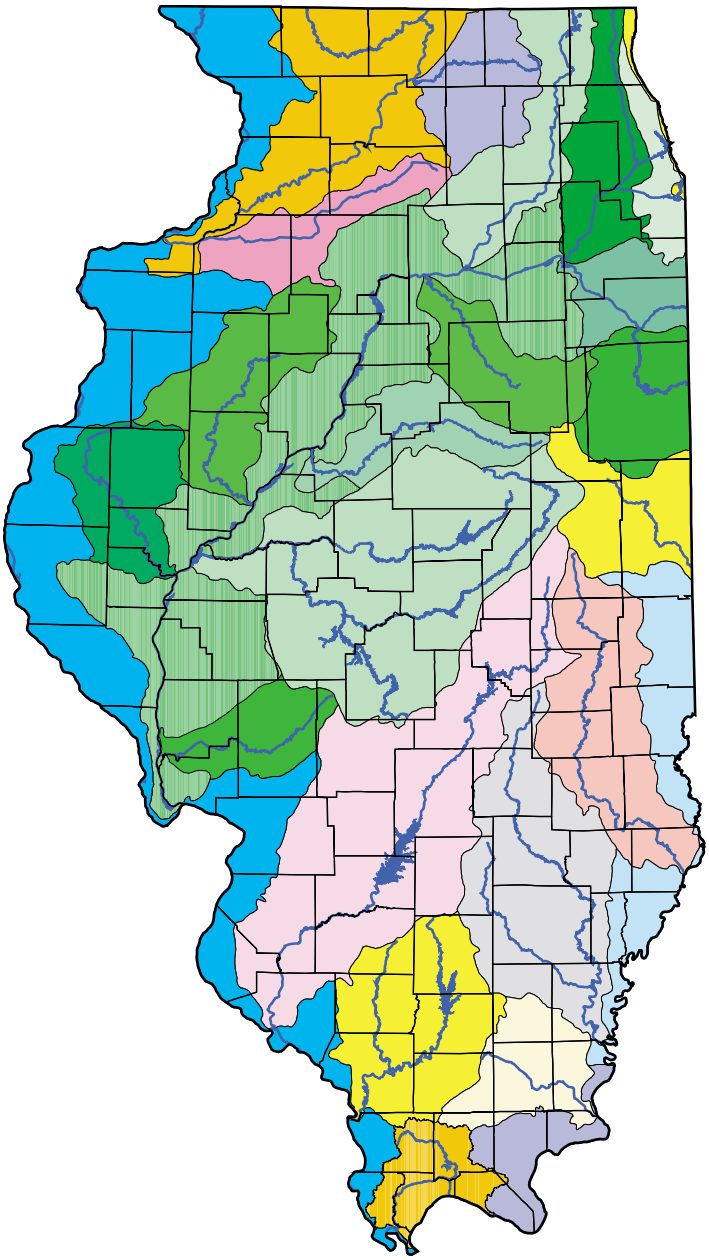
Illinois State Water Survey

Annual Report 1999–2000



Future of Illinois Waters . . .

Illinois State Water Survey Annual Report

1999–2000

STATE OF ILLINOIS

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ILLINOIS STATE WATER SURVEY
Derek Winstanley, Chief, D. Phil., Oxford University

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2000

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All uncredited photographs provided by Water Survey staff

Front cover: A Geographic Information Systems map of major Illinois watersheds based on digital data sets developed by the Department of Natural Resources and other state and federal agencies. The colors depict different watersheds. Shades of green represent watersheds in the Illinois River basin.

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

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From the Chief's Desk

Another year has brought new issues and challenges. Drought from July 1999 through May 2000 created concerns about the adequacy of some public water supplies and soil moisture for this year's crops. But concerns over water shortages were doused by floodwaters resulting from the third wettest June since 1895. One of the warmest Februaries on record and the eighth coolest July on record also occurred during the year 2000. And yet, despite these climate anomalies, or perhaps because of them, the prospect for good yields of corn and soybeans is uncertain.

These events have raised interesting questions. What is causing these wild swings in weather and climate? Are they merely manifestations of high natural climate variability? Can they be attributed to La Niña or El Niño in the Pacific Ocean? Or are they ignited by the sparks of global warming? Whatever the cause, these events demonstrate the continued importance of variations in climate and water resources in Illinois, issues the Illinois State Water Survey is addressing on a regular basis.

As we look to the future, can we better adapt to a variable and perhaps changing climate, or should we attempt to reduce human impacts on the climate system? Are local and voluntary efforts sufficient to mitigate droughts and floods and manage water resources, or do we need new state and federal laws and regulations? Do we need to expand and enhance efforts to conserve and recycle water?

Answers to these questions involve consideration of diverse private and public values, politics, property rights, economics, and science. And it is in the latter component, science, where the Water Survey continues to play an important role. While resource management decisions are rarely made on the basis of science alone, science can provide important input to effective decision making.

The Water Survey has a responsibility to take a broad geographic and long-term perspective on the state's water resources, including evaluation of potential sustainable yields from surface waters and ground-water aquifers. And we have a responsibility to determine the natural variations in water resources and evaluate the impacts of human activities on regional climates and water resources.

With these challenges in mind, the Water Survey convened a major water resources conference in Chicago in July 2000 that brought together scientists, analysts, and decision makers to discuss a suite of water resource issues of importance to Illinois (see sidebar). We were fortunate to have stimulating presentations by Lieutenant Governor Corinne Wood and Professor Paul Simon. Lieutenant Governor Wood focused on restoration of the Illinois River watershed, and Professor Simon provided a broad and long-range view of global water resource issues.

Derek Winstanley is Chief of the Illinois State Water Survey.

Water Survey staff also are participating in hearings organized by the Illinois Pollution Control Board and the new Water Resources Advisory Committee established by Governor Ryan to address public concerns associated with "peaker" power plants and a host of water resource issues. Staff members are involved in development of a water resources strategic plan by the Northeastern Illinois Planning Commission, attend meetings of the Illinois Water Planning Task Force, have helped develop a National Assessment of the Consequences of Climate Variability and Change, and serve on the Science Advisory Committee of the Illinois River Coordinating Council.

All these activities reflect our continuing commitment to provide scientific information to help protect, preserve, and restore natural resources, and to use them wisely.

Derek Winstanley, Chief

Conference Focuses on Water Supply and Demand Issues

More than 140 attendees at "Illinois Water Supplies: Is the Well Running Dry?" in Chicago gained new insights into issues that will face Illinois as the population and economy expand in upcoming decades, and perhaps the climate changes.

The July 18-20 conference organized by the Water Survey and the University of Illinois Division of Conferences and Institutes focused on water supply and demand issues that Illinois will need to address: projected water supply and demand, water quality issues, legal and management issues, and socioeconomic concerns.

Invited speakers included state and national experts in the field of water resources planning. Lt. Governor Corinne Wood, who also serves as Chair of the Illinois River Coordinating Council, presented opening remarks.

Former U.S. Senator Paul Simon, now a professor at Southern Illinois University (SIU) and Director of the SIU Public Policy Institute, was the keynote speaker. Professor Simon highlighted global concerns over clean, abundant water supplies and the potential for conflict as water demands exceed supplies in some parts of the globe and in selected U.S. areas.

Former Senator Paul Simon delivers the conference keynote address.

Lt. Governor Corinne Wood reviews the conference program with ISWS Chief Derek Winstanley.

The Chicago skyline provides a perfect backdrop for an evening cruise on Lake Michigan.

Director Brent Manning, IDNR, introduces Professor Simon.

Don Vonnahme, IDNR Office of Water Resources head, shares his thoughts with conference attendees.

Ken Kunkel, ISWS, presents his views on climate change and its impact on water resources.

Sally McConkey, ISWS, answers questions from the audience aided by session moderator Scott Meyer, ISWS.

Vern Knapp, ISWS, provides insight into the state's available surface water supplies.

Professor Paul Simon (left) shares some closing remarks with Chief Derek Winstanley (center) and Chief Emeritus Stan Changnon (right).

Dianna Heaberlin, IEPA, discusses the impacts of changing water quality regulations.

Gary Clark, IDNR Office of Water Resources, discusses Illinois water regulations.

Conference attendees enjoy an evening adventure aboard the four-masted sailing ship "Windy."

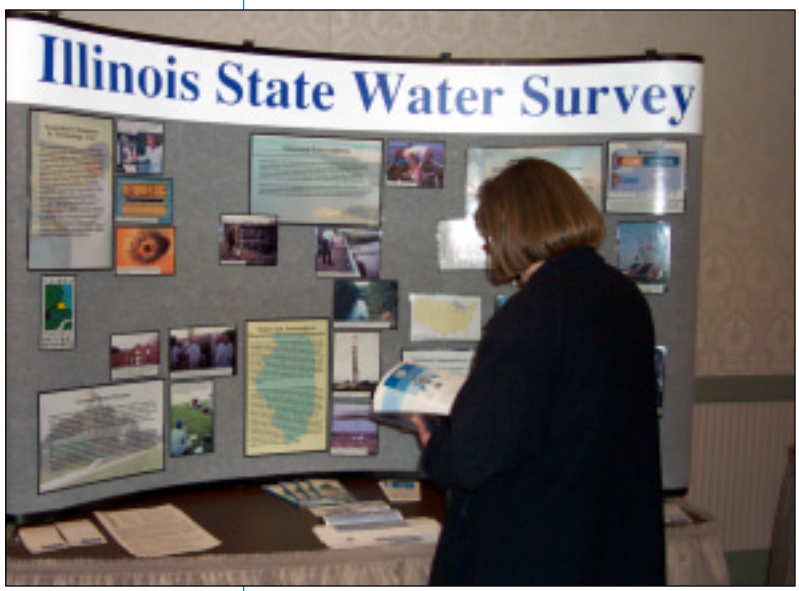
OFFICE OF THE CHIEF

Extension And Education Activities

University of Illinois Partnerships

"Environmental Horizons 2000." Environmental research being conducted on the University of Illinois Urbana-Champaign campus was showcased at "Environmental Horizons 2000" at the Illini Union on March 27-28, 2000. A campuswide planning committee that includes a member from each Scientific Survey organizes this annual conference sponsored by the University Environmental Council.

In addition to technical symposia, poster sessions and a career fair provided campus units with an opportunity to meet with other faculty, staff, and students to share research findings and investigate potential career opportunities. One highlight was the technical symposium organized by the Scientific Surveys on Illinois River issues such as the Conservation Reserve Enhancement Program, the Illinois River Decision Support System, declining biodiversity in the river system, and basinwide sedimentation problems. Overall, the conference provided an excellent forum for strengthening existing relationships and creating opportunities for joint research endeavors between Scientific Survey staff and University faculty and students.



A display by the Illinois State Water Survey was one of several available at "Environmental Horizons 2000."

Earth Systems Sciences Program. Additional efforts to enhance relationships between the Scientific Surveys and the University of Illinois have focused on developing a new joint graduate studies program in Earth Systems Sciences. The program will enrich the educational experience for graduate students by providing exposure to environmental and natural resources issues studied by the Surveys.

Upon completion of the program, participants will receive a graduate-level certificate in addition to their M.S. or Ph.D. diploma. Faculty from eight campus departments and the four Scientific Surveys will serve as advisors for students. Each research or thesis topic will involve at least one faculty member and one Survey staff member. Students will conduct research at the Surveys or within the home University department.

During the past year, a formal program description has been drafted and shared with participating campus department heads and college deans. A management committee structure has been approved, and a draft course listing has been prepared that pertains to the program mission and goals. Participating faculty and Survey staff have been identified. An Earth Systems Science seminar series is being developed.

Program funding is being sought, and efforts are under way to implement the program with new graduate students for the fall 2000 semester. Successful initiation of this program will contribute to a more practical graduate educational experience for University students while creating opportunities for additional Scientific Survey/University partnerships.

