

A photograph of a pond with yellowing leaves in the foreground and reflections in the water. The text is overlaid on the right side of the image.

**Illinois State Water Survey
Annual Report 2000–2001**

Illinois State Water Survey Annual Report

2000–2001

1	From the Chief's Desk
3	Office of the Chief
8	Analytical Chemistry & Technology Unit
11	Atmospheric Environment Section
14	Groundwater Section
17	National Atmospheric Deposition Program
21	Watershed Science Section
26	Publications by Water Survey Staff
36	Honors
38	Adjunct & Emeritus Appointments
39	Water Survey Contacts
41	Financial Statement, FY 01

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ILLINOIS STATE WATER SURVEY
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From the Chief's Desk

Energy is a foundation for our advanced society, and energy issues are entwined with other social, economic, and environmental issues. Everyone and each community in affected areas feel the impacts of energy shortages and blackouts. High energy prices ripple through the economy with effects on travel, industry, and private households.

Several events over the past 12 months have focused attention on energy issues. The electric utility industry is undergoing a restructuring process. Energy shortages in California resulted in blackouts. Gasoline prices have fluctuated dramatically and even rose to \$2 a gallon. Proposed construction of numerous peaker power plants has created concerns in Illinois about environmental impacts.

In response to energy issues in Illinois, Governor Ryan established an Energy Cabinet and is developing an energy policy. In response to energy issues in the nation, Congress is debating President Bush's proposed national energy plan.

Energy production, distribution, and use have many impacts on the environment, locally and globally. These environmental impacts vary according to the nature of the energy source and how that energy source is harnessed and used. Most energy in Illinois is derived from fossil fuels (coal, natural gas, and oil) and nuclear materials. Some risks and adverse human and environmental impacts, as well as many benefits, are associated with producing, distributing, and using energy from these sources.

Perhaps the biggest revelation over the past year has been a renewed recognition that well-designed energy policies and plans are needed to ensure reliable supplies of clean energy. Whereas fossil fuels and nuclear materials undoubtedly will continue to provide much of Illinois' energy in the years ahead, it is also apparent that new technologies will be applied to reduce the amount of waste and to increase safety. In addition, more attention will be given to increasing the efficiency of energy production and use, thus decreasing energy demand. And, increasingly, alternative sources of "green" energy—solar, wind, and biomass energy—will be developed.



Derek Winstanley is Chief of the Illinois State Water Survey.

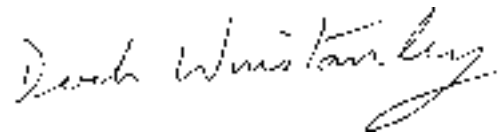
Why are all these energy issues important to the Illinois State Water Survey (ISWS)? In a nutshell, energy production from traditional sources requires water and green sources require atmospheric resources (sun and wind). Energy waste also is discharged into the atmosphere and our water bodies. And, of course, there are further impacts on air and water quality from the use of energy in homes, offices, and industries, and for transportation and recreation. In keeping with its mission to evaluate water and atmospheric resources, the ISWS has an important role to play in analyzing energy options for Illinois.

Below are the main energy-related ISWS activities.

- Lead the planning and organization for the Governor's Conference on Energy and the Illinois Environment in Springfield in November 2001 (<http://www.sws.uiuc.edu/hilites/confinfo/energy/>)
- Serve as Technical Advisor to the Governor's Water Resources Advisory Committee, which is addressing energy-related water resource issues (http://www.sws.uiuc.edu/hilites/waterweb/WaterResourcesIL_files/v3_document.htm)

- Monitor the chemical composition of precipitation nationwide, including chemicals resulting from the production and use of energy
(<http://nadp.sws.uiuc.edu/>)
- Develop and apply a linked regional climate and air quality model to generate climate and air-quality scenarios associated with plausible energy futures
- Continue to monitor wind and solar radiation throughout the state as part of the Water and Atmospheric Resources Monitoring Program
(<http://www.sws.uiuc.edu/warm/>)
- Evaluate the potential for Illinois soils to sequester and store the greenhouse gas carbon dioxide from the atmosphere
- Monitor and analyze small particles (2.5 microns and less) in the atmosphere to determine their composition and sources
(<http://www.sws.uiuc.edu/atmos/airqualchem.asp>)
- Evaluate the probable impacts on groundwater resources and existing water wells of proposed new water wells for energy production
(<http://www.sws.uiuc.edu/gws/>)
- Evaluate the probable impacts of proposed new surface water withdrawals for energy production on minimum in-stream flows
- Evaluate the possible impacts of climate variability and change on surface water and groundwater resources
(<http://www.sws.uiuc.edu/atmos/climatevar.asp>)
- Evaluate the sustainable yields of water from rivers, lakes, reservoirs, and groundwater aquifers
- Provide data on water use by energy producers
- Advise state facilities on effective water treatment for heating and cooling systems, thus conserving energy and water
(<http://www.sws.uiuc.edu/chem/iwt/>)
- Monitor climate conditions affecting energy demand (heating and cooling degree-days) and provide this up-to-date information to businesses and educational institutions
(<http://mcc.sws.uiuc.edu/>)
(<http://www.sws.uiuc.edu/atmos/statecli/index.htm>)

The ISWS is committed to providing analysts and decisionmakers with scientific data and information on atmospheric and water resources that can lead to the protection of the State's natural resources—including its energy sources—and to economic growth.



Derek Winstanley, Chief



OFFICE OF THE CHIEF

Extension and Education Activities

William C. Ackermann Scholarship Recipient

Rachel A. Brennan is the 2001 recipient of the \$1,000 W.C. Ackermann scholarship. Brennan, a Ph.D. candidate in the Department of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign (UIUC), received her M.S. degree from UIUC in 1999. She plans to work as a consulting engineer and ultimately become a professor of environmental engineering.

Derek Winstanley, ISWS Chief, and Nicholas Schneider, Executive Director of the Nature of Illinois Foundation, presented the scholarship at a ceremony held at the Water Survey on March 1, 2001 in conjunction with annual staff service awards. Also in attendance was Mrs. Margaret Ackermann, widow of William C. Ackermann. The annual scholarship was established in honor of Dr. Ackermann, ISWS Chief and professor of civil engineering at UIUC from 1956–1979. Brennan is the eighth scholarship recipient.

University of Illinois Partnerships

The ISWS and other Scientific Surveys participated in “Environmental Horizons 2001” on March 26–27, 2001. The campuswide event showcased environmental research being conducted at UIUC campus. The University Environmental Council sponsors the annual conference, which is organized by a campuswide planning committee that includes one member from each Scientific Survey. Paul Portney, President of Resources for the Future, Inc., delivered the keynote address. Topics for “Restoring the Illinois River,” a technical symposium



Rachel A. Brennan received the 2001 W.C. Ackermann scholarship at a ceremony attended by Mrs. Margaret Ackermann and Chief Winstanley.

organized by ISWS, included the Illinois Rivers Decision Support System, modeling efforts within Peoria Lake, beneficial reuse of dredged sediment, and the chemical quality of Illinois River sediment.

In addition to technical symposia, a poster session, career fair, and art exhibits also provided campus units with an opportunity to meet other faculty, staff, and students to share research findings, to investigate potential career opportunities, and to demonstrate the relationship between the environment and the arts. Overall, the conference provided an excellent forum for ISWS staff to share their scientific and artistic talents with University faculty and students, and to create new opportunities for future collaborations.

*Water Survey staffer
Scotty Dossett
displays his
environmental art
submission at the
2001 Environmental
Horizons Conference.*



Illinois State Fair

Exhibits were prepared for the Discovery Park tent in Conservation World and Lieutenant Governor Corinne Wood's tent near the Ethnic Village at the 2000 Illinois State Fair in Springfield on August 11–20. More than a dozen ISWS volunteers staffed educational exhibits that included posters of nitrogen sources in the state's rainwater and summaries of projects conducted to improve environmental conditions in the Illinois River basin.

Young fairgoers enjoyed "Taking the H₂O Challenge," a taste comparison of samples of distilled water and samples from the Springfield municipal supply. This activity also provided an opportunity to share basic facts about Illinois water resources with children and their parents. Raingage kits included assembly instructions and the ISWS Web site address for additional information on the State's climate and weather. Other educational materials available at the ISWS exhibit in Conservation World covered topics ranging from acid rain to sources of Illinois drinking water supplies.

*Attendees at the
2000 Illinois State
Fair were able to
build their own
raingage at
Conservation
World's Discovery
Park tent.*



Peoria Clean Water Celebration

Staff from ISWS and more than 40 other organizations, students, and teachers filled the Peoria Civic Center arena to capacity at the Peoria Clean Water Celebration on March 19, 2001. This annual science event teaches elementary through high school students and their teachers about the role of water in our environment and the importance of a clean water supply. The ISWS staff displayed the "Monitor" work boat and its lake and stream measurement equipment and also demonstrated making maps using a geographic information system.

Illinois Science Olympiad

More than 1200 students in teams from 36 junior high schools and 30 high schools—winners of regional events—converged on the UIUC campus to participate in more than 35 events at the State Tournament for the Illinois Science Olympiad on April 7, 2001. The ISWS, event organizer for the water-quality section of the tournament, prepared materials and monitored testing for all teams in a series of four 50-minute sessions held in historic Noyes Laboratory on the University quadrangle.

Each test consisted of a written test, biological species identification, and water chemistry testing. Staffers Mark Peden, Dan Webb, and Sally McConkey organized this year's event, and Peden noted that the breadth of knowledge shown by teams was impressive. Top teams receiving medals and trophies at an awards ceremony at Huff Hall will advance to national finals.

Earth Science Week

Scientists from the four Illinois Scientific Surveys celebrated Earth Science Week by taking their message to nearly 800 Jefferson Middle Schoolers in Champaign on October 12–13, 2000. A demonstration day for students in grades 6–8 included interactive demonstrations on seismicity, water chemistry, and insects, along with educational videos with earth science themes in the school's library.

Amid the cheers of other students, four teams at each grade level participated in the Natural Resources Quiz Bowl the next day. Survey scientists provided study materials, but the students had no advance knowledge of which questions would be asked. Both students and faculty have shown great enthusiasm for this program, which mixes science education with fun.

Local television coverage on both days highlighted the students' interest in science education and praised the partnership between the Scientific Surveys and local students. The Surveys have been invited back for a return performance in 2001.

Champaign Jefferson Middle School students confer before answering a question during the Natural Resources Quiz Bowl held in conjunction with Earth Science Week.



