Illinois State Water Survey
Annual Report 2004-2005

The Storm

Serving Illinois and the Nation

Illinois State Water Survey
Annual Report
July 1, 2004 – June 30, 2005

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Editor: Eva Kingston
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Front Cover: "The Storm" is a three-dimensional piece by Chief Derek Winstanley that includes a tornado (twisted bark), lightning (painted coral), and raindrops (crystals) against a painted backdrop.

Illinois State WATER Survey (1895)

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

ILLINOIS

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From the Chief's Desk

I am pleased to report that the Illinois State Water Survey (ISWS) continues to provide a wealth of scientific and engineering data for use by individuals, businesses, and government agencies throughout Illinois and the nation. The many uses of these data include education, research, natural resources planning, insurance, public health, transportation, policy analysis, agriculture, energy development, facilities maintenance, and construction. Below are examples of new and evolving ISWS products and services. More information is contained throughout this 2004–2005 *Annual Report*.

With release of the 310-page *Climate Atlas of Illinois*, more data and information are available about the climate of Illinois than any other area in the world. The atlas, with nearly 300 maps and graphs, and more than 80 photographs, focuses on the 20th Century and presents both spatial patterns and temporal distributions of climate conditions in Illinois. Chief Emeritus Stanley A. Changnon was the lead author.

The atlas provides answers to questions about all aspects of climate, including records of the warmest and wettest Illinois locations, and average annual snowfall amounts throughout Illinois. Individual chapters address factors that control climate and historical climate conditions; temperatures and precipitation, including snowfall; the statewide energy budget and wind conditions; special climate conditions caused by Lake Michigan, the southern hills, large cities, and human activities; atmospheric quality, including acid rain; climate extremes, such as droughts, cold winters, and various kinds of storms; outstanding weather and climate events of the 20th Century; weather conditions and air masses; and climate issues, such as global warming and El Niño. The atlas is available for purchase via the Web (http://www.sws.uiuc.edu/docs/climateatlas/).

Having the best Flood Insurance Rate Maps (FIRMS) possible is important because FIRMS are used for regulatory and flood-insurance purposes that promote responsible floodplain management, as well as to identify sensitive riparian corridors so that appropriate planning/mitigation efforts can minimize potential damage from natural disasters. Currently, however, many of Illinois' floodplain maps are outdated and available only in paper format.

Starting in 2004, Illinois took an aggressive step to remedy that with a new program at the ISWS, part of a collaborative project with the Federal Emergency Management Agency (FEMA) and the Illinois Department of Natural Resources, Office of Water Resources. This nationwide FEMA program will modernize floodplain maps over a 5-year period. New maps are being digitized by using the latest geographic information system and computer technology.

Heading up the ISWS Map Modernization Program is professional engineer Sally McConkey of the Center for Watershed Science. Already the ISWS is preparing digital maps for Clinton, Sangamon, Kane, Rock Island, and Champaign Counties. McConkey and the rest of the team will prepare maps for most counties in Illinois for this project. More information about FEMA's Map Modernization Plan is available on the Web (http://www.fema.gov/fhm/mm_main.shtm).

As population increases and the economy grows, so does the demand for water. But how much water will Illinois need in the future? To answer this question, the ISWS contracted with the Department of Geography and Environmental Resources at Southern Illinois University, Carbondale, to provide estimates of water withdrawals and use in Illinois counties to 2025. The principal outcome of this research led by Professor Ben Dziegielewski is a set of water-demand

Chief
Derek Winstanley

forecasts for seven water-use sectors in Illinois: thermoelectric, public supply, self-supplied commercial and industrial, irrigation, self-supplied domestic, mining, and livestock.

Total water use in Illinois is estimated to increase between 2000 and 2025 by nearly 28 percent, or more than 4.4 billion gallons per day. Nearly 82 percent of that projected increase in withdrawals is attributed to the thermoelectric generation sector, which is predicted to remain the largest water user in the state, and will continue to account for 84 percent of total withdrawals. Most of this water is recycled for the same use. Public water supply is projected to increase by 528 million gallons per day, or 31.5 percent.