William C. Ackermann Scholarship Recipient

Matthew J. Hoffman of Palatine, Illinois, was the 2000 recipient of the $1,000 W.C. Ackermann scholarship awarded annually by the Nature of Illinois Foundation (NIF) and the Illinois State Water Survey (ISWS).

Hoffman, a senior majoring in civil engineering and geography at the University of Illinois at Urbana-Champaign (UIUC), plans to pursue his master's degree in water resources management upon graduating in December 2000. He was selected as a participant in the University's Special Undergraduate Research Experience program and is an undergraduate student employee at ISWS.

Illinois State Water Survey Chief Derek Winstanley and Nicholas Schneider, NIF Executive Director, presented the scholarship at a ceremony held at ISWS on March 20, 2000. Also in attendance were Mark Peden, ISWS Director of External Relations, and Mrs. Margaret Ackermann, widow of William C. Ackermann. The scholarship was established in honor of Dr. William C. Ackermann, ISWS Chief Emeritus and Professor of Civil Engineering at UIUC from 1956–1979. Hoffman is the seventh scholarship award recipient.

Matthew J. Hoffman (second from right) received the 2000 W.C. Ackermann Scholarship at a ceremony attended by Dr. Nicholas Schneider, Executive Director, Nature of Illinois Foundation, Mrs. Margaret Ackermann, and Chief Winstanley.

Water Survey Joins Peoria's Clean Water Celebration

Five Water Survey staffers and more than 500 attendees participated in the Peoria Clean Water Celebration at the Peoria Civic Center in March 2000. This annual science event teaches elementary through high school students and their teachers about water in our environment and the importance of a clean water supply.

Water Survey displays and presentations included a floodplain valley model, statewide floodplain and watershed maps, and the "Monitor" workboat with lake and stream measurement equipment. A water "taste test" dramatically illustrated the effects of naturally occurring minerals on the taste of our drinking water supplies. There was a computer demonstration of geographic information system maps. Twenty-two teachers signed up to receive a map of major watersheds in Illinois for classroom use after seeing the poster version.

Illinois State Fair Sets New Attendance Record

A record-setting one million people enjoyed beautiful weather and several new attractions at the 10-day 1999 Illinois State Fair. Among the educational exhibits as part of the Department of Natural Resources Tech Town 2000 presentation was the Water Survey's 100-square-foot elevation model of the Illinois River basin. Youngsters particularly enjoyed a colorful oversized map of the major watersheds in Illinois on which they could locate their watershed by marking where they lived. The map was so popular that smaller poster and postcard versions were developed for public distribution. Additional educational material distributed at the Water Survey's exhibit in Conservation World ranged from acid rain to unusual weather phenomena.

Two children study the watershed map at the State Fair.

Geographic Information Systems

The Illinois State Water Survey (ISWS) has used Geographic Information Systems (GIS) since 1983. Detailed GIS databases include lakes, rivers, streams, reservoirs, aquifers, ground-water wells, atmospheric monitoring sites, and public water-supply intakes and wells.

Using these databases, staff have constructed other databases, conducted analyses, and created maps for scientists, resource managers, and decision-makers. For example, a 1902 map series of the Illinois River floodplain was computerized by digitizing various land cover types from the original maps, comparing this database to a GIS database interpreted from recent satellite imagery, and computing changes in acreage of cultivated land, woodlands, grasslands, wetlands, water, and urban lands. Historic map land elevations and water depths also were computerized, incorporated into computer hydrologic models, and compared to modern elevations and depths to quantify changes and create various future scenarios with different environmental conditions.

The ISWS continues to be an active participant in the Illinois Natural Resources Geospatial Data Clearinghouse (http://www.isgs.uiuc.edu/nsdihome/ISGSindex.html). This site, part of the National Spatial Data Infrastructure, allows people anywhere in the world to search GIS water resources databases. The Illinois Department Natural Resources is the chief contributor to this Internet site, which catalogs various GIS databases within Illinois governmental and nongovernmental agencies.

Because of rapidly changing technology, staff members are committed to learning new software, hardware, programming, and processing techniques. A GIS Web page (http://www.sws.uiuc.edu/chief/gis/) is available to assist beginning and advanced users with GIS applications. Use of GIS as a viable tool for water resources research and management is expected to continue well into the future.

Kingsley Allan demonstrates the new high-resolution color plotter.

Water and Atmospheric Resources Monitoring

Collecting data and reporting on numerous sources of Illinois water information are the primary tasks of the Water and Atmospheric Resources Monitoring (WARM) program. Data are collected at monitoring sites across the state, archived for future use, and summarized in timely Water Survey publications such as the monthly *Illinois Water and Climate Summary*, which describes the current status of Illinois' water and atmospheric resources. These data include observations on atmospheric and soil conditions, shallow ground-water levels, river and stream flows, reservoir heights, and suspended sediments in streams. Collectively, these data track the flow of water from precipitation, evaporation, and soil moisture to Illinois rivers, reservoirs, and aquifers. There are numerous users because these data support real-time needs and also contribute to research on historic data.

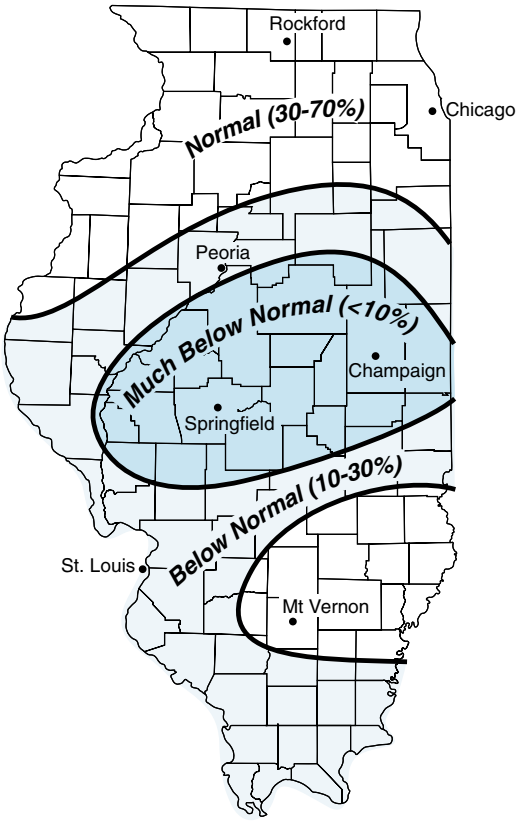
A major benefit to the State of these activities was realized during the recent drought conditions that gripped most of Illinois and a large part of the Midwest. Beginning during late summer and fall 1999 and continuing into spring 2000, a deficit of average monthly precipitation generated conditions in some parts of Illinois similar to those observed during serious drought epochs in the early 1930s and mid-1950s. Serious impacts on water resources were building across much of Illinois that involved very dry soil moisture conditions, low shallow ground-

water depths, and low reservoir levels. These conditions prompted some communities to initiate water conservation measures.

The WARM program's systematic current and archived observations on water and atmospheric conditions—some dating back to the early 20th century—form a solid historic informational database. With these data on hand, WARM program staff were able to analyze current water resources and relate them to previous dry periods with similar attributes. From these assessments and additional data collected by other state agencies, the Illinois Drought Task Force regularly appraised water conditions across the state to assess likely impacts of the recent drought on Illinois, drought trends, and future responses, given various rainfall projections.

A pilot study is assessing the benefits of continuous water quality monitoring of the Sangamon River near Monticello. Analyses of initial observations suggested the need for a rigorous baseline assessment of sensor quality to assure proper instrument siting in the Sangamon River and to develop useful data comparisons between new measurements and data from previous monitoring programs of the river. This assessment has progressed through extensive laboratory evaluation, and a report is being prepared.

All program networks are being readied for greater access and provision of user-friendly network data to support research and inform the general public about the state's water and atmospheric resources. This multi-stage process began with full documentation of all quality assurance and quality control activities used in data collection and archival procedures. Method summaries will appear concomitant with real-time and archived data as development of Internet access of each network's database proceeds.



Illinois streamflow levels for May 1-16, 2000.

What's New on the Web

Web operations for the Water Survey Web group surpassed one million hits, a new high, for the third quarter of fiscal year 2000. This increase was due in part to a greater presence in popular search engines (AltaVista, Yahoo!, Google, and many others). The Water Survey Web group—the main Water Survey site (http://www.sws.uiuc.edu/) and sites of the Midwestern Regional Climate Center (http://mcc.sws.uiuc.edu/), the National Atmospheric Deposition Program (http://nadp.sws.uiuc.edu/), and other programs—ranks highly in most of more than 1,000 search engines to which the sites have been submitted.

A completely revamped Web site with expanded search capabilities was released in February 2000. This release will help achieve one primary goal of the Water Survey's Web efforts: to disseminate a wide variety of information in an array of usable formats. The new site was designed to help users find relevant information quickly and easily using an entirely new navigational structure with multiple access points for each site area. Offerings include recent Survey documents, event highlights, publication information, and downloadable data. Hourly updates of outside temperature and wind speed now appear on the home page.

A new navigational aid, HydroNav (http://www.sws.uiuc.edu/hydronav/), lets users search our Web site by choosing areas of the hydrologic cycle. Clicking on a HydroNav keyword or image produces relevant links

just as if a text search had been performed. This will be especially helpful for users who want to search our site but do not know which terms to use.

The site map (http://www.sws.uiuc.edu/sitemap.asp), another new tool, allows users to browse a single page and find Water Survey documents, databases, links, articles, staff members, or other information. The map's collapsible feature provides a more abbreviated, easy-to-read Web site directory.

Many "behind the scenes" improvements also have been made. As Web site usage grows, often accessed database information is being ported to faster, more efficient programs. Survey staff contact information is now searchable by first or last name, by building, or by Section/Unit/Program/Office. The online publications search feature is being improved and refined constantly in an effort to offer the best possible access to Water Survey publications.

The internal Intranet site for Survey employees also has benefitted from numerous improvements. There is now increased Web access to staff resource information that previously existed only in paper form, in addition to policies, guidelines, Committee minutes, the most recent version of forms that change frequently, weather information, and other useful documents.

The Water Survey Web site won two awards.

The Illinois River Decision Support System

The Illinois River Decision Support System (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 decision-makers to assess and evaluate the effectiveness of different restoration projects, and the consequences of other natural or human-induced changes in the watershed.

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 of the Illinois River.

In FY 2000, the ILRDSS became associated with a new federal-state initiative *Illinois Rivers 2020*, a voluntary, incentive-based approach to address threats to economic and environmental sustainability of Illinois waterways. Because implementation will require extensive data and scientific support, the ILRDSS was included in the initiative's toolbox as the proposed primary information delivery system.

Activities to date have focused on developing ILRDSS conceptual design, garnering support of potential collaborators and informing them about proposed ILRDSS capabilities, and coordinating communication and development efforts among agencies involved. Over the next year, database and Web development will expand during construction of this comprehensive Web portal to information about the Illinois River and its watershed.

Chemistry Programs Provide Research Data and Public Information Services

The Analytical Chemistry & Technology Unit (ACTU) headed by Kent Smothers consists of several programs that provide key analytical support for research or furnish direct assistance to private citizens, state facilities, and utilities in Illinois. This role of research, internal support, and public service plays a vital part in achieving the Water Survey mission and goals.

Midwest Technology Assistance Center for Small Public Water Systems

The Midwest Technology Assistance Center (MTAC) for Small Public Water Systems funded by the United States Environmental Protection Agency (USEPA) works to foster technical, managerial, and financial capacity development in small communities. The USEPA has identified the preparation of emergency response plans as a tool to evaluate capacity development in drinking water systems.

One project that should have an immediate impact for small systems in Illinois is the *Public Water System Emergency Planning Interactive Guide*, which will provide step-by-step instruction on preparation of an emergency response plan for water-supply crises. The MTAC is funding the Illinois Section of the American Water Works Association (ISAWWA) to produce this product. When completed, it will be available (at no cost to utilities) in CD-ROM format and on the Internet at both the MTAC and ISAWWA Web sites.

