels of environmental mercury exposure on microbial diversity in salmonids is currently being investigated, as well as the correlation between mercury- and antibiotic-resistance. Mercury-resistant bacteria have been isolated from hatchery-reared rainbow trout (from the Jake Wolfe Fish Hatchery, Manito, Illinois). The hatchery raises rainbow trout for a period of approximately 11 months, and fish were sampled during the final month (November) of captivity during the 2002 rearing season as well as during the summer of 2003. Mercury-resistant bacteria (selected on 25 µM HgCl2-containing TSA plates) were identified through amplification and sequencing of a hypervariable region of the 16S rDNA gene. The isolates that have been characterized indicate that there may be a seasonal or development distinction between microfloral species. These bacteria have also been shown to be resistant to a range of 100 µM to 1000 µM HgCl2. Similar research has been conducted with researchers in Maine on other hatchery-reared salmonids (lake trout and brook trout). While similar bacteria have been isolated, there are unique patterns of antibiotic resistance.
This research suggests that even low levels of environmental mercury may be selecting antibiotic resistance traits. If, through horizontal gene transfer, the mercury-resistance trait, associated with antibiotic resistance traits, is passed to a fish pathogen, treatment of the aquaculture environment with antibiotics may be hindered.

Stream Mobility in a Low-Gradient, Third-Order, Perennial Stream

Presenting Author: Eric W. Peterson, Department of Geography-Geology, Illinois State Unviersity

Authors: Eric W. Peterson, Timothy B. Sickbert, and Suzanna Moore

Within a stream, the streambed plays an important role as the interface between surface water and ground water (hyporheic zone). Utilized by many macrinvertebrates as a habitat or as a refuge from various stream disturbance processes, hyporheic zone stability is vital to the stream ecosystem. Additionally, the structure of the hyporheic zone (e.g. grain-size distribution, sorting, and packing) controls the rate of interchange of fluids and solute between surface and ground water. Thus, entrainment and transport of sediment in a fluvial system can have significant implications on the structure and function of the hyporheic zone. This research test the hypothesis that in low gradient streams, the sediment transport threshold is exceeded by relatively low discharge events.

The hypothesis will be evaluated using basal shear stress calculations from a low gradient, third-order stream to determine if, and how frequently, flows are capable of mobilizing stream sediment. Streamflow measurments, discharge, velocity, gradient, and water depth, were made to calculate the potential for sediment entrainment by stream gauging and surveying a 1 km strecth of the stream. Sediment cores were also collected in riffles along the thalweg of the stream. Using sieve analysis, the grain-size distribution of the streambed was determined.

Sediment mobility was evaluated using a comparison of critical shear stress and basal shear stress. Basal shear stress, tb, provides an indication of the tractive force available for particle entrainment. Basal shear stress can be expressed by the equation: $tb = r\ g\ h\ S$
where r is water density in kg/m3, g is gravitational acceleration in m/s2, h is water depth in m, and S is water slope in m/m—that is dimensionless. By substituting the values for water density and gravity (i.e., the weight density of water) into the equation it can be rewritten as: $tb = 9{,}800\ h\ S$ which, has units of N/m2. Within the stream of interest, the slope (S) is 0.002 m/m, and the water depth ranges from a minimum of 0.10 m to 3.0 m at bankfull conditions (which occur 1 to 2 times per year), these values generate basal shear stresses of 1.96 to 58.8 N/m2.

Critical shear stress represents the tractive force at which particle erosion begins to occur. Critical shear stress, tc, can be expressed as: tc = q (gs - gw)d where q is the critical dimensionless shear stress (the Shield's Parameter), gs is the weight density of sediment (26,000 N/m3 for most common sediments), gw is the weight density of water (9,800 N/m3), and d is the particle diameter in m. Shield's Parameter, q, is equal to 0.044 for fully turbulent flows (typical of most streams), and substitution of the values into the above equations simplifies to: tc = 0.044(26,000 – 9,800)d = 713d with units of N/m2. Thus, tc becomes a function of particle size.