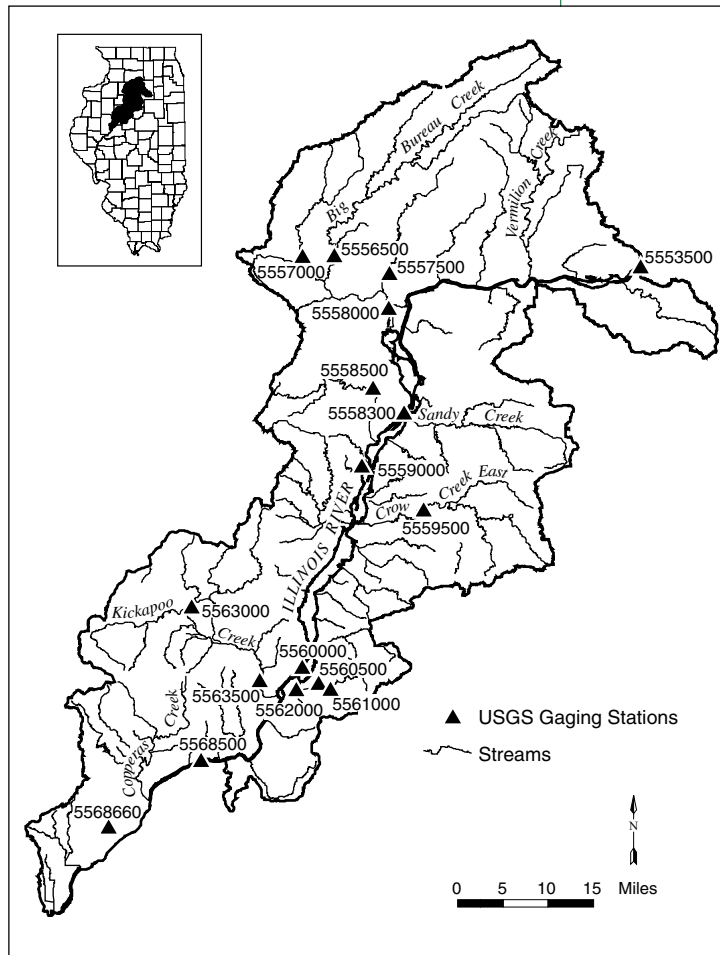
Geographic Information Systems

Geographic Information Systems (GIS) staff (<http://www.sws.uiuc.edu/chief/gis/>) help ISWS scientists make maps, process and analyze spatial data, and incorporate GIS into current projects. Six personal computers and three Unix workstations are available for staff use.

Many projects in this *Annual Report* used GIS in some way. For example, as part of the Illinois Rivers Decision Support System, the output of scientific models is being synthesized into virtual landscapes of areas along the Illinois River to include scientific aspects such as contemporary and historical land cover and lake levels.

Other work entailed generating maps for Illinois River basin proposals and the nitrogen cycle project; adding cross sections to the Embarras River streams coverage; digitizing proposed artificial islands for modeling of Peoria Lake and contour lines from transects for the Pekin area; preparing maps of public water supplies and municipal wells for the "Illinois Water Supplies: Is the Well Running Dry" conference in July 2000 and displaying the water-supply map at the Champaign County Fair; creating a map of Illinois with physiographic divisions and figures for Big Creek and the Little Wabash; and generating bitmap files of maps for the Internet or for PowerPoint presentations; and digital topographic maps have been acquired and processed for the National Atmospheric Deposition Program.

Seven maps were prepared for each of four Critical Trends Assessment Project (CTAP) reports. The ISWS is the lead agency for creating watershed boundaries and



providing them to CTAP staff at the other Scientific Surveys.

Training and technical support related to GIS are another important responsibility. A series of informal training seminars discussed GIS software. Training on other GIS topics is available as needed.

Location of streamgages in the Illinois River Bluffs Assessment area.

Water and Atmospheric Resources Monitoring Program

In cooperation with local, state, and federal agencies, the Water and Atmospheric Resources Monitoring (WARM) Program (<http://www.sws.uiuc.edu/warm/>) collects and compiles data on Illinois' water and atmospheric resources in various formats for multiple users across the state. Since the early 1990s when the program was reorganized and expanded, newer sensor technologies, automated recording of information, and remote downloading of data collected have improved the extent and timeliness of reported information.

The program coordinates data collection from ISWS monitoring networks that measure soil moisture, climate variables, suspended sediment in streams, and shallow groundwater levels, as well as compiling data on Illinois stream and river flows and reservoir heights. Data analyses provide a better understanding of interactions between these various resources and their impacts on Illinois' natural resources and economy.

The scientific community, internal staff, and the public receive regular data summaries from each sub-network. The monthly *Illinois Water and Climate Summary*, available in printed form and electronically, reviews WARM sub-network data for the previous month. Detailed, up-to-date data summaries from each site in the Illinois Climate Network (ICN) can be downloaded from the Internet as Excel® spreadsheets. Nineteen times a year the *Soil Moisture Summary* describes moisture

changes in Illinois soils, often the first sign of approaching drought stress.

In accordance with its mission, to provide a long-term continuous record of the quality and quantity of the State's water and atmospheric resources, the WARM Program also maintains an Internet-based inventory of other databases containing long-term data about Illinois' water and atmospheric resources. These databases include networks operated by ISWS, and by other State and Federal agencies. The inventory provides resource information describing types of data included, number of collection sites in Illinois, period of data collection, and contact information for data acquisition rather than the actual data.

Due to the quantity of information collected and the growing use of resulting products, streamlining and enhancing data collection are ongoing WARM tasks. Recent activities included installation of automated sensors to determine soil moisture and shallow groundwater well depth at most ICN stations. Continuous readings of these data variables can track real-time precipitation influences on these data sources. Eventually the sensors will replace once-a-month manual observations.

Another project, made possible through a grant funded by the Illinois Department of Agriculture, is monitoring daily soil temperatures under bare soils. The objective is to produce an Internet-based dissemination system for real-time data display to help farmers time fall applications of nitrogen fertilizer.

Staff gages also are scheduled for installation early in fall 2001 at selected Illinois reservoirs to provide greater precision in determining current reservoir levels at cooperating sites. Agreements with these operators for enhanced observations during heavy rain events will document the speed at which reservoir levels respond to increased streamflows into reservoirs and subsequent recovery periods.

Data dissemination is crucial to more fully understanding the quality and quantity of Illinois' water and atmospheric resources, as well as providing information used in developing quick responses to events during periods of weather extremes. Internet access to WARM data will continue to be developed.

Paul Nelson electronically services the ICN sensor array.



What's New on the Web

The ISWS strives to disseminate a wide variety of information in an array of usable formats. Web use has risen dramatically since redesign of the entire site last year. In an attempt to further enhance this record-level rise in Web use, many improvements now enable users to easily locate recent Survey documents, highlights of events, Survey publications, and downloadable data.

The Illinois Rivers Decision Support System (ILRDSS) is now on the Web (<http://ilrdss.sws.uiuc.edu>). The site is being expanded daily to provide scientific support and access to high-quality information for restoration of the Illinois River and its watershed as part of the Illinois Rivers 2020 Program. With the ILRDSS, decisionmakers will be able to answer "what-if" questions to assess and evaluate the effectiveness of different restoration projects, as well as the consequences of other natural or human-induced changes in the watershed.

Web server software and hardware have been upgraded to provide Web users with the latest technology, improvements that will also benefit Web development efforts at ISWS. As Web site usage grows, data and other heavily accessed information are being ported to

faster, more efficient programs. High-traffic areas of the Web site constantly are being upgraded and improved to offer the best performance to all ISWS Web users.

Web operations for the ISWS Web Group surpassed 5.5 million hits for the current fiscal year. The Web Group includes the Illinois State Water Survey (<http://www.sws.uiuc.edu/>), the Midwestern Regional Climate Center (<http://mcc.sws.uiuc.edu/>), the National Atmospheric Deposition Program (<http://nadp.sws.uiuc.edu/>), and the Illinois Rivers Decision Support System (<http://ilrdss.sws.uiuc.edu/>), among other sites.

This increase is due largely to an increased presence of the Survey Web site in popular search engines such as Google, AltaVista, Yahoo!, and many others. The Web site ranks highly in most of the more than 1,000 search engines in which it is regularly updated.

Frequent updates were made to the internal Intranet site for ISWS employees. This site provides day-to-day information, such as forms that change frequently, phone lists, and other documents. Office policy, weather information, and details of recent Survey activities and events also appear here.

New Web Site

The Nitrogen Cycles Project: Conceptual Model of Nitrogen Cycling (<http://www.sws.uiuc.edu/nitro/>) was developed with the Illinois Council on Food and Agricultural Research, the Department of Natural Resources, and the University of Illinois. The long-range purpose of the Web site is to provide an improved scientific basis for developing and testing mathematical models that simulate the cycling of nitrogen in Illinois environments. It also will be used to improve current methods used for nitrogen mass-balance studies. Intended for both the general public and educators, the Web site explains the general concept of biogeochemical cycles and the complex processes of nitrogen cycling. Future plans include applying current information to specific watersheds in Illinois.

ANALYTICAL CHEMISTRY & TECHNOLOGY UNIT



Chemical Analyses, Research Data, Training, Public Service, and Help with Common Water Treatment Problems

The programs of the Analytical Chemistry and Technology Unit (ACTU) focus on providing analytical support and research data for the scientific community, and on helping solve water problems of private citizens, communities, state facilities, and utilities in Illinois.

Analytical Services

The Analytical Services group provides chemical analyses in support of ISWS and University research. This year, the laboratory analyzed samples for 28 distinct research or service projects funded by state, university, and federal resources. While the scope of research projects varies from long-term water-

quality monitoring of watersheds to the effects of inorganic contaminants on waterfowl, all researchers need to be certain that their data meet the standards for precision and accuracy required for their work. The laboratory follows a stringent Quality Assurance Plan (QAP) that documents the protocols used for all methods and procedures. The Water Survey also has hired a full-time Quality Assurance Officer to work with ACTU staff, oversee the maintenance and update of the Laboratory QAP, and document that all guidelines adopted are being followed.

Public Service Laboratory Program

The Public Service Laboratory Program (PSLP) has analyzed water for private well owners, well contractors, governmental agencies, health professionals, and others for more than 100 years. Last year the PSLP performed analytical determinations for almost 500 samples and responded to nearly 300 phone requests for information. There is no charge for these water analyses.

The public often has questions about stained laundry or fixtures, the need for softened water, or the suitability of a lake for watering livestock. Recently, the PSL has been involved in testing water from private wells near a sand-and-gravel pit east of Morris in Grundy County. Concern over groundwater contamination due to activities at the pit led

Lauren Sievers reviews analytical data for anion analysis from the ion chromatograph for PSLP samples.



to baseline water-quality analyses of nearby residents' water. A private laboratory collected samples from about 50 homes and then submitted them to the PSL for mineral testing.