A *Technical Needs Assessment* for small public water systems in the Midwest also has been completed. More than 200 responses provided insight into the needs of small systems and the types of resources they access for assistance. Areas identified by the small utilities as the most critical over the next ten years are infrastructure maintenance and financial and regulatory issues. Survey results will help MTAC and other technical assistance providers better focus future capacity development efforts.

Kent Smothers is Head of the Analytical Chemistry & Technology Unit.

Complete survey results were presented at a one-day regional workshop co-hosted by MTAC and the Missouri Technical Assistance Center in St. Louis during February 2000. Attendees also received updates on various projects at both Centers. Discussions included critical issues in relation to drinking water production and management: corrosion control and disinfection in aging systems, financial management tools, innovative strategies for disinfection and Cryptosporidium destruction, and development of training and education programs.

Analytical Services

The Analytical Services group provides chemical analysis in support of Water Survey and University researchers. Reliable, accurate

laboratory analysis of water quality parameters is essential to validate study results and conclusions whether the data are part of a long-term water quality monitoring program or a short-term research project. The laboratory is accredited by the Illinois Environmental Protection Agency (IEPA) and adheres to rigorous quality assurance practices required for accreditation. Researchers can make conclusions and recommendations with full confidence in the quality of analytical data that can withstand the rigors of peer review.

As part of an ongoing effort to improve data reliability and information management, use of a Laboratory Information Management System (LIMS) has been instituted. This computer software and database program improves data tracking, quality assurance, and data management and retrieval for analytical services and for the Public Service Laboratory Program. While most analytical determinations were for water samples, staff also analyzed sediments, plants, and animals. The research projects varied from intensive site characterizations at the Depue Wildlife Management area and Lake Calumet to long-term monitoring of nutrients in watersheds and a cooperative survey of nitrate in private wells with local school districts and the Future Farmers of America.

Public Service Laboratory Program

The Public Service Laboratory Program (PSLP) continues to provide IEPA-accredited water analysis for private well owners, well contractors, governmental agencies, health professionals, and others. This service is provided at no cost to the individual or entity other than shipping to return samples to the laboratory. Staff provide a sampling kit that includes sample bottles, instructions, and a freeze pack to keep the sample cool during shipping. Staff also regularly answer questions about water suitability for its intended use, whether or not existing water treatment chemicals or equipment are achieving the desired result, and options to improve water quality from the standpoint of health or palatability. During the past year, the PSLP performed more than 18,000 separate analytical determinations for 428 samples and responded to about 500 phone requests for information.

Institutional Water Treatment Program

The Institutional Water Treatment Program (IWTP) advises state agencies on water treatment in all water-using systems in an effort to reduce water usage, maintain operating efficiency, and minimize chemical and fuel use. Efficient water treatment can allow systems such as cooling towers and boilers to reduce water usage by more than 50 percent. Additional fuel savings of several percent are achieved easily by maintaining clean heat exchange surfaces. Program staff generally recommend generic chemicals for treatment unless a specific proprietary product offers a clear advantage.

Chemicals are bid annually on a statewide basis under the direction of Central Management Services, resulting in substantial cost savings for state agencies. Combined savings of natural resources (water and fuel) and money make the IWTP a valuable asset for the State of Illinois.

More than 100 state facilities from eight state agencies and most public universities in Illinois currently participate in the IWTP, and staff members visit each facility several times a year. During the past year, program staff analyzed more than 3000 samples in the field to help monitor the chemical treatment program during more than 400 site visits. Phone consultation and correspondence also play a critical role in program success, and staff members returned or placed 1200 phone calls and sent more than 1500 mailings to state facilities. Laboratory staff performed 800 complete water sample analyses and analyzed several hundred miscellaneous samples.

Mark Brooks routinely tests water samples as part of the IWTP.

Future Directions

While there is some independent research within the Analytical Chemistry & Technology Unit (ACTU), the primary function of the group is that of service and research support. Accurate conclusions in critical research relating to watersheds, ground water, and atmospheric resources require reliable, high-quality analytical data. Much older data used today to formulate far-reaching policy decisions were collected with inadequate documentation of sampling or analytical method, and very little in the way of quality assurance practices viewed as standard today.

The ACTU needs to recruit and retain the best possible staff and pursue excellence in data quality so that data reliability in Water Survey studies never can be called into question. Accreditation of the laboratory group by the Illinois Environmental Protection Agency for a variety of water quality constituents is one step in this process. The purchase of a Laboratory Information Management System to improve sample tracking and quality assurance practices is another. Both of those steps have been achieved.

However, much of the laboratory equipment is aging, and replacement with state-of-the-art equivalents is very expensive. With the support of the Office of Chief, innovative ways have been found to begin the process of upgrading and replacing aging laboratory infrastructure. Such efforts need to continue to maintain the well-deserved reputation of excellence associated with analytical data from the Water Survey. Maintaining a strong research support unit within the Water Survey is critical to accomplishing the goals of the scientific sections individually, and the Water Survey as a whole.

Dan Webb checks test results on the ion chromatograph while talking with a client.

ATMOSPHERIC ENVIRONMENT SECTION

Atmospheric Science Addresses State and National Issues

Ken Kunkel heads the Atmospheric Environment Section.

Innovative scientific research from the diverse Atmospheric Environment Section (AES) provides data and other information used in decision making on state and national issues. Dr. Ken Kunkel heads the AES.

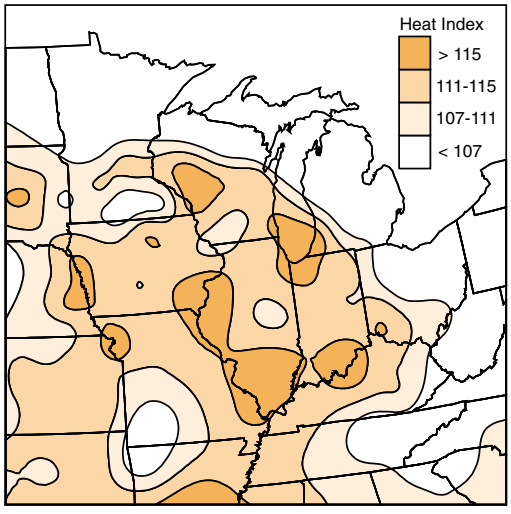
Climate and Air Quality Modeling

The climate, air quality, and impacts modeling system has developed rapidly. Initial development of a regional climate model for the Midwest was completed. Analysis of data from simulations shows that while the model can reproduce broad characteristics of events such as the 1993 flood, the 1988 drought, and the 1995 heat wave, additional development and testing are required for more accurate simulation of all the finer details. A state-of-the-art air quality model developed by Dr. Julius Chang and his colleagues at the State University of New York at Albany was implemented and coupled with the regional climate model. Initial testing has demonstrated the viability of a unique coupled air quality/climate modeling system. Because these models require major computational resources for simulations, funding was obtained for substantial time on the supercomputers of the National Center for Supercomputing Applications at the University of Illinois.

The models will be used to assess the consequences of contemporary trends, such as increasing greenhouse gas concentrations, urban growth, and energy deregulation, on future Illinois climate and air quality.

Climate Variability and Change

Several staff were involved in the U.S. National Assessment of the Consequences of Climate Variability and Change, a major effort involving federal agencies and researchers in university and government institutions. As part of this work, AES staff found that the frequency of heavy lake-effect snowstorms likely will decrease during the 21st Century in the southern Great Lakes region, including northeastern Illinois, if the future climate warms to the extent predicted by some climate models. Another study on potential climate



Maximum one-hour-average heat index values (°F) for the heat wave of July 19-31, 1999.

change effects on agriculture found a mix of positive and negative benefits but suggested little change in overall yields of corn and soybeans in the Midwest.

There were extensive studies of two climatic extreme events: the July 1999 heat wave and the 1997–1998 El Niño. The deadly 1999 heat wave resulted in 232 deaths across the nine-state Midwest. A similar analysis of impacts of the 1995 heat wave, during which 500 people died, led to heat wave planning by many cities, most notably Chicago. Analysis from the more recent study suggests these emergency plans were a major factor in the lower deaths during the 1999 heat wave. A thorough retrospective analysis of climatic conditions and impacts of the 1997–1998 El Niño was completed. A report resulting from that study found that the benefits of this event far exceeded any losses in the Midwest and Illinois.

Climate Services & Data

Climate services are a major component of both the Midwestern Regional Climate Center (MRCC) and the State Climatologist programs. Together these programs recorded about 1,700,000 hits to their Web pages and responded to nearly 7,000 e-mail and phone requests for information. Staff from both programs also developed a special Web page with access to heating and cooling degree-day data from six Illinois cities for EnergyNet, a nonprofit educational project for which students perform energy audits of their schools. Approximately 400 schools across Illinois participate in EnergyNet and Student Power 2000, a sister program sponsored by ComEd.

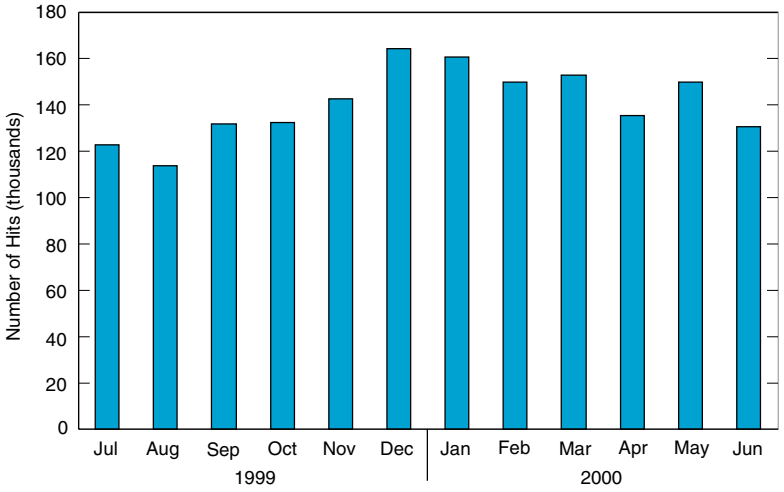
The State Climatologist, in collaboration with the MRCC, is constructing a digital record of daily temperature and precipitation data for sites in Illinois dating back to the early 1800s. This unique data set is being analyzed to provide a longer historical perspective on current extreme high temperatures. An analysis of records for Peoria starting in 1857 shows that the frequency of extreme high temperatures was relatively high in the latter part of the 1800s compared to the latter half of the 1900s. This suggests that the 1995 and 1999 heat waves may be less unusual than the recent historical record would suggest.

Monitoring Efforts

Wet and dry deposition of nitrogen from the atmosphere is an important component of the nitrogen input to watersheds in Illinois and across the nation. Input to Illinois watersheds is being estimated using measurements of air concentrations of nitrogen particles (ammonium and nitrate) and gases (nitric acid) from a few Illinois sites within two national networks. Differences in sampling equipment biases for those networks resulted in dry deposition estimates that differed by almost a factor of two for the site at Bondville, Illinois. Although one network has issued two database updates in the past year, correcting various errors, the factor of two difference remains. A comprehensive literature review is being conducted to ascertain which measurements are most accurate.

Three full years of continuous carbon, water, and energy flux monitoring over a no-till field have been completed. Analysis of these measurements has provided valuable insight into how short-term weather events during the growing season affect corn and soybean growth and yield and also show carbon cycle differences for those crops. For example, a net positive storage of carbon occurs in the soil during years of corn cultivation, while a net loss occurs during soybean years. These data show the potential of continuous carbon flux monitoring to study carbon sequestration in agricultural ecosystems, the process whereby carbon dioxide removed from the atmosphere is stored in the soil. Carbon dioxide is an important greenhouse effect, and this process can help reduce the concentration of carbon dioxide in the atmosphere and thereby reduce global warming.