A ratio of tb/tc greater than one indicates that the sediment transport threshold has been exceeded for the particle size in question. With a minimum tb of 1.96 N/m2, the stream is capable of entraining a 0.0027 m (2.7 mm) particle. Within the streambed, the mean particle size is 0.0021 m ± 0.0007 m (n = 25) suggesting that the streambed of a low-gradient third-order stream is not stable and is continuously changing at the lowest measured flows. At bankfull conditions (tb of 1.96 N/m2), a 0.0824 m (87.4 mm) particle could be entrained. Since greater than 90% (by weight) of the streambed is smaller than 0.0824 m, the streambed is entirely mobilized during bankfull conditions which occur at least once per year.

Erosion by Submerged Plane Wall Jet Impinging on a Layer of Sewer Sediment Resting on a Fixed Boundary

Presenting Author: Octavio Sequeiros, Civil and Environmental Engineering, University of Illinois

Authors: Octavio E. Sequeiros, Ven Te Chow

The magnitude of the erosion caused by a plane turbulent wall jet on a slightly cohesive sewer sediment laying on a fixed boundary was studied with the help of laboratory experiments. The results show a connection between the final steady state profile of the eroded front and the parameter $I = rU_o^2$ closely associated with the bottom shear stress created by the flow. Here U_o represents the velocity at the nozzle of the jet, while r is the density of the flow.

The erosion rate, or velocity of the front, decreases with time as the front moves away from the jet nozzle, because the flow velocity and bed shear stress decay away from the source of momentum. Eventually an asymptotic position is reached and the shear stress is not longer able to scour.

It was found that the position of the front along time and the front velocity collapse to dimensionless curves if referred to time and length scales corresponding to the asymptotic state.

The sewer sediment studied was provided by the Metropolitan Water Reclamation District of Greater Chicago, the samples were taken from O'Hare reservoir. The LISST-ST laser-diffraction instrument was used to characterize the material. Tests with and without disaggregated samples were made in order to estimate the size of aggregate formation. The mean size of particles belonging to the original samples (not disaggregated) was about 24.5 mm, and the typical settling velocity is 0.05 cm/s, while corresponding values for disaggregated samples were 10.8 mm and 0.008 cm/s, respectively. The mean size of the aggregates found in the original sediment samples (not disaggregated) was estimated indirectly, from particle size and concentration distribution measurements. The results indicated that the mean diameter of the aggregates was about 84 mm with a mean settling velocity of 0.5 cm/s.

Several runs were performed for different conditions, including jet velocity at the nozzle and sediment bed thickness to nozzle height ratios (b_s/b_o). Experiments were video recorded in order to study the evolution in time of the sediment front.

It was found the erosion caused by a plane turbulent wall jets applied to sewer sediment parallel to a fixed bottom to be a function of the jet properties: velocity and thickness; the properties of the eroding fluid; and the characteristics of the sediment: critical shear stress and bed thickness.

Poster Session (cont.)

Tile Drainage Modeling Study with a Hydrologic Conjunctive Model

Presenting Author: Feng Yue, Civil and Environmental Engineering, University of Illinois

Authors: Feng Yue, Albert J. Valocchi, Robert J. Hudson

Tile drainage is an essential practice that can maintain land sustainability and food productivity in the Midwest of America. But recent researches have identified its significant contribution to surface water pollution of agricultural chemicals. Ongoing research at the University of Illinois addresses the public environmental concern by developing numerical models to quantify nitrate load from tile-drained farmlands in surface water. The first phase of our work has produced a three-dimensional hydrologic conjunctive model that can simulate overland flow, infiltration, subsurface flow, tile flow and evapotranspiration. It will be coupled to a biogeochemistry model in the near future.

Current drainage models usually simulate only vertical flow environment and generally neglect overland flow and tile flow routing. With our conjunctive model, surface water ponding, groundwater flow path, and other spatial variability factors and their effects on tile discharge can be easily explored. In our current efforts, surface and subsurface hydrologic components are integrated through an alternative external coupling procedure for removing numerical iteration burdens from implicit coupling methods and preserving sufficient accuracy. Surface flow is solved with an alternating-direction-explicit (ADE) scheme and a flux-limiting procedure for ensuring numerical stability. Subsurface flow is solved using the operator-splitting technique and a modified flux-updating algorithm for promising mass conservation. Preferential flow has also been considered. The tile drainage network is simulated as a sink for subsurface flow and routed with the kinematic wave approximation. In this presentation simulated tile discharge is compared with data from Illinois farmlands and the relative contributions from various flow processes are analyzed.