The study demonstrated some of the challenges to the development of effective water-use forecasting in Illinois. The report is accessible via the Web (http://info.geography. siu.edu/projects/CountyLevelForecasts/FinalProductPDFs/ISWS%20IL%20Water%20Use%20Projections.pdf).

Dissemination of ISWS data, information, publications, and maps via the Web continues to increase. The user-friendly ISWS Web site (http:www.sws.uiuc.edu) is updated regularly with new materials. I encourage you to explore the site often.

Derek Winstanley, Chief

Water-Supply Planning

Drought returned to Illinois in 2005, again demonstrating the sensitivity of Illinois' ecological systems, economy, navigation, recreation, and public and domestic water supplies to climate fluctuations. All are dependent on the interconnected flows and reservoirs of shared water resources. Many water-supply problems can be avoided through rational, forward-looking planning and management, however.

Water-supply planning entails gathering and analyzing data and information required by decision makers in the wise management of water resources. The ISWS does not manage resources, but rather can facilitate that water-supply planning process and provide the necessary scientific and engineering data and information.

This aquifer test was in Piatt County on the Sangamon River.

In Illinois, public water supplies are managed in a decentralized manner by a plethora of individual communities and counties, and the private sector. Private water supplies, of course, are managed by individuals and individual companies. Water can be withdrawn from aquifers, rivers, and streams in reasonable quantities.

Many residents place high value on protecting property rights and maintaining minimal government intervention. Talk of improving water-supply planning and management can raise concern about increased government intervention and regulation. The ISWS remains neutral on proposed regulatory changes but does recognize a need and opportunity for improved water-supply planning and management within existing laws and regulations. The following goal and main components adopted by the ISWS encourage improved water-supply planning and management through steps that all communities and counties can follow.

Goal: To Ensure Adequate and Reliable Supplies of Clean Water at Reasonable Cost

Main Components in Water-Supply Planning

- Determine the capacity of existing water-supply facilities.
- Determine current water withdrawals, uses, and impacts.

- Determine potential yields and water quality from surface waters and aquifers under variable climatic conditions.
- Construct water demand scenarios.
- Identify and evaluate drought, climate change, and other risks and uncertainties.
- Present water-supply-and-demand scenarios (with uncertainties and risks).
- Evaluate the need for increasing water supply and/or decreasing demand.
- Identify and evaluate risks and costs (including negative impacts) of options for increasing water withdrawals, and/or decreasing demand.

Main Components in Water-Supply Management

- Define acceptable levels of confidence (risk) and costs in providing adequate supplies of clean water over a specified time period.
- Select and implement water-supply/water-treatment/water-distribution and/or water-conservation/water-reuse projects.
- Evaluate the need for changes to policies, regulations, and management strategies.

The ISWS also promotes adoption of an additional regional scale for water-supply planning and management in Illinois, as already is adopted in other states. Natural geographical entities for groundwater and surface water (aquifers and watersheds) extend across community and county boundaries. This does not mean that regional planning requires a new, higher level of authority than communities and counties, but rather it calls for a regional planning framework and a process of greater coordination and collaboration among communities and counties in a region.

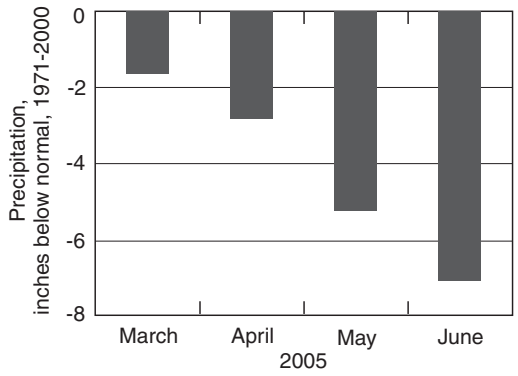
Withdrawals in neighboring counties can reduce streamflows and groundwater levels across county boundaries, so it seems reasonable to propose that planning and management of water supplies at the community and county level should take into consideration total water withdrawals from shared aquifers, rivers, and streams. Flows and pools of water in those rivers, streams, and aquifers are interconnected, making it reasonable to ask water-supply planners and managers to consider conjunctive use of surface- and groundwater.