Extensive research was conducted on lake-effect snowstorms that develop over the Great Lakes in winter in response to intense heat and moisture from the lakes. The resulting snowfall is highly localized and can be



This graph illustrates the popularity of Midwestern Regional Climate Center Web pages.

very intense and long-lived. In collaboration with the South Dakota School of Mines and Technology, a new mechanism was proposed as a possible cause of lake-effect snowbands. Use of these results should improve snowband predictability. The first detailed circulation study of a lake-effect vortex, which dropped heavy snow near the shores of Lake Michigan, also was completed.

Analysis of cloud physics field data suggested that large aerosol particles, which almost always act as cloud condensation nuclei, play a significant role in the onset of precipitation. A comparison of numerical simulations with observations showed that the initial radar return from developing cumulus clouds may occur because of small raindrops that have formed on large aerosol particles. The calculations also indicate that the development of the amount of liquid water in precipitation is sensitive to the concentration of cloud condensation nuclei in the atmosphere.

Clyde Sweet prepares to install a filter in the PM-2.5 sampler at Bondville.

Accurate knowledge of raindrop shape is a key requirement for improving rainfall estimates using the proposed dual-polarization upgrade to National Weather Service radars. Extensive measurements of raindrop shape from the Water Survey cloud physics laboratory have greatly increased knowledge about naturally occurring raindrop shapes. Existing field measurements of large raindrop shapes are inadequate because of distortion caused by airflow around the imaging sensors.

An important issue relating to airborne aerosols and their impact on human health is understanding the composition and source of particles smaller than 2.5 micrometers in diameter, commonly called PM-2.5. This particle size class is coming under federal regulation, and it will be the responsibility of Illinois to regulate the sources to achieve acceptably low PM-2.5 levels in the state. The control strategy will depend on whether these fine particles are produced by local emissions, like their larger counterparts, or in the atmosphere during long-range transport, similar to smog formation. Hourly PM-2.5 particle mass concentration was monitored at a local sampling site at which wind speed and direction were also monitored. It appears that for most of the year the PM-2.5 concentration is not dependent on wind direction, suggesting that much of the PM-2.5 is not of local origin.

Future Directions

Successful development of the coupled climate/air quality modeled system provides an opportunity to examine several important Illinois issues. One goal is to narrow the current large range of uncertainty on future precipitation and water resources in Illinois. Upcoming simulations will also examine the effects of power plant construction and operations, and urban sprawl on air quality in the Chicago metropolitan area, and the effect of global climate change on the future frequency and intensity of severe events (heavy rain, heat waves, cold waves, air pollution, severe winter storms, and severe thunderstorms). The effects of changes in rainfall on water supplies in Illinois will be evaluated in cooperation with the Watershed Science and Ground-Water Sections. Other

modeling studies will improve our understanding of lake-effect snow events and lead to better predictions.

Uncertainties in determining the effects of liquid water content in the early stages of development of precipitation-producing clouds on the subsequent evolution of precipitation suggests that a new field program should be proposed to gain a more complete description of the effects of large condensation nuclei on precipitation. Because of their expertise on raindrop shape, Atmospheric Environment Section scientists, at the invitation of hydrologists from the University of Iowa and the Iowa Institute of Hydraulic Research, will participate in a field program (late 2000–early 2001) to investigate rain properties using a new two-dimensional videoinstrument and a new radar equipped with the latest dual-polarization technology for remote sensing of rainfall.

Results from both comprehensive field studies will improve our understanding of severe Illinois storms. More accurate sensing of rainfall rates using radar ultimately can be used to anticipate and control runoff in urban areas such as Chicago.

Successful demonstration of the use of continuous carbon dioxide flux monitoring to evaluate the rate of carbon fixation in agricultural soils will provide the basis to develop more efficient agricultural carbon sequestering systems. This may be very important to Illinois farmers who may be able to sell carbon credits, given for adopting agricultural practices that most effectively sequester carbon, to electric utilities and other industrial emitters of greenhouse gases.

Increased familiarity with the strengths and weaknesses of various national monitoring and research networks will provide a resource to address important air quality issues for Illinois and the Midwest, including data sets to examine the validity of modules in the air quality model being developed at the Water Survey. These networks measure chemical species (including sulfur, nitrogen, and base cation species), visual range, and aerosol particle speciation. Because air quality monitoring is very expensive, it is important to maximize use of networks already in existence.

Most past measurements of airborne particulate matter smaller than 2.5 microns in diameter (PM-2.5) have relied on filter sampling followed by chemical analysis of the sample taken at a certain time of day at which wind direction can fluctuate. Clear identification of PM-2.5 sources should be possible with the availability of instrumentation to measure the PM-2.5 mass and its main chemical components (sulfate, organic carbon, elemental carbon, and nitrate) over short time periods.

Fifty years of Water Survey research on the Illinois climate will be tapped to produce a climate atlas for Illinois. This will provide access to our knowledge in one publication and in a format that will be useful and comprehensible to scientists and nonscientists alike.

Mark Belding calibrates a new digital recording raingage that will be used in the Cook County Network. This network measures rainfall for Lake Michigan diversion accounting for the U.S. Army Corps of Engineers.

GROUND-WATER SECTION

Using Scientific Information for Water Management in Northeastern Illinois

Manoutchehr Heidari is Head of the Ground-Water Section.

Water demand in some regions of Illinois, a water-rich state, is rapidly approaching the available supply. This situation necessitates better planning and management of resources, which places a greater emphasis on the collection and dissemination of good scientific data.

Water issues will be a focus of concern in northeastern Illinois for decades. As the region continues to develop, water needs will continue to increase. How will urban development affect the quantity and quality of available ground-water resources and that of water available to sustain ecological resources? How can these water resources be managed to allow growth into undeveloped areas while maintaining areas already developed? Scientists from the Ground-Water Section (GWS) headed by Manoutchehr Heidari intend to provide data and information to help answer those questions.

Addressing Potential Water Shortages

For example, the Chicago metropolitan region could face potential water shortages in the future even though it lies adjacent to one of the world's largest freshwater resources, Lake Michigan. Northeastern Illinois' traditional resources for large water supplies—water diverted from Lake Michigan or pumped from the region's deep bedrock aquifer system—may be inadequate to meet projected growth. Increasingly, planners will look to the region's shallow aquifers to satisfy future demands. Although shallow aquifers are a significant source of additional water, they are unevenly distributed within the region and can be compromised by urban development.

Section scientists are addressing various aspects of the adequacy of these shallow aquifers to satisfy future demands in the region. One project entails working with the Northeastern Illinois Planning Commission and Harza Engineering to develop projections, by township, of regional water demand and ground-water availability in 2020. Projected water use will be based on annual water use data supplied by municipalities, industries, and commercial enterprises through the ISWS Illinois Water Inventory Program.

These data are collected using annual water use summaries mailed directly to participating facilities statewide. Estimates published in historical ISWS reports serve as the basis for both shallow and deep ground-water availability. Comparisons of demand and availability will focus attention directly on areas in which demands exceed available ground-water resources.

Impacts of Urban Development

Another project is evaluating the impacts of urban development in northeastern Illinois on ground-water recharge rates. Base-flow separation techniques will be applied to selected long-term streamgage records within small watersheds that have undergone significant urbanization. Base-flow separation provides an estimate of the ground-water contribution to streamflow and is often equated with ground-water recharge. Examination of these long-term records will identify trends or temporal changes in ground-water

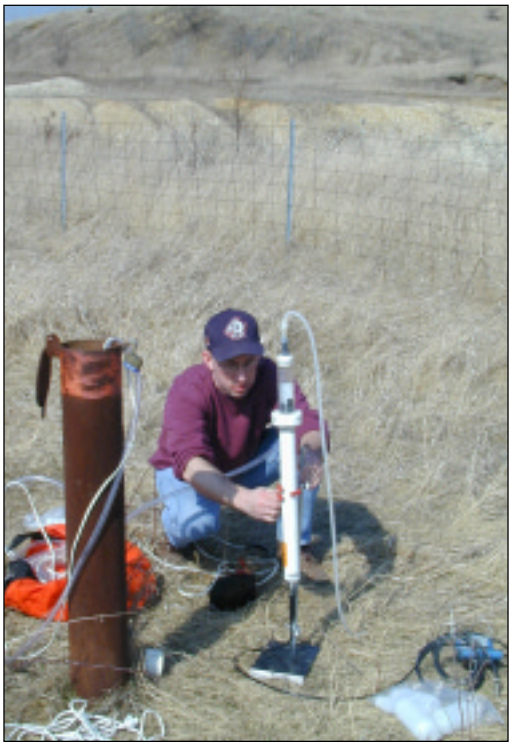
discharge. Changes in land use/land cover will be documented by analyzing historical aerial photos of watersheds contributing to the selected gages.

Identifying Trends

Yet another project is identifying trends in shallow ground-water quality in northeastern Illinois using historical water quality data maintained at ISWS and data available from county health departments. Changes in water quality are also likely a result of changes in land use and will be helpful to planners for future land and water development and ground-water protection.

Restoring and Preserving Wetlands and Nature Preserves

Proper water management can play a key role not only for water availability for human, agricultural, commercial, and industrial consumption, but also for ecological preservation. Restoration of highly disturbed wetland systems in the Lake Calumet region is an example. Research by GWS scientists and colleagues at the University of Illinois shows that water level manipulation and the mixing of water from different sources can improve wetland water quality and maximize the benefit to aquatic habitats. Because landfill and causeway construction have altered the hydrology of many area wetlands, restoration will help promote growth of more diverse vegetation. The addition of cleaner water will help ameliorate problems in wetlands dominated by ground water contaminated with extremely alkaline pH, ammonium, or high salinity. Aeration shows great promise in the remediation of extremely alkaline ground-water discharges.



Joe Karny samples Well 8 adjacent to a mining test pit.

A Monarch feeds at Lake in the Hills Fen.

Management strategies to reduce ground-water discharge are also being considered, such as use of capping material over slag piles. A capping material source being considered at the suggestion of GWS scientists is sediment from Peoria Lake. This soil was washed from the Illinois landscape, and efforts are now under way to dredge this material.

Ground-water issues have also involved Section scientists at Lake in the Hills Fen Nature Preserve, a 207-acre McHenry County site dedicated to the Illinois Nature Preserve System in 1990 to protect nine native ecological communities. Because of concerns over the influence of nearby sand-and-gravel mining on water quality of fen communities in the preserve, ground-water levels and chemistry have been monitored in and near two preserve fens since May 1999. A 12-well network is sampled monthly for alkalinity, total dissolved solids, pH, major anions, and metals.

While data do not exist to establish pre- and post-mining geochemical conditions at the fens, persistent chemical trends exist along a ground-water flow path in the preserve downgradient of the mine. Ambient shallow ground-water chemistry is expected to be diluted by precipitation at the mine, where most of the unsaturated zone has been

removed. Remineralization occurs as the ground water flows toward the preserve from the mined area. Fens are specialized ecosystems that depend on highly mineralized water, and even relatively minor changes in water chemistry can have a significant influence. Therefore, the remaining unsaturated deposits and concomitant long ground-water flow paths must be preserved to maintain the ground-water quality that currently sustains the fens.

Data for Mapping, Planning, and Monitoring

Although withdrawals from the deep bedrock aquifer system have declined significantly in the past two decades in response to delivery of Lake Michigan water to suburban areas and consequent retirement of deep bedrock wells, withdrawals continue at or slightly above the practical sustained yield of the system (65 million gallons per day or mgd). Researchers at ISWS have constructed potentiometric surface maps of water levels in the deep bedrock system in northeastern Illinois about every five years since the late 1950s for use in planning and monitoring impacts of aquifer system development. Section staff will collect water-level data again during Fall 2000 for a potentiometric surface map for the new millennium. It is expected that the effort will show some decrease in water levels associated with an increase in the 67 mgd withdrawals since the last mapping in 1995, and that most new development of the deep bedrock system has occurred in the outer collar counties (Kane, McHenry, and Will). This information will be extremely important to water resource planners and developers in the future.