Hydraulic Model Study of Chicago River Density Currents

Presenting Author: Claudia P. Manriquez, Research Assistant, Ven Te Chow Hydrosystems Laboratory (HSL), Department of Civil and Environmental Engineering, University of Illinois

In November 1999, a noticeable difference in the color of the water between Lake Michigan and the Chicago River was observed by the Illinois Department of Natural Resources and later confirmed by the Metropolitan Water Reclamation District of Greater Chicago. This observation was supported by measurements performed by the USGS in 1998 that revealed a bi-directional flow in the Chicago River. This finding suggests that water of poorer quality might be flowing into the Chicago River that could have an adverse impact on Lake Michigan. Furthermore, the Chicago River has a higher use classification, thus higher standards for water quality are required.

A plausible explanation of this phenomenon is the potential occurrence of density currents during the winter months at the junction of the Chicago River with its North and South branches. Density currents are flows driven by density differences.

The main purpose of the study performed in the HSL at UIUC is the design, construction, and operation of a physical model of the Chicago River to analyze in more detail the occurrence of density currents in the Chicago River, the conditions that lead to its development, and how they can be prevented. The physical model has a horizontal scale of 1 to 250 and a vertical scale of 1 to 20. This distortion is needed to have measurable flow depths in the laboratory. Scaling of flow and density gradients are achieved by maintaining the same densimetric Froude number in the

model and prototype. Profiles of mean flow velocities are measured with an Acoustic Doppler Velocimeter (ADV) and density profiles are monitored with a Microscale Conductivity Temperature Instrument (MSCTI model 125). The experiments have shown fair agreement with the numerical model and field measurements.

Web Tool for Watershed Information Dissemination

Presenting Author: Jodie Tate, Visiting Extension Educator, Natural Resources Management, Extension, University of Illinois

Authors: Jodie Tate, Susan Meeker, George Czapar

In June of 2003 University of Illinois Extension, Illinois Environmental Protection Agency, Illinois Department of Natural Resources and Illinois Council on Food and Agricultural Research launched the Illinois Watershed Management Clearinghouse (www.watershed.uiuc.edu). The site is designed to aid new and existing watershed groups in the state of Illinois and receives an average of 7,800 requests per month.

New watershed groups can find information on how to form an association, plan writing assistance and where to look for resource data. Established watershed organizations can use either of the two map engines, locate funding opportunities or receive help preparing grant applications. An Interactive calendar allows the 160 watershed organizations in Illinois to post their activities on a central website.

The "Find Your Local Watershed Group" feature helps individuals locate a watershed organization in their area while the Spotlight feature highlights upcoming activities, news events or topics of concern and is changed weekly.

Two map engines located on the site include the IEPA and Resource Management Mapping Service. Both engines are capable of creating buffers, performing queries, mapping watersheds, highlighting streams and identifying where conservation practices have been installed.

The site was a national finalist in the Communication division of the National Association of County Agricultural Agents awards program.

Variability in Illinois Streams

Presenting Author: Keyur D. Pathak, Department of Chemical and Environmental Engineering, Illinois Institute of Technology

Authors: Keyur D. Pathak, J. John Samuel, and Paul R. Anderson

Development can alter the hydrologic characteristics of streams resulting in decreased base flow, increased storm flow, increased flooding and erosion, and habitat alteration (Konard and Booth, 2002). Evaluating stream restoration programs that are intended to mitigate these problems can be complicated because stream flow patterns vary over different time scales. Furthermore, the causes of these variations are not limited to development.

In this project we examined hydrologic records for streams in Illinois and considered various stream flow statistics to assess flow variability. We considered TQ mean (total flow rate), variance and a power law relation as methods for characterizing stream flow.
For each statistic, we examined how the values depend on watershed characteristics such as area, aspect ratio, and development.