Analyses include tests for iron, manganese, hardness, sodium, chloride, nitrate, sulfate, pH, and some trace metals (chromium, copper, and nickel). No parameters tested seem unusual for area groundwater within the 40 water samples collected and analyzed thus far.

When someone requests a PSL analysis of a sample, he/she receives a sampling kit that includes sample bottles, sampling instructions, and a freeze pack to keep the sample cool during shipping. In response to a growing concern of well owners in some areas of Illinois, the laboratory recently has secured a new, state-of-the-art instrument to analyze very low levels of metals such as arsenic.

Institutional Water Treatment Program

Each year, more than 100 state facilities turn to the Institutional Water Treatment Program (IWTP) for advice on water treatment in an effort to reduce water usage, maintain operating efficiency, and minimize chemical and fuel use. Since 1949, IWTP services have ranged from presenting on-site training and seminars to providing chemical specifications and making recommendations about a comprehensive water treatment program for control of corrosion, mineral scale formation, and biological growths. Facilities receive detailed written recommendations and specifications for recommended treatment equipment, chemicals, and corrosion-resistant materials for use in construction projects.

Program staff also are involved in an annual workshop for Illinois Institutional Chief Engineers cosponsored by the Department of Natural Resources, the University of Illinois, and other state agencies. The workshop, now in its 53rd year, also provides information on pending regulations and water treatment developments of relevance for supervisory and administrative staff at individual institutions.

During the last year, IWTP staff responded to more than 1,100 phone requests and provided more than 1,500 written copies of detailed laboratory water analyses, recommendations for action based on analytical results, and other materials. Program staff made approximately 430 site visits to state facilities to evaluate the chemical treatment program, answer questions, solve problems, and analyze samples. Approximately 2,900



Here's an example of corrosion found under the insulation in the cooling system at a state facility.

water samples were analyzed in the field during site visits, and staff conducted complete analyses of 875 additional samples in the laboratory.

Midwest Technology Assistance Center for Small Public Water Systems

The Midwest Technology Assistance Center (MTAC) is one of eight Technology Assistance Centers for small public water systems funded by the United States Environmental Protection Agency (USEPA) to develop the technical, managerial, and financial capacity of small communities' water-supply systems. A new cycle of MTAC work will help small communities in Illinois and around the nation through outreach efforts, information dissemination, and competitive grants.

Outreach. Activities and products developed also will be suitable for use outside the State of Illinois, and project partners are being encouraged to distribute and share any information with their counterparts in other Midwestern states. Whenever possible, MTAC will facilitate this dissemination of information. Some outreach projects scheduled for this year are listed below:

- *Problem Bacteria and Speciation.* A total coliform and bacteria CD/workbook will be produced in cooperation with the Illinois Section of the American Water Works Association (ISAWWA). Project design includes interactive learning techniques, photographs, diagrams, and self-testing methods.
- *Self-Evaluation Project.* A CD and an accompanying workbook will be produced in cooperation with the Illinois

EPA and ISAWWA. The product will be flexible and sophisticated enough to be tailored to specific treatment and distribution components of individual water systems.

- *Emergency Response Planning.* A workbook will be developed in cooperation with the ISAWWA to supplement the existing MTAC Emergency Response Planning CD/Interactive Program.
- *Financial Tools for Small Systems Workshops.* A series of workshops will build upon the findings of the MTAC economic benchmark investigation and other relevant research. Initial funding from MTAC will serve to develop the materials and to fully test the workshop approach.
- *Capacity Development/Emergency Planning Workshops.* Two two-day workshops will be cosponsored with the Illinois Rural Water Association.
- *Distance Learning Interactive Course on Operation and Maintenance.* Interactive training courses will be offered at community colleges around Illinois in cooperation with the Environmental Resources Training Center located at Southern Illinois University-Edwardsville. Each course will consist of a series of

training videos plus an interactive question-and-answer period.

Information Dissemination. Several different methods will be used to distribute MTAC products and information to small drinking-water systems around the country. The MTAC Web site lists products, partners, and helpful links to additional resources. Together with the National Drinking Water Clearinghouse, MTAC is producing and distributing technical briefs related to MTAC-funded research projects. Moreover, all Technical Assistance Centers are planning a joint conference to highlight their activities, and MTAC will be taking a leadership role in organizing that meeting.

Competitive Grants. Up to four major projects will receive funding through MTAC's competitive grant process. Proposals will be solicited for the following subject areas: financial planning, capacity, and performance; arsenic mitigation; and source water protection. The intent is to fund at least one proposal for each subject area. All proposals submitted will undergo rigorous peer review to ensure that only proposals of the highest quality are funded. Reviewers will be selected from a pool of university professors, state and federal regulators, and technical assistance providers.

Emerging Issues: Finding Solutions through Partnership

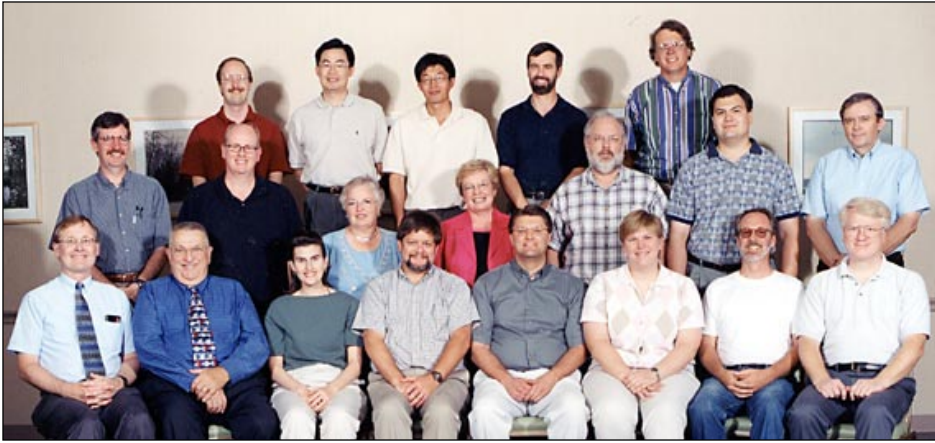
Corrosion control and water treatment experience of ACTU staff has led to an ongoing association with the U.S. Army Construction Engineering Research Laboratory (USACERL) in Champaign. In the past, ACTU staff have participated in several USACERL-funded corrosion research projects for potable water. They also helped write U.S. Army Public Works Technical Bulletin 420-46-07, which provided guidelines for lead and copper corrosion control in potable water.

Currently, ACTU staff are engaged in two USACERL-funded projects: 1) rewriting the U.S. Army manuals for water treatment and monitoring requirements in heating and cooling systems, and 2) writing a manual specifying water treatment equipment for those same systems.



A hot water boiler such as this is common in heating systems of buildings.

Plans call for continuing this type of cooperative work by field testing new, environmentally friendly (green) chemical treatment programs at U.S. Army bases at which ACTU staff will monitor system chemistry, corrosion rates, etc. Green chemical programs that prove effective then will be incorporated into the IWTP so that State facilities can minimize the environmental impact of their water treatment programs.



ATMOSPHERIC ENVIRONMENT SECTION

Addressing Atmospheric Issues through Research and Service

The Atmospheric Environment Section (AES) houses several diverse research programs, the Illinois State Climatologist, and the Midwestern Regional Climate Center.

Modeling

The regional climate and air-quality modeling program made great strides during the past year. One goal was to improve the regional climate model to more accurately simulate heavy precipitation episodes. A standard version of the model produced rather poor simulations of major flooding that occurred in Illinois and surrounding states during summer 1993.

Certain problem areas were pinpointed during a comparison of these initial simulations and observed data, including Water and Atmospheric Resources Monitoring data. Based on this comparison, changes were made in how the model describes certain key physical processes. Then two heavy precipitation episodes, summer 1993 and fall 1986, were simulated. Like 1993, the 1986 episode resulted in severe flooding in the Midwest.

Estimates of precipitation amounts and spatial distribution were much better in the revised model. These results are significant because the improved model will allow more realistic assessments of potential impact of global climate changes on heavy precipitation frequencies and amounts.

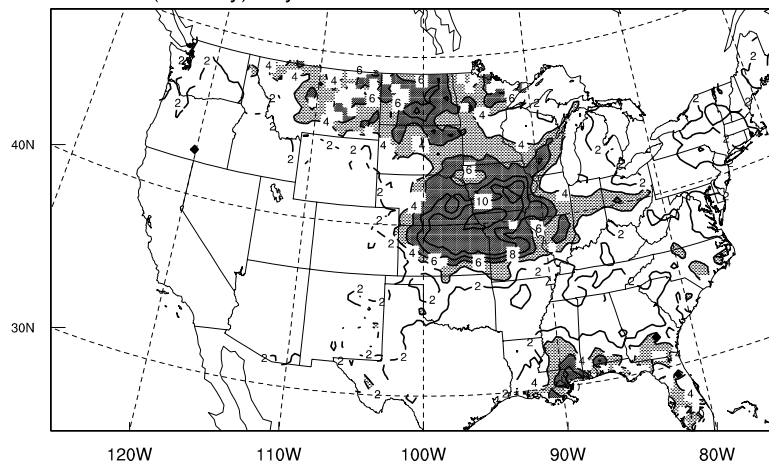
A second significant accomplishment was the completion of the first version of an air-quality modeling system, which includes a process to estimate pollution emissions and

a complex state-of-the-art model that incorporates key chemical reactions and processes.

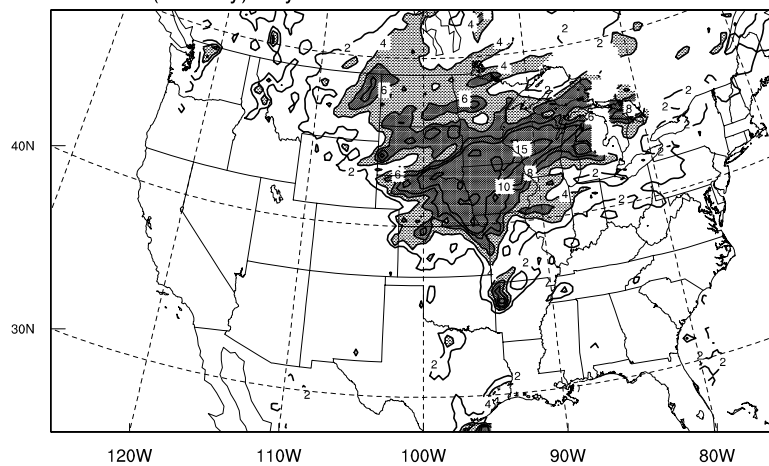
This system was demonstrated by simulating summer 1995 rainfall, and results were in good agreement with observations. Although

The climate model is generally successful in simulating rainfall location and magnitude as shown in the comparison of rainfall observed (top map) vs. model simulation for the July 1993 flood month.