Future Directions

Improving Data Storage, Access, and Retrieval

Historical files maintained within the GWS contain a wealth of data related to the state's ground-water resources. Primary among these data are construction reports for nearly a half million wells built in Illinois since the turn of the 20th Century. Entry of these thousands of well records into a computer database began in the mid-1980s. Computer systems have evolved significantly since then, and GWS computer programmers have kept busy keeping up with the evolving technology. Along with new hardware, new programs have been and are being written that will significantly improve data entry and retrieval efficiency.

Construction of new databases will link a wide variety of other important ground-water data, including aquifer hydraulic properties, ground-water withdrawals, ground-water quality, and ground-water levels. These data will be accessible on-line and available in various formats for subsequent manipulation and analysis, including GIS-compatible formats. A major goal is to allow access not only by database managers but by scientific staff and eventually by the general public. Links are also envisioned to databases maintained by other agencies such as the Illinois State Geological Survey, the Illinois and U.S. Environmental Protection Agencies, and the U.S. Geological Survey. These efforts will provide more immediate and improved response to public and scientific inquiries and better position the GWS to handle critical ground-water resource questions of the future.

Assisting Metro-East Redevelopment

Portions of the American Bottoms area of southwestern Illinois (including metropolitan East St. Louis, Metro-East) have just the opposite problem from northeastern Illinois. Since the 1960s, a number of locations in this area have experienced damage to infrastructure and buildings caused by *too much water* in the form of high ground-water levels.

The ISWS started routine monitoring of ground-water levels in this area during the mid-1950s drought. Significant declines in industrial and municipal pumpage during the 1960s caused ground-water levels to rebound from mid-1950 historical lows. Unfortunately,

Researchers collect water samples during a step test on IDOT's 25th Street dewatering well.

rebounding ground-water levels damaged basements, sewers, and highways designed in the 1950s when water levels were low. The Illinois Department of Transportation (IDOT) alone pumps 20-25 million gallons per day to protect low sections of highway along portions of Interstates 55, 65, and 270.

After experiencing a period of economic blight over the last 30 years, the Metro-East area now seems headed for a period of resurgence. The impacts of high ground-water levels on new infrastructure and buildings, and efforts to maintain ground water at acceptable levels, will be of major concern during redevelopment. Continuing observation of ground-water levels, working with other state agencies, including IDOT and DNR's Office of Water Resources, and developing and updating of ground-water models of the area will ensure the necessary information is available to assist with redevelopment plans.

Prioritizing the State's Aquifers

Collection and interpretation of data for ground-water management is a central theme for the GWS, and Section scientists are prioritizing the state's major aquifers to address issues of critical regional importance. Programs are being developed for data collection and interpretation and for the creation of regional aquifer simulation models.

Such models can be used to explore management alternatives, to test drought and climate change impacts, and to determine the effects of ground-water development on surface water resources. Chief among these aquifers are the shallow sand-and-gravel and shallow bedrock aquifers in northeastern Illinois, the deep bedrock aquifer system in northeastern Illinois, the Mahomet aquifer in east-central Illinois, and aquifers along the Wabash River and its tributaries in southeastern Illinois.

In keeping with this theme, Section scientists serve as technical advisors to the grassroots Mahomet Aquifer Consortium, a group dedicated to scientific study of the Mahomet aquifer and development of management options for its use. As population, industry, and irrigation continue to grow in Illinois, the competition for water will escalate. Efforts to improve GWS capabilities for data collection, archival, retrieval, and analysis will ensure the state has sufficient water for future generations.

Members of the Mahomet Aquifer Consortium are developing management options for this valuable resource.

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

National Atmospheric Deposition Program Helps Us Understand How Atmospheric Deposition Affects Our Nation's Water Quality

Van Bowersox heads the NADP.

A key issue for scientists, policy-makers, and the public is the extent to which atmospheric chemical deposition affects the quality of our nation's lakes, streams, and estuaries. Data from NADP's monitoring networks provide the scientific basis for these evaluations.

Acid Rain. For nearly three decades, scientists have been monitoring the surface waters of New York's Adirondack Mountains, where acid rain has been blamed for increased acidity in small water catchments and first-order streams without tributaries. Many of these surface waters are naturally acidic from organic acids that drain from humic matter in Adirondack soils; however, studies have shown that the lake acidity is now dominated by inorganic sulfuric acid, largely from precipitation. Scientists have raised similar concerns over high-elevation catchments along the Appalachian Mountains from Maine to Georgia.

Nutrients. Another problem is eutrophic waters along our shorelines, a condition in which nutrients degrade water quality by stimulating microscopic plant and animal growth. Many estuaries along the Atlantic and Gulf Coasts experience excess algal growth from large influxes of nitrogen, a nutrient. Decaying algae remove dissolved oxygen from water, sometimes below levels that will support fish and other animals, a condition known as hypoxia. Nitrogen in estuarine waters has many sources, and one oft-neglected source, atmospheric deposition, is now receiving increased attention.

Mercury. Recent newspaper articles have raised concerns over mercury in rainfall in the Great Lakes region. Although mercury is present in precipitation at only 5 to 20 parts per trillion, concern stems from mercury accumulation in the food chain. Fish consume microscopic plants and animals containing small amounts of mercury that collect in fish tissue and accumulate through bioaccumulation as larger fish consume smaller fish. Nearly 40 states now have advisories against consuming fish from certain lakes with high mercury concentrations in fish tissue. Because many of these lakes are remote from urban sources or industrial discharges, scientists wonder whether atmospheric deposition of mercury may be sufficient to cause the problem.

Evaluating the Role of Atmospheric Deposition

Established in 1978 under the leadership of State Agricultural Experiment Stations (SAES), the National Atmospheric Deposition Program (NADP) is now SAES National Research Support Project-3 housed at the Illinois State Water Survey. This cooperative program, headed by Van Bowersox, operates three precipitation chemistry networks: the 220-station National Trends Network (NTN)

measures acids, nutrients, and base cations in precipitation to determine spatial and temporal trends in wet deposition in the United States; the 9-station Atmospheric Integrated Research Monitoring Network (AIRMoN) evaluates effects of emission changes on precipitation chemistry, combining measurements with atmospheric models; and the 44-station Mercury Deposition Network (MDN) investigates the role of atmospheric deposition as a mercury source in remote lakes and streams.

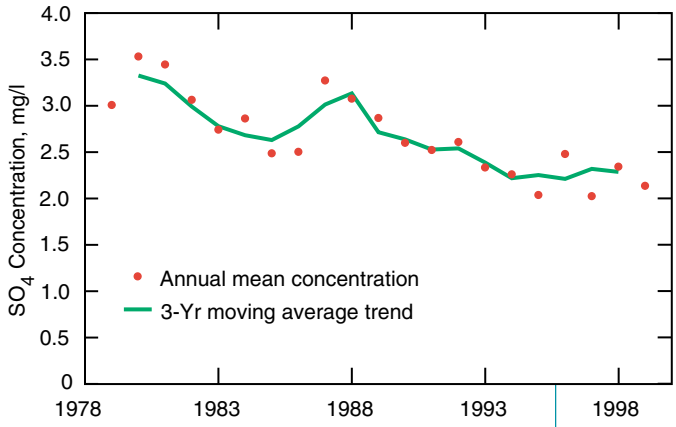
More than 200 NADP cooperating agencies include SAES; federal, state, and local governments; universities; tribal organizations; private companies; and other research organizations. Among NADP's goals is to provide chemical deposition data that will support research related to surface and groundwater chemistry, including estuaries. Highlights of selected July 1999–June 2000 publications demonstrate how NADP data are used.

***Acid Rain, Emissions Trends and Effects in the Eastern United States* (U.S. General Accounting Office, Washington, DC).** This report to the U.S. Congress uses NADP/NTN data to analyze deposition trends in three environmentally sensitive areas in the eastern United States: the Adirondack Mountains, the mid-Appalachians, and the southern Blue Ridge Mountains.

In the Clean Air Act Amendments of 1990, the Congress directed the Environmental Protection Agency to decrease adverse effects of acid rain by reducing sulfur dioxide and nitrogen oxide emissions. Beginning in January 1995, the Act placed annual limits on sulfur dioxide emissions from the largest electric utilities. It also permitted buying and selling of emission allowances, each representing one ton of sulfur dioxide, allocated to power plants.

Report findings were that 1990–1998 total U.S. sulfur dioxide emissions decreased 17 percent, largely a result of reduced power plant emissions; total nitrogen oxide emissions changed little. The largest decline in sulfur dioxide emissions occurred between 1994 and 1995, when the Act mandated reductions at 263 electric utility units—most in states bordering the Ohio River.

Scientists used NTN data to evaluate whether these reduced sulfur dioxide emissions decreased sulfate deposited by precipitation, particularly in the three environmentally sensitive areas. Compared with 1983–1994, the 1995–1998 mean annual wet sulfate deposition decreased 26 percent (Adirondacks), 23 percent (mid-Appalachians), and 9 percent (southern Blue Ridge Mountains).



Annual SO_4 concentrations, 1979–1999, NADP/NTN Site IL 11, Bondville, IL.

Similar comparisons for nitrate showed changes of 5 percent or less, except for an 11 percent increase in nitrate deposition in the southern Blue Ridge Mountains.

From 1992–1999, the amount of sulfate decreased in 48 of 52 Adirondack lakes surveyed, consistent with the downward trend in sulfate emissions and deposition. However, nitrate levels increased in 48 percent of the lakes, decreased in 25 percent, and remained the same in 27 percent, even though nitrogen oxide emissions and nitrate deposition remained relatively unchanged.

***Soil Calcium Status and the Response of Stream Chemistry to Changing Acidic Deposition Levels* (Lawrence et al., Ecological Applications 9(3):1059-1072).** Except for one south-central Maine station, NTN data show that sulfate deposition has decreased in New York and New England by 14 to 34 percent over a 15-year period, 1983–1997. The acidity of certain northeastern streams is not decreasing despite reductions in sulfate deposition. Decreases in calcium and in other base cations in soils lining streams and in watersheds may have impeded stream recovery. Acid-neutralizing capacity of the streams, raising their pH, has not changed. There is evidence of calcium declines in some streams, particularly those at high elevations.

Acidic deposition over several decades has leached calcium from these watersheds at a rate that exceeds calcium replenishment from weathering. Further, NTN data show that calcium concentrations in precipitation have decreased over the last 20 years. With lower base cation input from atmospheric deposition and with soils depleted of base cations, these streams are likely to respond only slowly to decreases in acid rain.

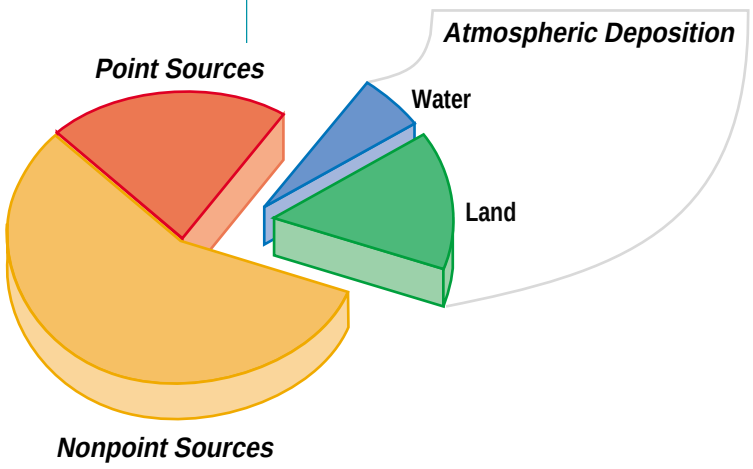
***Deposition of Air Pollutants to the Great Waters - Third Report to Congress* (U.S. Environmental Protection Agency, Research Triangle Park, NC).** This report

presents current information about atmospheric deposition of pollutants to the Great Waters (collectively the Great Lakes, Chesapeake Bay, Lake Champlain, and coastal waters) based on research and program activities since the second report in June 1997. The report focus is 15 pollutants of concern including mercury (measured at NADP/MDN sites) and nitrogen compounds (measured at NADP/NTN and NADP/AIRMoN sites).