Poster Session (Addendum)

Hydrologic and Hydraulic Modeling of the Emiquon Area

Presenting Author: Geremew Amenu, Civil and Environmental Engineering, University of Illinois at Urbana-Champaign

Authors: Geremew G. Amenu, Yanqing Lian, and Misganaw Demissie

There are major ecological and hydrologic restoration plans being developed for the Illinois River under different state, federal, and regional programs. One of the most significant restoration efforts is for the Emiquon area led by The Nature Conservancy. The Emiquon area was an ecological diverse floodplain/backwater complex of the Illinois until it was disconnected from the Illinois River through a system of levees and drained for agricultural production. The area has been in agricultural production since 1924. The Nature Conservancy purchased the levee and drainage district from the Wilder Farms for the purpose of restoring the ecological diversity of the Illinois River floodplain. Successful restoration of the area requires proper understanding of the hydrologic and hydrodynamics of the area. In support of this effort, the Illinois State Water Survey (ISWS) has been developing hydrologic and hydraulic models for the Emiquon area to guide the ongoing restoration effort. Two-dimensional numerical finite element hydraulic models, RMA2 and SED2D, which are part of the Surface Modeling System (SMS) package, were used to simulate the hydrodynamics and sediment transport dynamics of the area for different scenarios to the Illinois River. A hydrologic model is also developed for assessing the water budget of the area under different management alternatives. Results of the modeling efforts for the existing conditions and different management scenarios will be presented.

Groundwater Resources Investigations in Kane County, Illinois

Presenting Author: WilliamDey, Illinois State Geological Survey

Authors: Dey, W.S., J.C. Sieving, B. B. Curry, C.C. Abert and A.M. Davis

Kane County, Illinois, has recently undergone tremendous population growth. Its population was 370,361 in 1996 and is project to grow by 30-40% by 2020. Because of current water resource limitations and in anticipation of much larger, future demands the County has contracted with the Illinois State Water Survey (ISWS) and the Illinois State Geological Survey (ISGS) to assess it=s water resources. The results of this assessment will provide Kane County with the scientific basis for developing policies and management strategies for more effective management of its water resources. The two Surveys are in the third year of the five year study.

The ISGS is performing three-dimensional geologic mapping of Quaternary deposits and shallow bedrock in Kane County and adjacent areas with an emphasis on groundwater resources. Preliminary maps products produced to date include a map of major Quaternary aquifers, a bedrock geology map, an aquifer sensitivity map, a three-dimensional geologic model and a series of geologic cross sections. Final versions of these products are scheduled for completion in 2007. In addition, the three-dimensional geologic model is being incorporated into a groundwater flow model being developed by the ISWS.

The preliminary map products will be presented as part of the poster presentation.

Pre-Conference Workshop

"Illinois Water Monitoring Council?

A Pre-Conference Workshop on Determining the Need and Desire of Creating a Collaborative State-Level Monitoring Council in Illinois

Tuesday, October 12, 2004,
1:00-5:00 p.m.
Holiday Inn, Urbana, IL

Registration and Details on the Illinois Water Resources Website:
http://www.environ.uiuc.edu/iwrc/Water2004/default.asp

Speakers:

Mr. Gregg Good, Manager, Surface Water Section, Illinois EPA
Springfield, Illinois
Moderator and Pre-Conference Workshop Overview

Ms. Toni Johnson, Exec. Sec., Advisory Committee on Water Information
U.S. Geological Survey, Reston, Virginia
A National Perspective: Roles and Responsibilities of the National Water Quality Monitoring Council

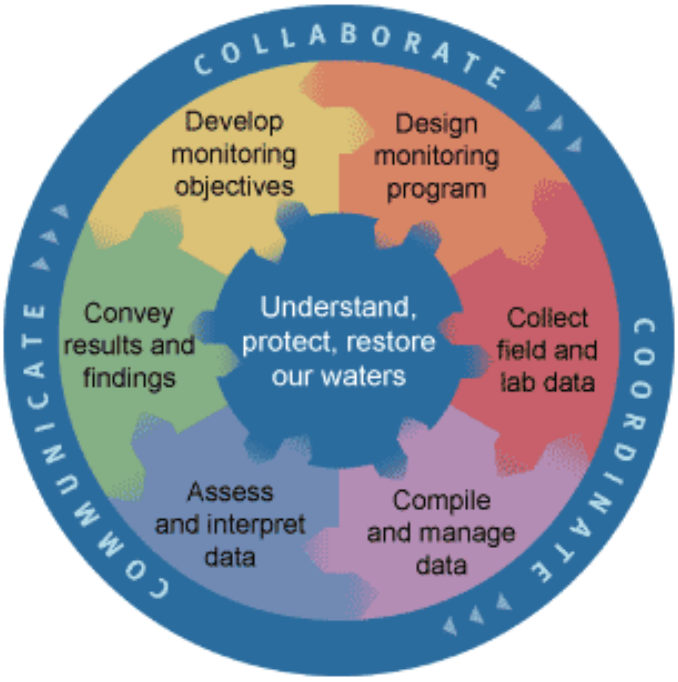
Mr. Bill Stack, Baltimore Department of Public Works, Chair of the Maryland Water Monitoring Council, Baltimore, Maryland
A State Perspective: The State of Maryland's Experiences with Creating and Sustaining a State-Level Monitoring Council