Rain (mm/day) July 1993 OBS



Rain (mm/day) July 1993 RCM 30km



many improvements are planned, the modeling system can be used now to assess the impacts of various societal and environmental trends on air quality.

Cloud Processes

The Cloud and Aerosol Physics Laboratory at ISWS has been in continuous operation for the past 40 years. The laboratory has specialized in measurements of small-scale microphysical parameters relating to the properties of warm rain and the removal of aerosols by cloud drops (aerosol scavenging).

On a broader scale, the purpose of warm rain research is to obtain data that can be used to improve understanding of cloud processes, which are important to the assessment of techniques for weather modification. Cloud properties and processes are also important to understanding the radiation balance in the atmosphere, and they are incorporated into models of radiative energy transfer in support of climate change research.

Aerosol scavenging research has provided data to quantify processes by which clouds cleanse polluted air, research funded primarily by federal grants. Recent research has focused on determining the efficiency by which large droplets collect smaller droplets in clouds. This process is primarily responsible for the growth of droplets to raindrops. Experiments to measure these efficiencies must accurately control droplet sizes, air relative humidity, temperature and pressure, as well as the electric charge on both the collector drop and the collected drop.

Recently, the first measurements were made of the effects of drop charge on the collection efficiencies for freely falling drops in an environment characteristic of Illinois clouds. Additional measurements of the effects of temperature, humidity, and pressure on collection efficiencies for a wide range of

drop sizes have broadened our knowledge of the physical processes leading to development and evolution of precipitation in Midwestern clouds.

Erosion

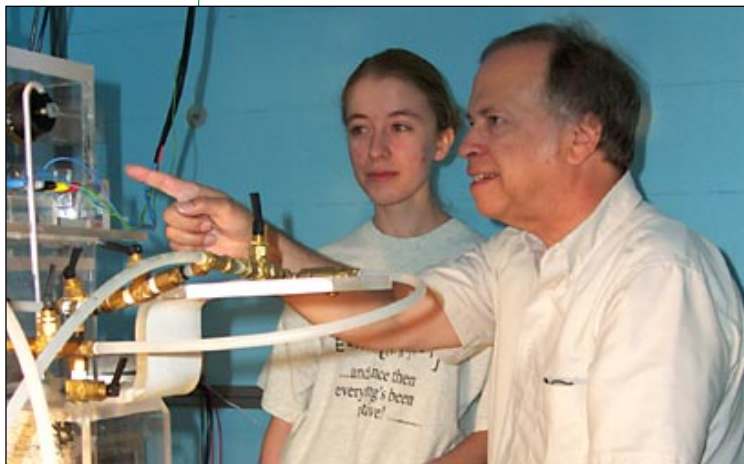
Erosion of topsoil has long been a concern of agriculture. Heavy rainfall and the resultant runoff are a primary cause of soil erosion. The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) uses calculations from the Revised Universal Soil Loss Equation (RUSLE) to estimate soil erosion losses from land surfaces. A major component of the RUSLE is the R-factor, a measure of rainfall ability to loosen soil at a location. In simple terms, the heavier the rain, the greater its ability to loosen soil and cause erosion.

Rainfall data from the mid-1930s to the mid-1950s were used to compute the R-factor for the eastern two-thirds of the United States and from the 1950s to the early 1980s to compute the R-factor for the western third of the nation. The different periods used in the two computations along with different procedures to compute the R-factor resulted in a discontinuity in the resulting map along the state lines of the Front Range of the Rocky Mountains (Colorado, Montana, New Mexico, and Wyoming) and the High Plains (Kansas, Nebraska, North and South Dakota, Oklahoma, and Texas).

The ISWS, under a contract from the USDA-NRCS, is completing a new computation of the R-factor using 15-minute and daily precipitation data from 1971 to 1999. Earlier computations required extensive human intervention and data evaluation, but Water Survey climatologists have developed computer programs that automatically quality control the 15-minute rainfall data, compute equations that relate the erosion potential of individual 15-minute rainfall data to the daily total rainfall, and then compute the mean R-factor for each station using data from daily raingages. Locations that measure daily rainfall are typically more numerous and have fewer missing observations than those collecting the 15-minute raingage data.

This automated process will make it possible to assess R-factor changes using the same procedures. The new R-factor computation provides one map compiled over a single time period. The final map will be produced by Oregon State University using a special program, PRISM, that will modify the R-factor as a function of elevation, slope aspect, and proximity to oceans.

Cloud physicist Harry Ochs shows experimental apparatus to a student.



This program accounts for the effects of orographic features that affect rainfall in the mountainous regions where data often are scarce. The new R-factor will be incorporated in RUSLE-II, which is scheduled to be released in late 2001.

Odor Levels

Odor levels from swine houses and manure lagoons (see sidebar) at a certain distance from the source were related to odor levels at the source through dispersion modeling, an important tool to assess the impacts of various odor-reduction strategies and techniques. Model results provide a basis for quantitatively determining setback distances for siting neighboring facilities.

A preliminary assessment of the odor impact from three hog confinement facilities used source strengths from published literature and archived meteorological data as inputs. Offset distances were derived quantitatively from model results in terms of frequency of exceeding specified odor-intensity levels from 0 (no odor) to 5 (very strong odor).

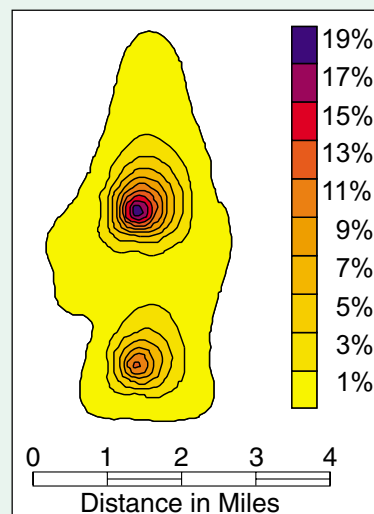
Present calculations indicate that Illinois setback distances correspond to an intensity of less than 1 occurring at a frequency of 1 percent of the time. However, it was found that resulting setback distances are very sensitive to distinctions between subjective sensory levels, such as whether “faint” or “just perceptible” odor intensity is the governing criterion.

Emerging Issues: Energy, Weather, and Production Agriculture

The recent energy crisis in the western United States highlights the need for sound energy planning. Siting of new power plants could benefit from regional models in development at the Water Survey. These models integrate weather and atmospheric chemistry data, which can be used to determine potential environmental impacts of the power plants. This information will allow industry and government to make informed, cost-effective decisions. Development of alternative energy sources such as wind and solar energy also may benefit from the application of these models in the planning process.

While we can't do much about controlling the weather, there are ways to mitigate its effects. A relatively new but rapidly expanding concept is that of weather derivatives. These risk-management contracts are available to companies whose businesses are affected by weather. The first transaction in the weather derivatives market took place in 1997, and utilities have been the largest users of these instruments. The market has expanded considerably since then. Quality-controlled climate data are critical to this industry in which the difference of only a few heating degree-days can have major impacts on contract settlement. The Midwestern Regional Climate Center works with the National Climatic Data Center, the national archive of weather records, to ensure that quality data are collected and disseminated.

As the size and number of large swine production facilities continue to grow, so do concerns and complaints from nearby residents about increased odors. Lawmakers seek an appropriate balance between the economic desirability of such facilities and the need to provide protection from their impacts. Past experimental research has been hampered because odor is traditionally “measured” using human panels. Current research at the Water Survey is attempting to develop instrumental methods to measure odor and identify odor-producing components. If successful, such methods will allow routine, continuous monitoring, something not possible with human panels. This, in turn, will increase our knowledge of odor dispersal in the atmosphere.



Simulated odor levels for two University of Illinois South Farms confinement facilities. Contours represent the frequency of time the odor is at the detection threshold value.

GROUNDWATER SECTION



Applying Expertise and Data to Groundwater Issues in Illinois

The Groundwater Section conducts research, collects and analyzes data, provides public service on issues important to Illinois citizens, and serves as the primary repository of groundwater records and data.

Addressing DNR Priorities

The Groundwater Section is often asked to provide technical expertise for DNR-owned natural areas. Section scientists recently completed a study of potential metals contamination of groundwater beneath property at the Depue Wildlife Management Area.

Staff also have been sampling monitoring wells to assess the potential effects of sand-and-gravel mining near Lake-in-the-Hills Fen Nature Preserve and reviewing available data at Illinois Beach Nature Preserve in regard to the sale of an adjacent industrial facility.

Areas that contribute groundwater to selected nature preserves have been outlined in an effort to protect them. The IEPA will petition so that these areas become Class III groundwaters of the State, which receive special protection.

Assisting State Agencies

Other State agencies also seek technical assistance from the Groundwater Section. Cooperative studies of ongoing or recurring problems occasionally result from long-term working relationships between the agencies. For example, Section scientists monitored and evaluated the Illinois Department of Transportation (IDOT) interstate ground-

water dewatering system in the American Bottoms of southwestern Illinois near East St. Louis.

This system, which includes 54 wells, maintains the elevation of the water table below the highway surface in areas where the interstate is lower than the original land surface. Results from this ongoing study help IDOT keep its dewatering wells and system operating efficiently and effectively.

The Section also has a multi-year project with the Illinois Department of Agriculture to help implement a Statewide groundwater quality monitoring network. This year's work included installing 28 monitoring wells and collecting groundwater quality samples from the 196-well network with coinvestigators at the State Geological Survey.

Well Records: Implementing Change

Over the last two years, Section staff have been involved in upgrading the Survey's well databases. The databases were migrated from a UNIX operating platform to the Survey's new SQL server. New data entry, editing, and query forms also were created.

On July 1, 2001, the data became Web accessible through the Water Survey's homepage (www.sws.uiuc.edu). Creating this Internet highway to the Section's well records will make it easier for scientists, drillers, contractors, and the Illinois public to find answers to their questions about groundwater resources.

Northeastern Illinois Water Resources

Rapid growth in the Chicago metropolitan area has had varied impacts on groundwater quality and quantity. Increasing water demand also threatens to outpace the availability of water from regional resources. Water withdrawals from Lake Michigan, the region's principal water resource, approach the legally mandated limit. Furthermore, analyses show that physical limitations constrain long-term withdrawals from the region's deep aquifer system to approximately the present rates.

The Section is actively involved in research concerning these issues and in providing technical data for local governments to manage groundwater resources. Section staff participated in research directed by the Northeastern Illinois Planning Commission to compare projected water demand and water availability in the region. The projections indicate that 11 of 102 townships in the six-county northeastern Illinois region are likely to face water-supply shortages by 2020.