Along with runoff and pollutant discharges into waterways, atmospheric deposition is an important pathway of pollutant inputs to the Great Waters. The contribution of atmospheric deposition to overall pollutant loadings varies greatly by pollutant and location. For example, studies show that atmospheric deposition contributes from 2 to 38 percent of the nitrogen load to certain coastal waters. Improvements in the quality of the Great Waters require an understanding of all pollutant sources and cycles in Great Waters environments.

Mercury. Emissions of mercury to the atmosphere come from human-made (anthropogenic) sources, natural emissions, and re-emissions from biologic and geologic processes. Current emissions inventories attribute ~53 percent of U.S. anthropogenic mercury emissions to fossil fuel combustion in utility, industrial, and residential boilers. Municipal, medical, and hazardous waste combustion account for another 33 percent.

What's poorly understood is the chemical form in which these sources emit mercury. Elemental mercury is water-insoluble and may be transported over long distances, whereas ionic mercury is highly soluble and is readily removed by precipitation.



Sources of nitrogen to the Chesapeake Bay. ***Source****: Chesapeake Bay Program,* The State of the Chesapeake Bay, *CBP/TRS 222/108, October 1999.*

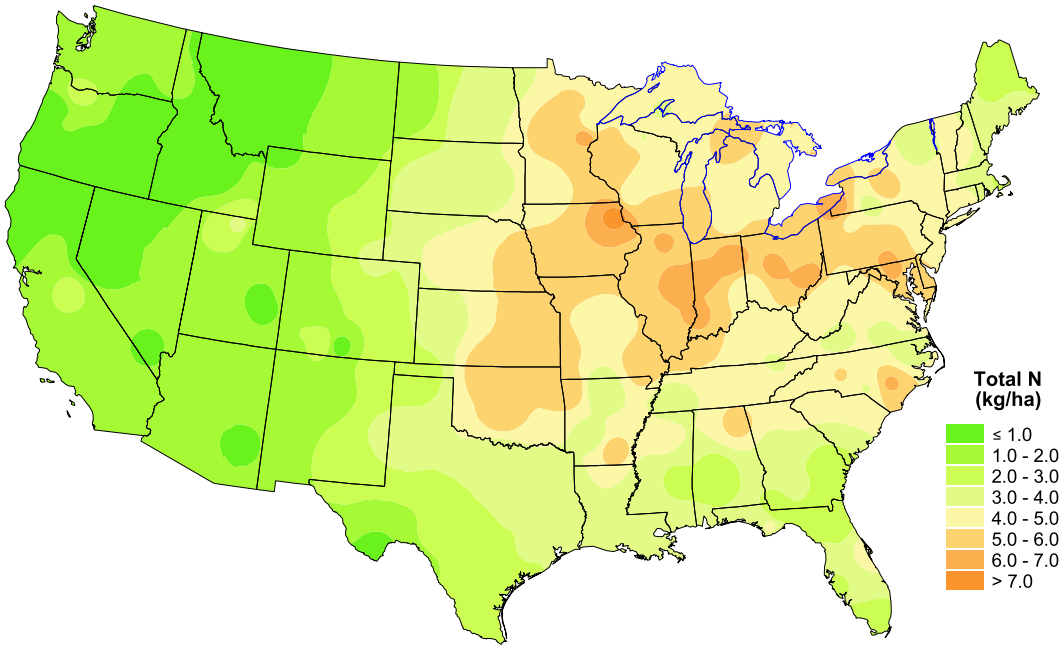
Computer simulations of mercury emissions, transport, and deposition are very sensitive to the chemical form of mercury in the atmosphere. These simulations rely on MDN deposition data for model evaluation and development. Overall, modeled spatial patterns of annual wet deposition agree within a factor of two with MDN measurements, although modeling underestimates measured wet deposition. The MDN sites are concentrated on the East Coast and in the upper Great Lakes basin. A major source area in which simulations suggest mercury deposition peaks is the Ohio River valley. However, data within this area are sparse, and more sites are necessary to ascertain if this is true.

Annual loadings of mercury measured by the MDN range from 2 to 25 micrograms per square meter with concentrations from 6 to 18 nanograms per liter. Average summer concentrations in the eastern United States are more than double the winter concentrations, and average summer depositions are more than triple the winter values.

Several MDN sites in New England have recorded some extraordinary mercury deposition from heavy rainfall with relatively high mercury concentrations. These storms first tracked along the coastal urban corridor from New Jersey and New York to Providence and Boston. Scientists speculate that mercury emitted from these urban centers entered storm air masses for redeposit in New Hampshire and Maine.

Nitrogen. Nationwide emissions of nitrogen oxides (NOx, or NO and NO_2) to the atmosphere have fluctuated between 21 and 23 million metric tons per year since 1985. Exhaust from on-road and nonroad engines and vehicles accounts for 49 percent of NOx emissions, and 46 percent comes from fuel combustion, largely in electric utilities and industries. Principal sources of reduced nitrogen (ammonia and ammonium, or NH_3 and NH_4) to the atmosphere in the United States are volatilization from animal waste and microbial decomposition of organic matter in soils and oceans. Release of reduced nitrogen approaches the release of nitrogen oxides in areas with high concentrations of animal farming operations.

Scientists are using NTN and AIRMoN data to evaluate rates and trends of inorganic nitrogen (nitrate plus ammonium) deposited in Great Waters watersheds and to examine the link between nitrogen oxide and reduced nitrogen emissions and deposition. There are NTN sites in or near most of these watersheds.



Estimated inorganic nitrogen deposition from nitrate and ammonium, 1999.

Annual deposition fluxes of inorganic nitrogen range from less than 1 to nearly 10 kilograms per hectare. These fluxes have been essentially constant for the Chesapeake Bay, Great Lakes, and Lake Champlain watersheds since 1980, whereas fluxes in Tampa and Sarasota Bays have increased significantly in the past decade.

Scientists are combining inorganic nitrogen deposition data from the AIRMoN site on the bay shoreline with estimates of dry deposition to evaluate total atmospheric inorganic nitrogen deposition to Tampa Bay. Wide variations (changes of 100 to 1,000) were observed in wet to dry nitrogen deposition ratios, and the atmosphere was found to be an important nitrogen contributor.

One of the greatest sources of uncertainty in assessing the importance of nitrogen deposited by precipitation to the Great Waters is quantifying the amount transferred from a watershed to the lake or estuary it supplies. Nitrogen transfer rates depend on land use and cover and vary greatly among and within watersheds. Investigators are using NTN deposition fluxes in their ongoing research to estimate transfer rates for each Great Waters watershed.

These estimates range from 3 percent (wetlands) and 38 percent (urban landscapes) to 90 percent (tributary streams). This means that land and tributary surfaces deliver from 3 to 90 percent of the nitrogen they receive from precipitation to lakes and estuaries. When these amounts are averaged over the entire watershed, 21 percent of the atmospheric nitrogen received by the Chesapeake Bay watershed actually enters the bay.

***Where Air and Water Meet, the Role of Atmospheric Deposition in the Gulf of Mexico Hypoxic Zone* (The Ecological Society of America, Washington, DC).** This workshop report uses NADP/NTN data to review the role of atmospheric deposition in the Gulf of Mexico hypoxic zone and to identify additional information needed to fully understand the significance of this relationship.

Hypoxia in the Gulf occurs mainly in the warm season (June–August) and reaches a maximum area of 16,000–18,000 square kilometers. Among the reasons cited for development of this hypoxic area is the influx of nutrients from the Mississippi-Atchafalaya Rivers. Some scientists have targeted fertilizer in runoff, sewage, and industrial effluents as the nutrient source.

Another source is the inorganic nitrogen entering the Mississippi drainage from the atmosphere. Nitrate and ammonium are the predominant inorganic nitrogen-containing compounds in precipitation. Nitrate is derived from nitrogen oxides released as combustion byproducts (automobile exhaust or smoke from industrial boilers). Ammonium comes from animal waste. Precipitation efficiently removes both compounds from the atmosphere.

Scientists are using NTN data to quantify the flux of inorganic nitrogen entering the Mississippi drainage from precipitation.

Estimates of the fraction of nitrogen from the atmosphere range from 1 percent directly to Gulf waters to 18 percent to the 31-state watershed. These estimates may be low: ammonia was ignored in many cases because it was assumed to be deposited within the same watershed from which it was emitted. Moreover, little is known about the timing and importance of spring runoff, hurricanes, and other large storms in triggering the onset of hypoxia. Measuring nitrogen in atmospheric deposition, surface runoff, streams, and coastal waters is important to create a better understanding of nitrogen cycling in the environment.

Maintaining a Long-term Commitment to Monitor Our Nation's Precipitation

The NADP's Central Analytical Laboratory (CAL) first began operations at the Illinois State Water Survey (ISWS) in 1978, when the 22 original NADP sites first started collecting precipitation. In spring 2000, the CAL analyzed the 200,000th NTN and 10,000th AIRMoN sample. These 22 years of ISWS involvement have resulted in nearly 4,000 site years of precipitation chemistry data and more than 1.5 million chemical analyses. The CAL continues to be a world leader among laboratories that measure precipitation and has been invaluable in building the long-term, high-quality database for which the NADP is noted the world over.

Continuing to monitor precipitation chemistry over space and time helps describe the chemical climate of the United States. Many factors affect our chemical climate: pollutant emissions; how pollutants are mixed, transported, and chemically changed in the atmosphere; and how pollutants are removed by precipitation or dry deposition. This interplay of meteorology and atmospheric chemistry affects precipitation chemistry and defines the chemical climate.

Atmospheric chemical deposition affects the nutrient status, growth, and development of plants on land and in surface waters. While it may benefit agricultural crops by adding nutrients that promote growth, adding nutrients to surface waters may boost algal production and reduce water quality. Atmospheric deposition of acids and other trace constituents can influence fish health and reproductive capacity, biogeochemical cycles, and modify natural weathering rates.

Maintaining a long-term precipitation chemistry monitoring program requires the steadfast efforts and cooperation of NADP scientists, staff, and sponsors. It also requires a program that responds to and meets changing needs of scientists and educators who use NADP data. The NADP remains committed to its vision of being an organization of scientists serving science and education and supporting informed decisions on air quality issues related to precipitation chemistry.

Future Directions

Improving Site Operations

The National Atmospheric Deposition Program (NADP) has one of the longest multi-site records of precipitation chemistry in the world and has maintained an effective quality assurance program by ensuring long-term commitment and uniformity of site operations. Precipitation is currently collected and measured at every site using an Aerochem Metrics (ACM) 301 precipitation collector and a Belfort B5-780 recording raingage.

In an effort to reduce down time and speed data recovery, the NADP is planning to replace this equipment, which is labor-intensive to maintain and operate. Each site will receive a versatile collector capable of collecting four separate samples for analysis of a broad suite of chemical constituents and an all-weather weighing precipitation gage with telemetry capabilities. Deteriorating solar or AC power system infrastructure and field laboratory equipment also will be replaced or upgraded. Plans call for completion of equipment testing in 2002 and installation and use in 2003.

Expanding Geographic Information System Capabilities

Recognizing that a principal contemporary use of NADP data is to estimate the atmospheric deposition of nutrients in watersheds, the NADP has initiated a multi-year effort to add Geographic Information Systems (GIS) coverages. Applications being developed will allow on-line retrieval of deposition rates (fluxes) and loadings (masses) for watersheds by seasons and years. Additional GIS coverages are planned for land use/cover, ecoregions, point and area sulfur and nitrogen oxides emissions, census information, animal populations, road and highway distributions, and topography.