Ms. Abby Markowitz, Tetra Tech, Inc., Owings Mills, MD
Facilitated Open Discussio

Abstract

The National Water Quality Monitoring Council (NWQMC) provides a national forum to coordinate consistent and scientifically defensible methods and strategies for improving water quality monitoring, assessment and reporting. One of the Council's many goals is to promote partnerships that foster collaboration, advance the science, and improve management within all elements of the water quality monitoring community. The Council is co-chaired by the U.S. Geological Survey and U.S. Environmental Protection Agency.

NWQMC's *"Framework for Water Quality Monitoring"*



Under the umbrella of NWQMC, there are twelve recognized regional and state-level water-monitoring councils. These councils represent government agencies, industry, academic researchers, and a wide variety of private organizations dedicated to monitor, protect and restore water resources and their watersheds. One such council is the Maryland Water Monitoring Council, whose purpose is to "help achieve effective collection, interpretation, and dissemination of aquatic resource monitoring data for use in addressing the issues, policies and management of the State's waters."
Like other states, there exists a wide-variety of Illinois agencies, organizations and institutions that annually collect some level of water resources-related data (i.e., IEPA, IDNR, INHS, ISWS, ISGS, IDPH, IDOA, IDOT, USGS, ACOE, MWRDGC, Sierra Club, various "Friends of" organizations, lake management associations, schools, point source dischargers; to name a few). Therefore, the ultimate questions are:

1. *In the long-term, would the State of Illinois benefit from the institution of a state-level collaborative, coordinated and communicative water monitoring council?*

2. *If so, do monitoring entities at this time possess the time, energy and other resources necessary to create and sustain an Illinois Water Monitoring Council?*

Annual Meeting of the
Illinois Section of the American Water Resources Association (AWRA)

In cooperation with
Illinois Water 2004 Conference
Thursday, October 14, 2004 at 7:30-8:30 am
Holiday Inn – Salon C
Continental Breakfast will be provided

- Multidisciplinary water resources community dedicated to advancing management, education and research in Illinois and throughout the USA

_____DID YOU KNOW?
AWRA was founded and headquartered in Urbana, Illinois forty years ago (1964)?

- Formation of Student Chapters on Illinois university campuses provide information and opportunities to students pursuing a career in water resources

- Are you university faculty? Would you be interested in being a faculty advisor? Student chapter information will be available at the meeting or go to the AWRA website at http://www.awra.org/studentstu-manual.pdf

- Would you be interested in seeing Water Issue Forums that gather water resource professionals for discussions on some of the more pressing water resource issues facing the State of Illinois? Bring your topic!

- Discuss regional joint sessions with other Midwest AWRA State Sections, or other scientific societies, covering similar water resource issues and benefit from the experience of others.

- In a world of interdisciplinary research and focus, discussion of expanding activities in cooperation with other scientific fields to address mutual issues is needed (ex. Aquatic ecology). Do you know of a group or annual conference that would be interested?

- Contact Karl Williard, Section President with questions at williard@siu.edu

Students – Free Advice and Food!
AWRA is hosting a Student Career Panel session on Wed., Oct. 13th at 6:30 pm. Join us for lively discussion and Q&A about water resources careers led by a panel of experts with diverse professional experience. Hear about training needs, interviewing tips, strategies for job searching, typical responsibilities, and career tracks in governmental agencies, academia, consulting, and NGOs
http://www.environ.uiuc.edu/forms/

AMERICAN WATER RESOURCES ASSOCIATION
Community, Conservation, Connections