Trends in shallow groundwater quality in the region are the subject of another investigation. Preliminary results indicate that dissolved solids contents of groundwater in some areas have been increasing over the past several decades, and continued degradation of water quality appears likely.

Another investigation is using estimates of base flow in northeastern Illinois streams to characterize changes in groundwater recharge accompanying growth in the region. Initial indications are that, while impervious surfaces associated with growth may reduce base flow and groundwater recharge rates in northeastern Illinois, these reductions may be offset in many areas by leakage of imported water from sewers and water distribution systems.

Mapping groundwater levels in the deep aquifer system was completed in Fall 2000. While the maps show water-level recovery in areas where Lake Michigan water has been delivered in the past 20 years, water levels continue to decline in collar-county areas where Lake Michigan water is not available.

Groundwater Quality

In addition to running a broad-based program to determine groundwater quantities in Illinois, the Section is involved in a number of studies regarding groundwater quality. Fundamental questions being addressed include: What is the overall quality of a particular groundwater source? What

contaminants are present? What is the source and behavior of these contaminants in aquifer systems? Shallow groundwater is most vulnerable to contamination due to human activities at the Earth's surface, and thus many of the Section's investigations concern shallow groundwater quality.

Sources of potential contamination being studied include nonpoint and natural sources (nitrogen, arsenic, and suburban expansion) and point sources (livestock manure and industrial activities). These studies are being conducted in many parts of the state, including northeastern Illinois, the Mahomet Aquifer and shallow groundwater sources in central Illinois, and the karst region of southwestern Illinois. State, county, and municipal agencies, and various interest groups are using the information collected to manage and protect groundwater quality.

Mahomet Aquifer

Significant new discoveries have increased our understanding of the Mahomet Aquifer and its potential to supply water to central Illinois communities. Hydrologic, geologic, and chemical evidence indicates that the Sangamon River is connected to the Mahomet Aquifer just downstream of Monticello.

This discovery was made during a study that compared an existing groundwater flow model with the water-level data collected during the operation of Decatur's emergency wellfield for 84 days starting in November 1999. The City of Decatur operates a series of 10 groundwater wells in DeWitt and Piatt Counties that serve as an emergency water supply in times of low surface water levels in Lake Decatur.

The model overpredicted the drawdown in Piatt County, which suggested that the Mahomet Aquifer may have another source of water besides the small amount of infiltration from precipitation. An analysis of water-level data collected by Decatur's consultant

Mark Anliker (left), assisted by Aaron Weeger of Terra Dynamics, uses bentonite to seal the annulus of a well at George B. Fell Nature Preserve. Monitoring is occurring due to concern about effects of increased mine dewatering on native plant communities.



showed a very good correlation between the water levels in the river and the aquifer.

The log of a test boring in the area showed that the Mahomet Aquifer is directly connected to the shallow Glasford Aquifer, while another boring showed a connection between the Glasford Aquifer and the river. Chemical analyses of groundwater samples show a much lower chloride concentration

downgradient of this area, suggesting some dilution of the groundwater by the river water. Future work will focus on developing a more complete understanding of the connections between the aquifer system and the river. If the Sangamon River can provide a large amount of recharge, the amount of water that can be withdrawn safely may potentially be much greater than previously estimated.

Emerging Issues: Concern Growing over Arsenic in Groundwater

Arsenic, a known carcinogen, received new attention in 2001 because of President Bush's decision to delay lowering of the arsenic standard to below the current standard of 50 micrograms per liter ($\mu\text{g/L}$) in public water supplies.

While a new arsenic standard is debated in Washington, public concern over arsenic in drinking water has increased. Some want the standard to remain at 50 $\mu\text{g/L}$, but many health and environmental groups feel that even 10 $\mu\text{g/L}$ poses too great a health risk.

More than 4 million Illinois residents, including 90 percent of Illinois rural residents, use groundwater daily. Groundwater in many areas of Illinois contains natural concentrations of arsenic.

A lower arsenic standard could have significant effects on many small Illinois communities. Depending on the final standard for arsenic, many of these communities may be required to reduce the amount of arsenic in their finished water. This will provide a cleaner supply of water, but it will increase treatment costs.

Private wells are not regulated and are, therefore, not subject to a national arsenic standard. Because most private water supplies are not tested for arsenic and few use treatment to remove arsenic, the health risks for domestic well owners and their families are probably higher than for users of public water supplies.

Water Survey researchers have begun a program to assess the occurrence of arsenic in Illinois' groundwater, including collecting additional water samples as part of the Aquifer Assessment Program. Limited data suggest that private wells may contain higher concentrations of arsenic than those in community wells in the same aquifer. Researchers are currently trying to determine the factors that may influence arsenic mobility in groundwater to better understand this discrepancy.

The mechanisms that affect arsenic removal in water treatment have been a topic of ongoing Groundwater Section research. Bicarbonate and silica occur in nearly all groundwaters, and experiments to determine the effects of bicarbonate, silica, and phosphate, which are found in some groundwaters, on arsenic removal indicate that these constituents affect arsenic mobility in groundwater.

Cooperative efforts with other agencies, including the Illinois Environmental Protection Agency, the Illinois Department of Public Health, the U.S. Geological Survey, and the Illinois State Geological Survey, are in the planning stages. The intention is to pool knowledge and resources to learn more about the occurrence of arsenic in Illinois groundwater and the levels at which Illinois residents are exposed. The Water Survey organized a meeting of these groups in July 2001 to discuss arsenic issues.



This is a well head common on many domestic wells.



NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

Providing Resources Today for Tomorrow's Scientists

The National Atmospheric Deposition Program is a cooperative research program of Federal, State, and private organizations.

Old Archives - Future Resources

Researchers have found an important new use for National Atmospheric Deposition Program/National Trends Network (NADP/NTN) precipitation samples: measuring the concentrations of hydrogen and oxygen isotopes in them. Precipitation is, of course, water from the atmosphere, and water is H_2O , that is, two hydrogen atoms combined with one oxygen atom. Precipitation contains trace quantities of pollutants in water, and for 23 years the NTN has focused almost exclusively on these trace pollutants—acids, nutrients, and base cations. Only recently have scientists begun focusing on water in NTN samples and, in particular, on the forms of hydrogen and oxygen in the water.

Isotopes of an atom are different forms of the atom with slightly different weights but virtually identical chemical properties. Hydrogen, one of two atoms comprising the water molecule, has two relatively abundant isotopes, 1H , which accounts for 99.985 percent of all the hydrogen in nature, and 2H , which accounts for 0.015 percent.

These percentages are averages, and the 2H abundance in water under different conditions varies. Indeed, therein lies the interest. The relative abundance of 2H says something about where the water came from and where it has been. Measuring the isotopes of both hydrogen and oxygen adds even more interest and more specificity about water pathways.

Scientists are using NTN archival samples to take a retrospective look at the origin of the water in these samples, as well as other questions about how water from precipitation cycles through surface- and groundwater systems and plants. So far their interest has been in 2H and ^{18}O , the second most abundant isotopes of hydrogen and oxygen, respectively.

All NTN samples are sent to NADP's Central Analytical Laboratory (CAL), where—volume permitting—trace pollutants are measured, and a portion of sample is archived in a sealed bottle stored in a large walk-in cooler. Data analysts at CAL study the measurements looking for possible errors or problems.

If a question arises, the stored portion may be removed from the cooler and re-analyzed. Fewer than one percent of every 100 archival samples are removed for such quality-control checks. This leaves a large archive of samples in the cooler. Standard CAL procedures require archiving samples for five years, which constitutes an archive of about 35,000 samples for the 220-site NTN.

The mixture of isotopes comprising the hydrogen and oxygen of the water molecule is very sensitive to evaporation, so the first question confronting researchers wanting to use NTN archives was “Have the samples changed in storage?” So far, tests show that these samples are suitable for isotopic studies. Scientists are comparing the ^{18}O and 2H in NTN samples with standard mean ocean water. This comparison lets them readily relate measurements from different parts of the world to the same standard.

Among the questions being addressed with these measurements are:

- What were the relative contributions of the Gulf of Mexico, North Pacific Ocean, Atlantic Ocean, or terrestrial sources of the water vapor that led to precipitation? (Each water source has a different isotopic signature.)
- How do different plants tap into surface water, groundwater, or precipitation to satisfy their thirst for water? Are certain plant varieties more efficient at mining groundwater or at storing precipitation? (Water extracted from plant tissues has an isotopic composition that can be used to identify its source.)
- How do distance from the ocean, elevation, and temperature affect the isotopic composition of precipitation?

Scientists measuring the ^{18}O and ^2H in NTN samples are planning to store the data in a database that will be accessible to isotope researchers the world over. Data over a 14-year period from 80 geographically distributed NTN sites will be stored. Plans are for these sites to comprise the U.S. contribution to the International Atomic Energy Agency's Global Network for Isotopes in Precipitation. This database will complement existing on-line NADP databases and serve as a resource for future research on biogeochemical cycling of water and pollutants. What was once an archive is now a resource.

New Tools for the Future

Much of NADP's current success comes from the on-line accessibility of its 23-year record of the chemical climate of precipitation in the United States. Scientists, students, policymakers, and the public can access individual data records, color contour maps,

tabular summaries, NADP publications and manuals, and related information on the Internet with just a few mouse clicks, evidence that an information technology revolution is under way.

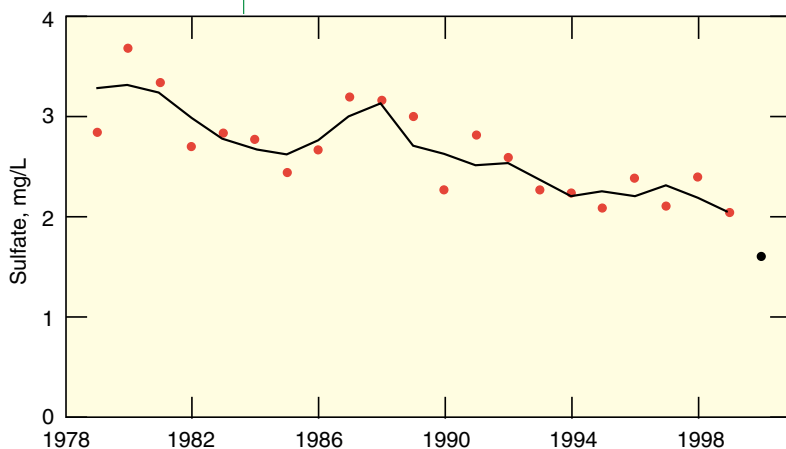
From 1998 when the NADP Program Office moved to the Water Survey until last year, the annual number of "hits" on NADP's Internet site (<http://nadp.sws.uiuc.edu>) grew from just over 250,000 to just under one million. Last year the site received more than 40,000 unique visitors, and nearly 25 percent were return visitors to the site, which logged more than 100,000 user sessions. Data products most frequently accessed were the color contour maps of pollutant concentrations and depositions. Site users viewed nearly 146,000 maps and retrieved nearly 17,000 data files.