Developing New Data Products

Scientists and decision-makers continue to need information about the effects of chemical deposition in precipitation on managed and natural ecosystems and cultural resources. The NADP Program Office will develop data products, brochures, and on-line presentations that facilitate NADP data use and application.

The new brochure, *Nitrogen in the Nation's Rain*, is an example. It presents a concise summary of the phenomenon of nitrogen in precipitation by addressing how nitrogen deposition is measured, which human activities contribute nitrogen, and effects associated with nitrogen deposition.

Currently under development is an on-line presentation of air-parcel trajectories. Users will be able to select AIRMoN samples of interest, rapidly retrieve sample concentration and deposition flux measurements, and run a program that presents a 48-hour, backward air-parcel trajectory that terminates at the sample collection site. This information will be useful in studying pollutant sources and in determining air stagnation and other meteorological effects on chemistry of the samples.

Kaye Surratt processes and analyzes samples in the laboratory.

WATERSHED SCIENCE SECTION

Resource Management at a Watershed Level: Looking to the Future Using Past Experience

Mike Demissie is Head of the Watershed Science Section.

State and national water resources will be managed at a watershed level in coming decades. The Watershed Science Section (WSS) headed by Mike Demissie is poised to continue and improve its leadership role in providing "sound science" for appropriate water resource management at a watershed level.

All human-induced and natural actions affect all living creatures and resources within defined watershed boundaries. Illinois watersheds vary from less than a square mile to as much as 30,000 square miles for the Illinois River. A systematic management scenario will require a thorough understanding of physical, biological, and chemical processes at work in the watershed and solid scientific evaluation of the causes and effects of human-induced changes supported by high-quality long-term data. Most Section activities include data collection and monitoring, hydrologic evaluation, hydrologic and hydraulic modeling, watershed restoration and revitalization, and information dissemination.

Data Collection and Monitoring

Without a long-term monitoring and data collection program, there would be no documentation of changes in our water resources or about the success or failure of actions implemented by various management agencies. The Illinois State Water Survey (ISWS) has a history of active involvement in this area, which includes a historical collaboration with the U.S. Geological Survey (USGS) on flow measurements in Illinois streams and rivers, continuing the Benchmark Sediment Monitoring Network of selected Illinois streams, and conducting sedimentation surveys. The program has expanded significantly in recent years to initiate hydrologic and water quality monitoring for more than ten watersheds as part of the Illinois Interagency Pilot Watershed Program and the Illinois River Conservation Enhancement Research Program (CREP) projects.

The WSS has established hydrologic, sediment, and nutrient monitoring programs for the Illinois River CREP, Illinois Interagency Pilot Watershed Program, Illinois Department of Natural Resources (IDNR) Ecosystem Partnership Program, Illinois Council on Food and Agricultural Research Water Quality-Strategic Research Initiative (C-FAR WQ-SRI), and the City of Decatur. The monitoring networks consist of 20 streamgaging stations (of which 14 stations are new this year) and 5 sampling sites at USGS streamgages.

The Illinois River CREP is a major State of Illinois and U.S. Department of Agriculture (USDA) initiative to implement conservation practices that improve water quality and wildlife habitat in the Illinois River watershed over a 15-year period. As part of the evaluation program, IDNR has funded WSS monitoring of sediment and nutrients during CREP implementation in four small watersheds in the Illinois River basin: Court and Haw Creeks in the Spoon River watershed and Panther and Cox Creeks in the Sangamon River.

The Interagency Pilot Watershed Program was developed through the Watershed Management Committee of the Natural Resources Coordinating Council (NRCC) in

an effort to coordinate and evaluate watershed management activities in Illinois. Using agency priorities, the Pilot Watershed Focus Group found that the programmatic interests of the Illinois Department of Agriculture, Illinois Environmental Protection Agency (IEPA), Natural Resources Conservation Service (NRCS), and IDNR occurred in parts of four major watersheds: Spoon, Cache, Embarras, and Kaskaskia. Those areas provided opportunities for all four agencies to work cooperatively. The study intends to address hydrologic and water quality (sediment and nutrient) data needs for the Pilot Watershed Program in the Big Creek, Hurricane Creek, and Sugar Creek watersheds.

The IDNR Ecosystem Partnership Program has supplied funds for the Embarras River Management Association and Vermilion River Partnership to collect watershed data at monitoring stations to establish baseline information for future scientific analysis to document shifts in streamflow, suspended sediment and nitrate-nitrogen (nitrate-N) levels, and yields. The WSS is monitoring these same variables (except yields) for two years in watersheds upstream of Lake Vermilion and Georgetown Reservoir, and Hurricane Creek, a tributary of the Embarras River. Three new streamgaging stations were installed in the Hurricane Creek watershed for the study.

The Section has been monitoring hydrology and nitrate at eight stations in the Lake Decatur watershed (Upper Sangamon River) since 1993 in cooperation with the City of Decatur, where the water supply occasionally has been exceeding the IEPA drinking water standard of 10 milligrams per liter for nitrate-N concentrations. This monitoring is helping the city meet IEPA requirements and provide data necessary for drinking water management decisions.

The Illinois C-FAR WQ-SRI has provided a focused funding source to coordinate and integrate critical nitrogen research. The WSS has established two watershed monitoring efforts in the Upper Sangamon River and Big Creek of the Cache River. Additional funding awarded enhances both projects through instrument upgrades at existing streamgage monitoring stations in the Upper Sangamon and by adding sampling for nitrogen, phosphorous, and sediment in both watersheds. This additional funding also enhances ongoing efforts to gain an understanding of nutrient transport in Illinois watersheds.

Since Water Year 1981, the Water Survey's Benchmark Sediment Monitoring Program has collected data in Illinois waterways that are used to generate and manage a long-term database on sediment transport. Quality long-term data are essential to understanding the relationship between erosion and sediment deposition, and the effects on land surfaces, streams, lakes, and other water bodies.

Amy Russell takes a discharge measurement in Big Ditch.

The network has 15 sampling sites strategically located throughout Illinois. Approximately 23,000 suspended sediment samples have been collected to date. Sediment loads are calculated from the laboratory data and water discharge information.

Hydrologic Evaluation for Future Management

The ISWS is conducting a comprehensive evaluation of the Illinois streamgaging network to determine current and future streamflow information needs, and provide guidelines for a core State streamgaging program that is sustainable and financially stable. The network operated by the USGS with State support provides vital hydrologic information for the effective operation of dams and reservoirs, water supply facilities, hydropower plants, wastewater treatment facilities, and water diversions. It also provides an essential database for use in research and in general management of State water resources.

Streamflow analyses are continuing for selected watersheds as part of the Illinois

Streamflow Assessment Model (ILSAM), an interactive program developed for personal computers that provides users with estimates of streamflow frequency for stream locations in selected major watersheds. These data are essential for watershed planning and management, including evaluations of water supply availability, water quality assessment, and protection of in-stream flow needs for recreation and aquatic habitat.

Flow estimates are currently available for four major Illinois watersheds—the Fox, Sangamon, Kankakee, and Kaskaskia basins—with work in progress for the Little Wabash and Rock River basins. This work addresses WSS goals to advance knowledge of temporal and spatial variability of streamflows in the State and to provide technical assistance on water quantity issues to state and local agencies, municipalities, and the general public.

Stratton Dam controls outflow from the Fox Chain of Lakes in northeastern Illinois. Over the past ten years, the ISWS developed a flow forecasting system for this State-owned and operated dam, and conducted studies to examine the impact of dam operation on flooding.

Modeling

Watershed simulation models are tools that can analyze nonpoint source pollution problems and help find solutions through land-use changes and best management practices (BMPs). Models help in evaluating and selecting alternative land-use and BMP scenarios that may reduce damaging effects of pollution. A dynamic watershed simulation model (DWSM) being developed at ISWS uses physically based equations to simulate storm event rainfall-runoff, propagation of flood waves, soil and streambank erosion, sediment entrainment and transport, and common agricultural chemicals in agricultural and rural watersheds.

By using existing and some new data collected on the Upper Sangamon River watershed above Lake Decatur, the DWSM hydrology and sediment components were tested successfully. Testing of the nutrient and pesticide component is in progress. Satisfactory results were obtained from testing the Court Creek watershed model. Model capabilities will be expanded by including tile and base flows and streambank erosion.

Hydrodynamic and sediment transport modeling expertise are being used in developing the Illinois River restoration plan. Top soil, a vital resource, is being lost to erosion. Some of this extremely fertile, organic substance ultimately ends up in roadside ditches, streams, lakes, and large rivers. Peoria Lake, a prime example, contains an estimated 133 million cubic yards of rich soil eroded from the watersheds of the Illinois River. One beneficial use for this resource is to dredge the sediment and build artificial islands that enhance deep water habitats while simultaneously providing bird and animal habitats above water that include trees and other vegetation.

Before undertaking this action, however, there needs to be a thorough understanding of the removal of sediments from the lake and the effects of proposed islands on water movement and sediment deposition. Section engineers have been doing exactly that and now have a calibrated mathematical model to evaluate various islands or island configurations within Peoria Lake. Modeling will play a vital role in island selection, orientation, and placement as one or more islands are built in Peoria Lake over the next 3 to 15 years.

Water level fluctuations within navigation pools of the Illinois and Mississippi Rivers have been identified as a major detriment to aquatic and terrestrial habitats of these rivers. Section engineers have been conducting research to determine how water levels can be manipulated to enhance habitats without affecting navigation. The feasibility of different floodplain management alternatives is being evaluated mathematically to determine the effects on flood heights, river conveyance, and ecosystems. While highly technical, these and other related research projects will have significant effects on how decision makers manage a major State resource such as the Illinois River in coming decades.

Watershed Restoration and Rehabilitation

Many Illinois rivers have deteriorated as a result of numerous human activities. It is now accepted that pristine conditions will never return. However, to maintain current conditions or enhance river quality, WSS staff have been working with many governmental and nongovernmental entities to determine the best alternatives to revitalize these extremely valuable resources. Section staff are now helping evaluate upland watershed stabilization, enhancement of floodplains and backwater lakes, and possible reduction of extreme water level fluctuations for the Illinois River as a whole.

Scientific and engineering analyses on removal of recurring sand bars at or near the

Illinois-Indiana state line are being provided for the Kankakee River, which was channelized in Indiana 100 years ago. Those research results will be used to determine how to reconnect the Upper and Lower Cache River.

Two projects related to long-term watershed studies on Lake Pittsfield and the Waukegan River document BMP effectiveness on sediment delivery, physical habitat, and aquatic biota. These examples of adaptive management on a watershed scale in Illinois benefit from continuing cooperation between IEPA and IDNR while in-stream habitat is enhanced over the next four years. Priorities of selected pilot watersheds and IDNR properties will be determined by IDNR.

Other restoration and rehabilitation projects include Court Creek in the Spoon River watershed and the Big Creek pilot watershed in the Cache River watershed. These projects follow the ISWS strategic plan to develop and evaluate BMPs at a watershed scale with long-term monitoring.

Information Dissemination

A colorful wall map of major Illinois watersheds was so popular at the 1999 State Fair that the ISWS developed poster and postcard versions for mass production. These same watersheds are used in hydrogeographical files of historical and current data.

Staff also provide floodplain information and technical assistance to individual homeowners, community staff and administrators, agency staff, engineering consultants, surveyors, researchers, and other members of the public. The Floodplain Information Repository includes regulatory floodplain maps, studies, and engineering data related primarily to the National Flood Insurance Program (NFIP). Technical services provided facilitate community and property owner compliance with state and local floodplain management practices, and with NFIP provisions.

Staff responded to 643 requests in FY 00 that included flood zone determinations for individual properties, calculations of 100-year flood elevations, specific engineering and technical data, flooding and floodplain management information, and surface water information and data. Staff also helped compile surface water data for the monthly *Illinois Water and Climate Summary* published by ISWS.