User statistics show that researchers primarily use NADP data to study atmospheric deposition and watershed processes, as well as environmental phenomena such as the effects of deposition on aquatic and terrestrial ecosystems and on cultural resources. Electronic data requests are now split about 60 percent for research purposes and 40 percent for educators from elementary schools, secondary schools, and colleges. Educational usage continues to increase, perhaps reflecting interest in new educational materials now available on the site (see next section).

Last year, two other new features were added to the NADP Internet site. Trend plots let users visualize how precipitation chemistry is changing over time. Users select a site, a chemical of interest, and then choose between concentration or deposition. The time-series plot generated shows annual average values from the first year of site operations to the present. A line superimposed on these annual average data points gives viewers a sense of whether data scatter may mask underlying changes. This line runs between three-year averages based on sample data from the preceding through the following year. The sulfate concentration trend plot for the central Illinois (Bondville) site operated by the Water Survey shows a rather steady decline in sulfate concentrations over the last 20 years (see graph).

Another new feature lets users graphically display concentrations of individual Atmospheric Integrated Research Monitoring Network (AIRMoN) samples and then run a model that displays a backward trajectory for the user-selected sample. The National Oceanic and Atmospheric Administration's

Annual sulfate concentrations decreased at Bondville, Illinois, 1979-2000.

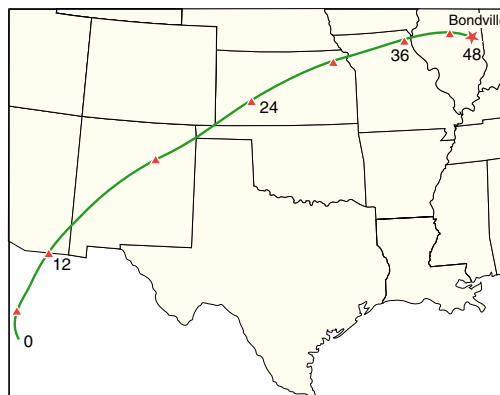


HYSPLIT model is used to calculate trajectories. The resulting map (see sample map) shows the modeled air-parcel path ending at the collection site during the precipitation event and beginning at its position 48 hours earlier, hence the term “backward trajectory.” Backward trajectories are used to examine the effect of emissions regions on pollutant concentrations in precipitation.

These additions are in keeping with NADP’s strategic plan, which also calls for adding Geographic Information System overlays that show watersheds, land use and cover, pollutant sources, census information, road and highway distributions, topographic maps, etc. Application of information technologies that facilitate use and analysis of NADP data and support informed decisions on air-quality issues related to precipitation chemistry are envisioned.

Training Tomorrow’s Scientists

Children today spend hours on the Internet playing games and e-mailing friends. To harness this fascination with technology, some teachers are requiring their students to search the Web for information and answers to assignments. With financial support from the U.S. Geological Survey and the expertise of several NADP scientists, the National Science Teachers Association developed a Web-based curriculum entitled, “Inside Rain, Working with Precipitation Chemistry Data.” Released last spring, this curriculum teaches students how rain forms and about what’s in rain and how it got there.



Backward trajectory ending at Bondville, Illinois, February 15, 2001.

The seven-section curriculum addresses different aspects of precipitation chemistry. Students must connect with the NADP Internet site and download data to answer questions and complete their exercises. After retrieving data, students use software on their own personal computers to create plots and figures, and then answer questions that require them to think about what the data mean.

These Web-based assignments are complemented by laboratory measurements, providing a hands-on, high-tech educational experience. To accommodate the added new traffic on the NADP site, a separate URL and Web page were created, offering students and teachers access to special instructions and postings of Web site changes.

Having a Web page that links the world to quality-assured data and information on the chemicals in precipitation has become a fascinating new resource for tomorrow’s scientists, and one that NADP founders never even dreamed of 23 years ago.

Emerging Issues: Interest in Mercury Increasing

Last December the U.S. Environmental Protection Agency (EPA) announced that it would require pollution controls on utility mercury emissions as early as November 2007. This decision came after more than a decade of EPA study and deliberations, following the listing of mercury as a hazardous air pollutant in the 1990 Clean Air Act Amendments. The EPA’s inventory of air emissions of mercury from human activities or anthropogenic emissions shows that approximately a third comes from incineration of municipal, medical, and hazardous wastes.

Regulations that will cut these emissions are already in place. Before EPA’s announcement, coal-burning electric utilities, which account for about 31 percent of anthropogenic emissions of mercury, had been the largest unregulated source. Reducing emissions from burning coal will affect Illinois utilities, which emit 5–6 percent of the mercury from U.S. utilities.

Regulators turned their attention to mercury because it is toxic, persists in the environment, and has reached levels causing officials to advise against consuming

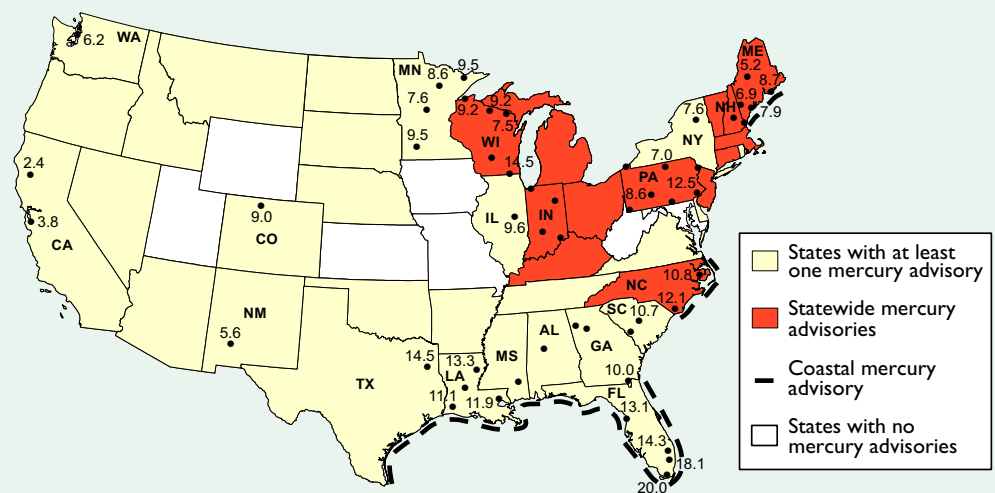
certain fish from specific lakes and water bodies. Forty-one states have at least one such advisory (see figure), and some to limit fish consumption. Neurotoxins—such as methylmercury, an organic form of mercury—destroy nervous tissue. Those most at risk of brain and nervous system damage are the fetuses of mothers who eat large amounts of methylmercury-containing fish during pregnancy. In Illinois, advisories warn against consuming large-mouth bass from Cedar Lake and Kinkaid Lake near the southern tip of the state.

Mercury can enter streams and lakes from many sources. Industrial effluent, runoff, and some sediments contain mercury. Scientists use computer models to assess the importance of all potential sources, and these studies show that atmospheric deposition is the principal source of mercury in many of the lakes with contaminated fish. Atmospheric deposition includes the mercury deposited by precipitation and deposited in gaseous and particulate forms during dry weather. Airborne mercury comes from anthropogenic sources, such as incineration and coal-burning, and natural sources, such as volcanos, forest fires, oceans, and certain rocks and soils.

By hosting the National Atmospheric Deposition Program's Mercury Deposition Network (MDN), the Water Survey plays

an important role in trying to understand how much mercury from natural and anthropogenic sources is deposited by precipitation. The MDN now measures the total mercury in precipitation at 60 sites, 52 in the continental United States. The figure shows the locations of U.S. sites and the amount of mercury deposited at sites active throughout 2000. These data can be accessed on-line through a link from the Water Survey's home page. Last year there were nearly 22,000 "hits" on the MDN Web page alone, signaling the burgeoning level of interest in mercury measurements.

In our efforts to reduce mercury in fish, many questions remain unanswered. Reducing mercury from coal-fired power plants will lower the amount of mercury released to the atmosphere. However, current estimates are that only about 40 percent of this mercury is in an oxidized form that readily dissolves in rain. Just how reductions in stack emissions translate into lower mercury concentrations in rain is unknown. Even less is known about how mercury in rain is transformed to toxic methylmercury in fish. Much more work is needed to understand the pathways that lead to mercury-contaminated fish. What is known is that long-term high-quality MDN measurements can help scientists shed some light on the way.



Total mercury deposition ($\mu\text{g}/\text{m}^2$) is shown at sites active in 2000. Dots without data represent new sites activated in 2000.

This map shows results from the NADP's Mercury Deposition Network in 2000.



WATERSHED SCIENCE SECTION

Science for Resource Management at a Watershed Level

Water is an important, life-sustaining commodity. Identifying and addressing pressing water resource issues of the State of Illinois through sound and dependable science-based analyses is the hallmark of the Watershed Science Section (WSS).

Water resources have been managed at a watershed level for the last few decades, and it is expected that future management will continue along this same vein. The water-rich State of Illinois needs information about water and its interactions with soil, another vital resource. For more than a century, Section staff have provided sound science to manage both of these important resources by concentrating on issues of paramount importance to the people of Illinois.

The 2000–2001 reporting year was no exception to this long-term goal and mission. Core areas of concentration included data collection and monitoring, hydrologic and hydraulic assessment and evaluations, mathematical modeling, watershed restoration and rehabilitation, and information dissemination. During the last three decades, the WSS also has conducted extensive research on large rivers, which has resulted in a major initiative, *Illinois Rivers 2020* (see sidebar). This is another area where WSS contributions have been and will continue to be extremely important in coming years.

Data Collection and Monitoring

Section staff had the foresight to initiate benchmark sediment data collection throughout Illinois in 1981. These efforts are bearing fruit now that *Illinois Rivers 2020* and many other Illinois initiatives are based on the same fundamental issue: excessive sediment in

streams, rivers, and lakes is a major hindrance to better management and use of Illinois waters. During the last several decades the WSS also has cooperated with the U.S. Geological Survey (USGS) in collecting water-quantity data that are crucial to formulating plans and building water resource projects.

Detailed data collection also has been initiated for pilot watersheds in support of the Conservation Reserve Enhancement Program (CREP)—a joint state and federal initiative to take marginal lands out of production in the Illinois River basin—and the Pilot Watersheds program. Other monitoring activities include work for the Illinois Council on Food and Agricultural Research Water Quality-Strategic Research Initiatives (C-FAR WQ-SRIs), Ecosystem Partnerships, and the city of Decatur. Twenty monitoring stations have been established as a result.