Floodplain management concerns and ISWS services are also promoted at public forums and professional organizations such as the Illinois Association for Floodplain and Stormwater Management, which held its first statewide conference in Peoria during May 2000. This successful conference co-chaired by a WSS staffer attracted more than 230 participants throughout Illinois.

The Court Creek bank erosion site near Dahinda has averaged 2000 tons of sediment per year since 1940 (top). With funding from USCOE Waterways Experiment Station, biotechnical bank stabilization was completed in 1994 (center). The site has remained stable throughout a series of large floods (bottom).

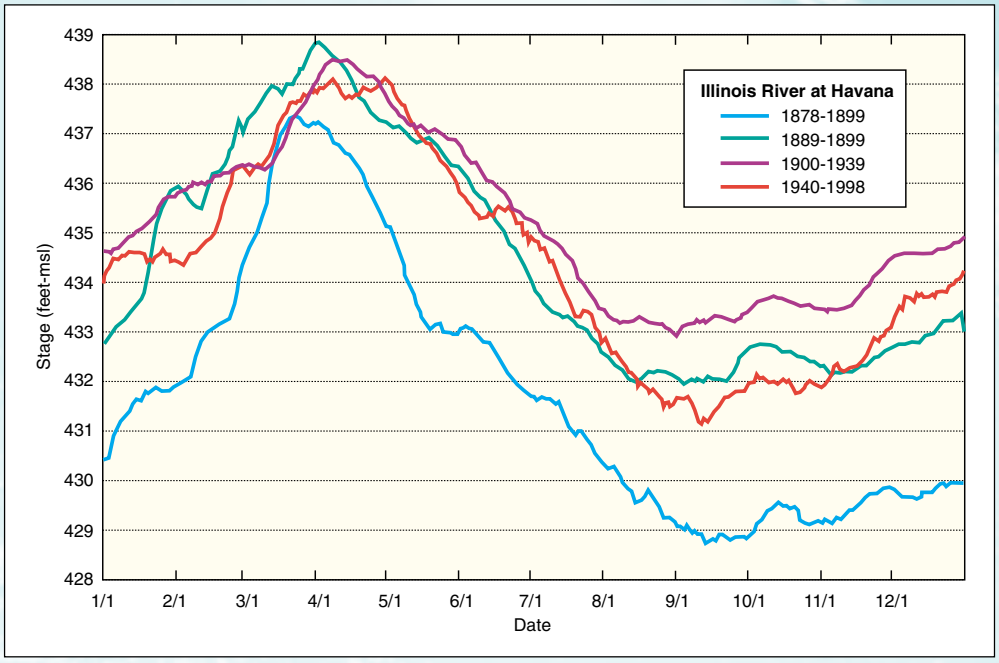
Future Directions

The WSS is in an ideal position to address critical and timely issues related to the state's water resources. Most water quality and quantity issues are being addressed at the watershed level, as indicated by the formation of more than 30 watershed boundary-based ecosystem partnerships in Illinois, with similar trends nationwide. There are also Illinois Environmental Protection Agency and U.S. Environmental Protection Agency programs based on targeted watersheds for total maximum daily loads and nutrient standard applications, etc.

The Section has the technical expertise and also the experience to provide scientific leadership with better tools such as expanded watershed monitoring capabilities, improved modeling expertise, and broader efforts to restore and rehabilitate impaired streams and watersheds. Local, state, and federal agencies increasingly will need this type of expertise as watershed management and restoration plans are being developed.

One major watershed effort will focus on the most important river in the state, the Illinois River. The ISWS always has played an important role in keeping Illinois River issues in the public eye by providing the most relevant hydrologic, sediment, and water quality data and information. Now that state and local agencies have made major commitments to restore the Illinois River, many questions need to be answered before selecting the most effective projects and programs. Once again the WSS intends to play a key role in providing essential scientific data and information that can be used to select, implement, and evaluate Illinois River basin restoration projects and programs.

Efforts at ISWS also will include smaller watersheds within and outside the river basin. For example, WSS staff will continue to provide valuable data and information as local, state, and federal agencies are working hard to develop watershed management plans for the Kankakee River watershed in northern Illinois and the Cache River watershed in southern Illinois.



Historical average annual water levels in the Illinois River at Havana.

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Ground-Water Section

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Mike Snider empties an NADP bucket while in the field.

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Watershed Science Section

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Jim Slowikowski installs a transducer mounting bracket on Panther Creek.

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Dana Shackleford and Mike Machesky collect a sediment core in Peoria Lake.

HONORS

Kingsley Allan
Recipient, Illinois GIS Association Service Award for service to the GIS community, November 1999

James Angel
President-Elect, American Association of State Climatologists

Nani Bhowmik
Elected Fellow, International Water Resources Association

Deva Borah
Member, American Society of Civil Engineers Task Committee on Environmental Hydraulics (1999-2001)

Van Bowersox
Chair, Basic Sciences Division, Air & Waste Management Association

Mark Brooks
Symposium Vice-Chair, National Association of Corrosion Engineers 1999 Annual Conference, San Antonio, TX

Stanley Changnon
Member, Climate Research Committee of the National Academy of Sciences

Karen Harlin
Member, Standard Methods Review Committee, American Water Works Association; and Secretary, Environmental Quality Methods Committee, Association of Official Analytical Chemists International

Brian Kaiser
Member, Education Committee, Illinois Section of American Water Works Association

David Kristovich
Member, Boundary Layer Panel, "Workshop on the Midwest Collaborative Regional Climate Center," Argonne National Laboratory, Argonne, IL

Edward Krug
Listed in *Who's Who in Science and Engineering, Who's Who in America, Who's Who in the World* (Marquis), *2000 Outstanding Scientists of the 20th Century, and 2000 Outstanding Intellectuals of the 20th Century* (International Biographical Centre)

Kenneth Kunkel
Member, American Meteorological Society Committee on Biometeorology and Aerobiology

Shundar Lin
Life member, American Water Works Association, March 2000

Scott Meyer
Invited member, Northeastern Illinois Planning Commission Water Supply Task Force

Harry Ochs
Chairman and organizer, World Meteorological Organization Fifth International Cloud Modeling Workshop

Mark Peden
Member, American Society for Testing and Materials Executive Subcommittee on Sampling and Analysis of Atmospheres

George Roadcap
Recipient, Outstanding Contribution Award for organizing National Ground Water Association Midwest Focus Conference field trip, October 6-8, 1999

Jane Rothert
Chair, National Atmospheric Deposition Program Network Operations Subcommittee

Kent Smothers
Chair, Technical Committee T-7G (Corrosion and Its Control in Water-Supply Systems and Water-Using Systems in Buildings), National Association of Corrosion Engineers

Gary Stensland
Invited participant and presenter, "Where Air and Water Meet: The Role of Atmospheric Deposition in the Gulf of Mexico Hypoxic Zone" workshop sponsored by Ecological Society of America, September 26, 1999, New Orleans, LA

Derek Winstanley
Appointed, Research Committee of the Illinois Council on Food and Agricultural Research; Chair of Illinois Global Climate Change Task Force; External Users Advisory Committee of the Illinois-Indiana Sea Grant College Program; Science Advisory Committee to the Illinois River Coordinating Council; Illinois Department of Natural Resources Director's Science Advisory Council; Water Resources Advisory Committee to the Northern Illinois Planning Commission; National Academy of Sciences Blue Ribbon Panel on A National Digital Library for the Physical Sciences; and provided testimony to Agriculture Committee of U.S. House of Representatives on H.R. 4502, Water Pollution Program Improvement Act of 2000, and impact of EPA's TMDL rules on U.S. agriculture and silviculture, June 28, 2000

Bee balm is one of the many plant species found at Lake in the Hills Fen.

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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Associate Coordinator for Toxics and Mercury Deposition Network: Clyde Sweet, (217) 333-7191
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Restoration & Rehabilitation: Don Roseboom, Peoria, (309) 671-3196, Ext. 207
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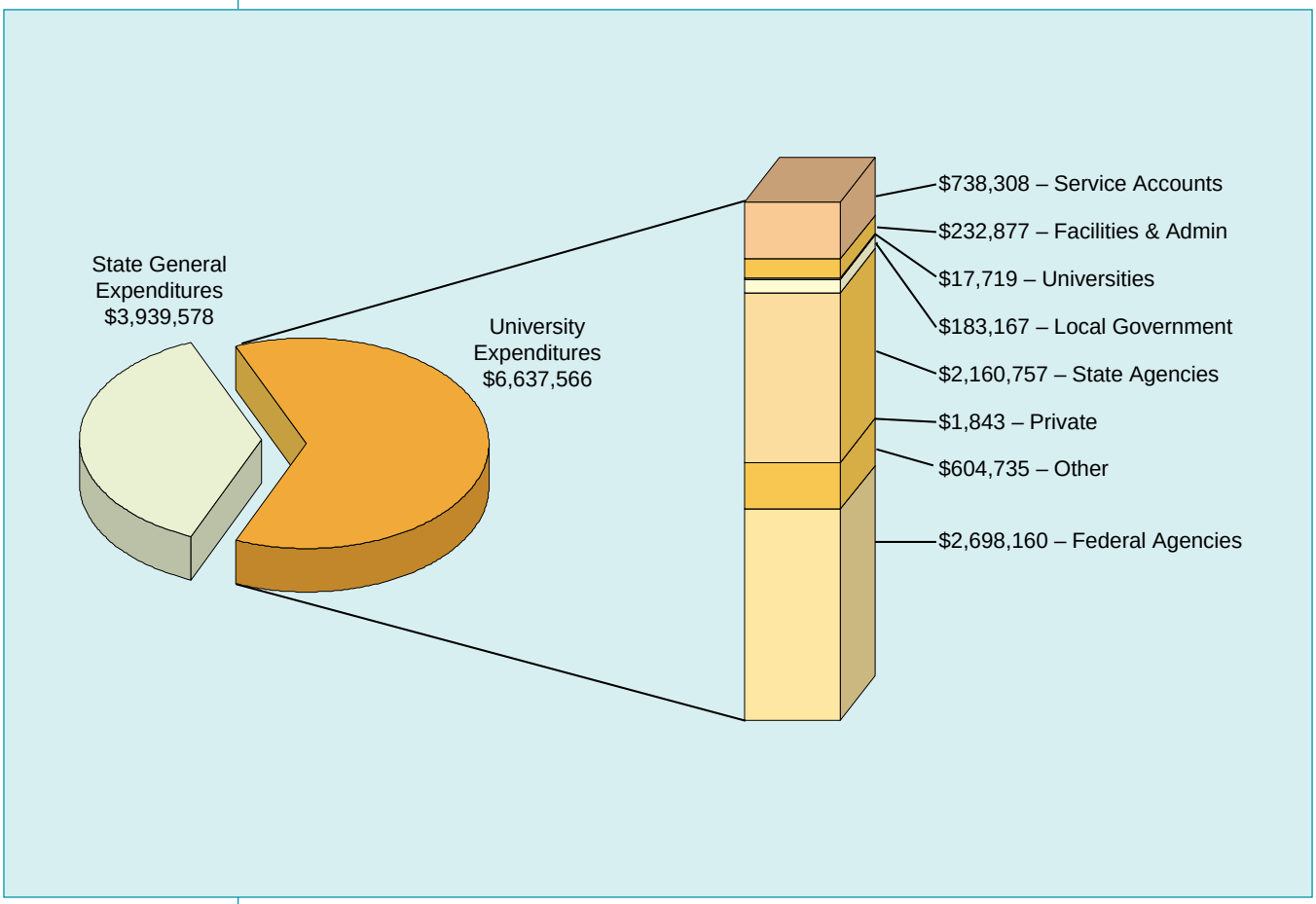
FINANCIAL STATEMENT, FY 00

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