The CREP program is a 15- to 30-year program for which basic and fundamental water and sediment data are collected to determine changes in various parameters over time as various best management practices (BMPs) are implemented. Monitoring encompasses the Spoon River watershed (Court Creek and Haw Creek), and the Sangamon River watershed (Panther Creek and Cox Creek).

The Pilot Watershed program is a joint activity between the Illinois Department of Natural Resources (DNR), Illinois Environmental Protection Agency (IEPA), and the Natural Resources Conservation Service (NRCS). Program participants have a basic understanding that monitoring of selected watersheds is essential if fundamental



Bill Bogner recovers survey points and determines GPS coordinates.

processes are to be understood at a watershed scale for systematic management of this resource. Monitoring has been initiated for the Big Creek, Hurricane Creek, and Sugar Creek watersheds.

The DNR Ecosystem Partnership, a joint state and local watershed group, was formed to better understand the watershed and develop management alternatives at the grass-roots level. In support of that program, two-year monitoring projects were initiated in watersheds upstream of Lake Vermilion and Georgetown reservoir, and in Hurricane Creek.

Lake Decatur has experienced significant sedimentation problems since its construction in the early 1920s, and WSS staff have monitored these problems from the start. Another issue is high nitrate levels in Lake Decatur, the drinking water source for the city of Decatur. In order to identify the nitrate sources, the WSS has initiated nitrate and flow monitoring on the Lake Decatur watershed since 1993. These monitoring efforts are helping the city to meet IEPA requirements.

The C-FAR WQ-SRIs also have provided support to enhance water-quality monitoring efforts for the Upper Sangamon River, Big Creek on the Lake Decatur watershed, and Cache River in southern Illinois.

The WSS monitoring and data collection program has been and will continue to be an integral component of formulating management alternatives for the “waters” of several major watersheds in Illinois.

Hydrologic and Hydraulic Evaluations

Staff concentrate their varied and multi-dimensional efforts on applying solid and fundamental engineering and scientific

principles to formulate and solve pressing water resource problems of the State of Illinois.

A scientific evaluation of Illinois streamgaging network has just been completed. This analysis will help DNR and the USGS identify future streamgaging needs, especially those requiring new gages and areas where regional analyses could provide sufficient information and data.

Basic and fundamental streamflow analyses are proceeding. The Illinois Streamflow Assessment Model (ILSAM) has been completed for six major basins (Fox, Kankakee, Kaskaskia, Little Wabash, Rock, and Sangamon). Such analyses provide vital information about surface water for public water supplies, water-quality assessments, and in-stream flow needs, including recreation and aquatic habitats.

Section staff are also in the process of completing an analysis and evaluation of the Fox Chain of Lakes in northern Illinois using ISWS research findings from mid-1975 and more recent data. The Fox Waterway Authority and DNR are working with ISWS to formulate future management alternatives, particularly for Grass Lake and Nippersink Lake where excessive sedimentation has been a problem. Other lake-related work includes sedimentation surveys of Lake Decatur and water-quality assessments of Nashville Reservoir, Lake Vermilion, and Lake Paradise.

A major research project relates to the Kankakee River basin. The ISWS completed the original scientific analysis of the river in 1980, and other agencies have done work on the river since then.

Recently, DNR funded WSS work in three areas: compiling all data, collecting river geometry and sandbar distribution data, and evaluating bank erosion along the main stem of the river. All work has been completed; color-coded bank erosion maps for the 111 miles of the river are now available in CD format; and all old and new data on sediment, river geometry, and sandbars are now available through the Illinois Rivers Decision Support System.

One of the major findings was that Six-Mile Pool near the city of Kankakee and the Momence Wetland area are experiencing excessive sediment deposition. It is almost certain that corrective measures will be implemented soon to address these problems.

Modeling

Modeling is an important tool for hydrologists and engineers. It offers an

opportunity to predict future conditions based on present ones and to make projections for other areas or watersheds for which detailed data and other information are not readily available. The WSS has been using state-of-the-art models with some modifications in several important projects. Some staff have been developing and calibrating the Dynamic Watershed Simulation Model (DWSM) that simulates storm event rainfall-runoff, evaluates flood wave propagation, incorporates bed and bank erosion (including sediment entrainment and transport), and routes common agriculture chemicals. The model has applications for rural and agricultural watersheds. It was tested for a sub-basin of the Lake Decatur watershed and Court Creek on the Spoon River.

The Illinois River Restoration plan, a component of Illinois Rivers 2020, is an ambitious multi-agency, multi-year plan to restore and enhance the Illinois River basin. Even though data and analyses on the engineering component are available at various locations, they are not yet available at a number of specific sites. The Illinois River valley presently accumulates about 8 million tons of soil every year, and Peoria Lake and many other backwater lakes are almost full of sediments.

In close cooperation with the U.S. Army Corps of Engineers, DNR, and the Peoria Lake Basin Alliance, the WSS has taken a lead in formulating, calibrating, and verifying hydrodynamic models to determine the effects of sediment removal and use to build artificial islands within Peoria Lake. Based on ISWS historical research and the present mathematical modeling efforts, four potential construction sites have been selected within Lower Peoria Lake, and it is expected that state and federal governments will build one or two of these islands within the next three to six years.

Natural water-level changes have been altered by construction of locks and dams along the Illinois and Mississippi Rivers. These rapid water-level fluctuations have detrimental effects on aquatic and terrestrial habitats. Levee construction along the Illinois River, especially below Peoria Lake, also has confined the flow. Several research projects have been completed based on mathematical models to determine the effects of removing some of the levees, or the effects of building notches along levees to let floodwaters move behind levees. This type of research will have significant impacts on decisions about future



management of the Illinois River, which will hinge on how well managers are able to balance multiple demands placed on the river.

Watershed Restoration and Rehabilitation

Watershed-based restoration efforts, including streambank stabilization, have received worldwide publicity and recognition. Restoration and rehabilitation are being done knowing fully well that it is not possible to return to conditions 50 to 100 years ago. However, it should be possible to prevent future deterioration as long as these efforts are in agreement with the physical laws of nature.

Water depth is being restored at the Stateline Bridge along the Kankakee River by removing recurring sandbars using WSS research. Long-term research on the Lake Pittsfield watershed has been used all over the country and is assisting in the evaluation of BMPs, sediment detention basins, sediment delivery, and physical and aquatic habitats. Section staff also are continuing to assist DNR with stream rehabilitation and restoration projects in the Jim Edgar Panther Creek State Fish and Wildlife Area, Big Creek on the Cache River, and Court Creek on the Spoon River by providing technical know-how and sharing expertise in project implementation.

Information Dissemination

One of the basic functions of the ISWS has been to provide technically correct, timely information on water resources to the people of Illinois. This has been a long-term commitment of WSS staff, who provide

Water Survey staff sample sediment from a test artificial island constructed within Lower Peoria Lake (Photo by Waste Management & Research Center).

information through reports, brochures, pamphlets, letters, radio and television interviews, and public service programs.

The WSS has provided floodplain delineation maps and information on flood potential for the last 30 years so that managers and local communities can manage their resources wisely. Staff also responded to requests, determined 100-year flood eleva-

tions, and provided surface water information to numerous private, state, and federal agencies. Surface water data also were compiled for the monthly *Illinois Water and Climate Summary* published by ISWS and extensively used by state and federal officials and regulators to develop and postulate plans before an extreme event such as a flood or drought.

Emerging Issues: Developing the Illinois Rivers Decision Support System

The WSS is leading the development of the Illinois Rivers Decision Support System (ILRDSS) in support of Illinois Rivers 2020, an ambitious program being initiated by a partnership effort to enhance, restore if possible, rehabilitate in selected locations, and prevent further deterioration of the Illinois River due to excessive sedimentation and water-quality deterioration. Partners include the Federal government along with State, local, and nongovernmental agencies and environmental groups. This 20-year program is expected to cost about \$2.5 billion. The State of Illinois is a full partner in this program with DNR serving as the local sponsor.

Many basic premises and concepts of Illinois Rivers 2020 are based on fundamental and applied research conducted by WSS staff over the last four decades. Activities, projects, and programs being developed for this program also are based on WSS research on the Illinois River.

Actual projects along the main stem of the river and its watersheds are expected to be implemented over the next 5 to 20 years. A preliminary list of projects includes: construction of artificial islands in Peoria Lake, restoration of Pekin Lake along the Illinois River; a sediment management plan for the Fox Chain of Lakes; sandbar removal along the Kankakee River at the Stateline Bridge; re-establishment of flow along several reaches of the Kankakee River; and rehabilitation of the Iroquois River, a tributary of the Kankakee River. Almost all of these projects were selected for implementation based on WSS applied research

completed during the last 25 years.

The ILRDSS will provide scientific support and access to high-quality information for restoration of the Illinois River and its watershed. Once fully developed and tested, the ILRDSS will enable decisionmakers to assess and evaluate the effectiveness of different restoration projects, and the consequences of other natural or human-induced changes in the watershed. The ILRDSS also will improve dissemination of scientific tools and information by using the Internet as primary access to inventories of current and historical projects, data, simulations, and involved agencies/participants within the Illinois River watershed. The ILRDSS Web site (<http://ilrdss.sws.uiuc.edu/>) provides this information faster, more economically, and in a more usable form than current methods.

This proposed technology and communication framework will include information resources, modular databases, and simulation models to evaluate the impact of water resources development, land-use changes, economic development, and climate variability on sedimentation, water quality, ecology, hydrology, and hydraulics in terms of long-term restoration and sustainability for the Illinois River.

The figure displays in bold text the simplified relationships between the four main IRDSS components: the information system containing data products, simulation and assessment models in the analytical tools component, system users, and the information processing system (communication pathways) that underpins the ILRDSS and allows information transfer

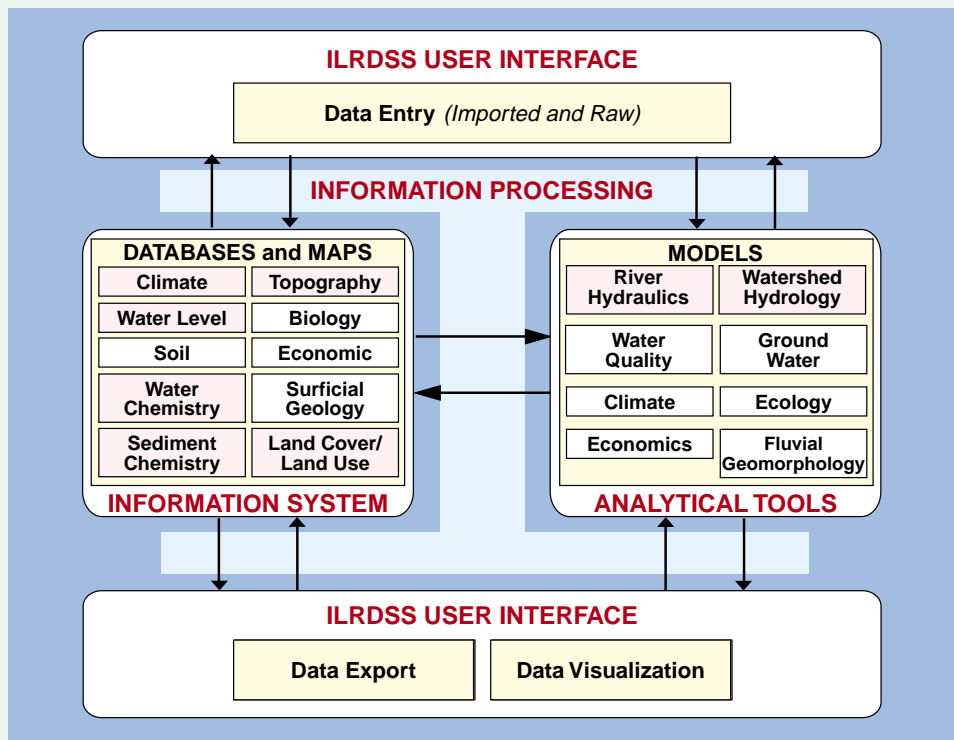
among all components. The diagram also details potential data and modeling sub-components for inclusion in the information system and analytical tools modules. Early versions of the ILRDSS will provide basic information exchange between the user and individual data and tool components via direct database access and Web-based interfaces. Later work will add Web-based interactive modeling and simulation features and direct linkages between ILRDSS databases and models.

Initial users are scientists and professionals within State and Federal agencies and the general public. As the ILRDSS matures and more components are added to aid in decision processes, system users

will expand to include a broader range of decisionmakers.

At present, the ILRDSS consists of a prototype Web site containing water resource databases, reports, and project descriptions. Hydraulic and hydrological models are being developed and tested for the analytical tools sections.

Future activities related to Illinois Rivers 2020 will depend heavily on WSS contributions. The Section's future as the prime watershed science entity in the State of Illinois is bright and promising as long as capabilities continue to be enhanced in the areas of data collection and monitoring, research and evaluation, and public service.



A conceptual framework for the Illinois Rivers Decision Support System.

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Kip Stevenson surveys a log jam on the Iroquois River.



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Laura Keefer trains Momcilo Markus, Yiping Guo, and Yanqing Lian as she prepares equipment for filtering and preserving hundreds of nitrate and phosphate samples collected over a three-hour period on the first of two collection days.

Changnon Honored for ISWS Service

In recognition of his five decades of service, atmospheric scientist Stanley Changnon (right) was honored at a reception held at ISWS on June 1. Changnon served as chief for the agency from 1980 until 1985. Chief Derek Winstanley presents Changnon with one of several awards.



HONORS

James Angel

Member, National Precipitation Frequency Atlas Technical Committee

Kenneth Beard

Member, Meteorology Review Committee for Fulbright Scholar Program

Nani Bhowmik

Elected Chairman, Environmental Committee of the Mississippi River Parkway Commission

Bill Bogner

Nominations Chair, Illinois Lake Management Association

Deva Borah

Member, American Society of Civil Engineers Task Committee on 3D Free Surface Flow Model Verification/Validation Monograph (2001–2003)

Van Bowersox

Invited Presenter, “Acid Rain: Are the Problems Solved?” Conference sponsored by Center for Environmental Information, Washington, DC, May 2, 2001

Mark Brooks

Vice-Chairman, National Association of Corrosion Engineers Committee TEG-156X (Corrosion and Corrosion Control in Potable Water Systems Used in Buildings)

Stanley Changnon

Member, Council on Long-term Climate Monitoring, National Oceanic and Atmospheric Administration

Mike Demissie

Nominee, Emiquon Science Advisory Council

Karen Harlin

Recipient, Fellow Award, Association of Official Analytical Chemists International

(AOACI); Chair, Environmental Quality Committee, AOACI; and Member, Official Methods Board, AOACI

David Kristovich

Editor, *Journal of Applied Meteorology*

Kenneth Kunkel

Co-convenor, American Geophysical Union special session on cold land processes, Fall 2000

Robert Larson

Vice Chair, National Atmospheric Deposition Program Data Management and Analysis Subcommittee

Mike Machesky

Associate Editor, *Geochimica et Cosmochimica Acta*

Mark Peden

Appointee, Executive Board, University of Illinois Water Resources Center, 2000-2001

Mark Peden and Dan Webb

Recipients, Certificate of Appreciation for conducting water-quality section, Illinois Science Olympiad, April 7, 2001

Jane Rothert

Chair, American Society for Testing and Materials Atmospheric Deposition Subcommittee on Sampling and Analysis of Atmospheres

Loretta Skowron

Chair, American Society for Testing and Materials Task Group D 5086–95

Kent Smothers

Recipient, Award of Appreciation commending service and contribution on the Water Quality Association Magnetics Task Force

Gary Stensland

Technical Expert (Invited), U.S. Environmental Protection Agency Gulf of Mexico Expert Panel on Atmospheric Deposition of Nitrogen, August–September 2000

Derek Winstanley

Appointee, Steering Committee, Illinois Buffer Initiative, September 2000; Appointed Advisor, Illinois Nature Preserves Commission, August 2000; Reappointed Member, Research Committee, Illinois Council on

Food and Agricultural Research; Conference Chair, “Is the Well Running Dry?” Chicago, IL, July 18–20, 2000; Chair, Steering and Planning Committee, Governor’s Conference on “Energy and the Illinois Environment,” Springfield, IL, November 7–8, 2001; listed in *Marquis Who’s Who in the World*, *Marquis Who’s Who in America*, *Nationwide Register’s Who’s Who in Executive Business*, and *Strathmore’s Who’s Who*; and Recipient, 21st Century Award for Achievement, IBC



*Starved Rock
Lock & Dam on
the Illinois River.*

ADJUNCT & EMERITUS APPOINTMENTS

Adjuncts to University of Illinois at Urbana-Champaign

Office of the Chief

Derek Winstanley, Department of Geography

Atmospheric Environment Section

James Angel, Department of Geography

Kenneth Beard, faculty, Department of Atmospheric Sciences

Stanley Changnon, Department of Geography and Department of Atmospheric Sciences

Steven Hollinger, Department of Natural Resources and Environmental Sciences

David Kristovich, Department of Atmospheric Sciences and Department of Geography

Kenneth Kunkel, Department of Atmospheric Sciences

Harry Ochs, Department of Atmospheric Sciences

Adjuncts to Illinois State Water Survey

Dr. Geoffrey Hewings

Regional Economics Applications Lab

Department of Geography

University of Illinois at Urbana-Champaign

Urbana, IL

Dr. Scott Isard

Department of Geography

University of Illinois at Urbana-Champaign

Urbana, IL

Dr. Roger A. Pielke, Jr.

Environmental & Societal Impacts Group

National Center for Atmospheric Research

Boulder, CO

Thomas A. Prickett

Thomas A. Prickett & Associates

Urbana, IL

Emeritus Appointments

Russell Lane, Principal Scientist Emeritus, 1981

Ralph Evans, Principal Scientist Emeritus, 1984

Stanley Changnon, Chief Emeritus, 1985

Robert Sasman, Professional Scientist Emeritus, 1987

Richard Schicht, Principal Scientist Emeritus, 1989

Eugene Mueller, Principal Scientist Emeritus, 1990

Donald Staggs, Professional Scientist Emeritus, 1990

Richard Semonin, Chief Emeritus, 1991

Chester Neff, Principal Scientist Emeritus, 1992

Michael Terstriep, Principal Scientist Emeritus, 1993

Krishan Singh, Principal Scientist Emeritus, 1996

Wayne Wendland, Principal Scientist Emeritus, 1996

Thomas Butts, Senior Professional Scientist Emeritus, 1998

Raman Raman, Principal Scientist Emeritus, 1998

Donald Gatz, Principal Scientist Emeritus, 1999

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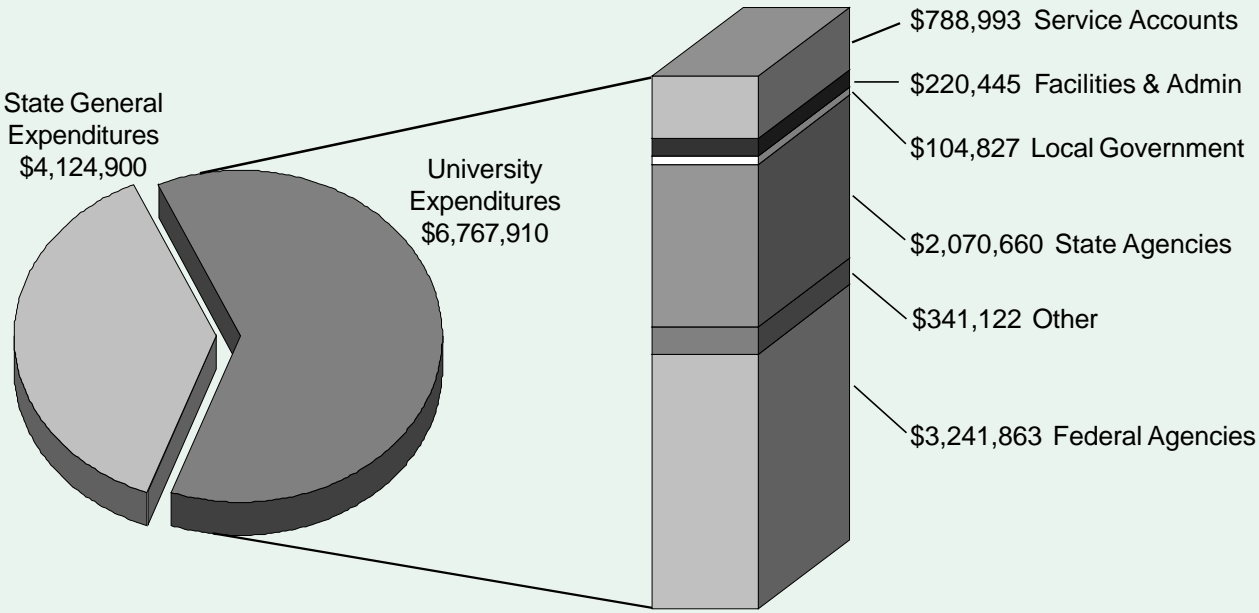
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FINANCIAL STATEMENT, FY 01





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