Drought

Floods come and go over a few hours or days, but droughts evolve slowly over months, and one is never quite sure when a drought is over. Precipitation in Illinois was below normal in March 2005, but many months have below normal precipitation. Precipitation also was below normal in April and May. By the end of June, Illinois had experienced its third driest March–June on record since 1895. The 2005 drought at the start of and well into the growing season had negative impacts on agricultural production in Illinois. Nobody expected 2005 crop yields in Illinois to be as high as those in 2004, a record year; but nobody wanted a drought either.

In response to the drought situation, the Governor activated the Drought Response Task Force. Chief Winstanley serves on the Task Force, and ISWS scientists have prepared for the Task Force regular updates on climate, soil moisture, hydrologic, and groundwater conditions. By mid-summer the Governor sought and received from the U.S. Department of Agriculture disaster assistance to aid Illinois farmers. The worst hit area is north and west of a line from St. Louis to Chicago, where precipitation has been up to 10 inches below normal.

Not surprisingly, many rivers and streams, including the Illinois River, have experienced very low flows, even record low flows. Dredging and streamflow control by the U.S. Army Corps of Engineers have kept navigation channels open for barges on the Illinois and Mississippi Rivers. Communities throughout northern Illinois adopted water conservation measures as water-supply systems struggled to cope with higher demand for water. Large



Illinois monthly cumulative precipitation departure, March–June 2005.

amounts of groundwater were withdrawn for irrigation in sandy areas of Lee, Whiteside, Mason, and Tazewell Counties. Some domestic wells went dry and new wells were drilled; pumps in other wells were lowered because of falling groundwater levels.

To facilitate pooling and sharing of drought information, the ISWS established a drought Web site (http://www.sws.uiuc.edu/hilites/drought/). In addition to real-time streamflow data, current climate conditions, agricultural summaries, and press releases, the site includes regular updates from Task Force representatives with other State agencies.

Droughts occur periodically in Illinois and, judging from climate statistics, Illinois was due for another significant drought. The last comparable drought was in 1988–1989, and climate records show that droughts occur, on average, about once per decade. Those records also show that droughts can last for more than a year, and it's not always clear whether any tantalizing rain signals an end to the drought or merely a brief respite.

As Yogi Berra might say, you only know a drought is over when it is over. In response to the drought, and to capitalize on emerging scientific capabilities, the ISWS has launched a one-year pilot project to evaluate the feasibility of issuing probability forecasts of drought and other climate extremes one to three months in advance.

Water-Supply Planning in the Lake Michigan Area

STRADDLING THE DIVIDE CONFERENCE

When seeing vast Lake Michigan from a Chicago vantage point, it is hard to imagine that communities in the surrounding region could be concerned about water shortages. Yet international treaties and U.S. Supreme Court decrees restrict water diversions from the Great Lakes, forcing the region to use alternative water sources to serve a rapidly growing population.

Census-based forecasts project that future growth patterns in Wisconsin, Illinois, and Indiana along Lake Michigan will present distinct challenges for regional planners. Growth trends in those states are west of built-up land ringing the lake in southeastern Wisconsin, in northeastern Illinois suburbs furthest from Chicago, and far south of the lake's industrialized strip in northwestern Indiana. In essence, population and land development are increasing where Lake Michigan water is not available, intensifying the need for careful planning to sustain groundwater and meet future demand.

Lieutenant Governor Pat Quinn delivers the conference's keynote address.

In response to the clear potential for supply shortages, the Northeastern Illinois Planning Commission and the ISWS, with support from the Joyce Foundation, organized "Straddling the Divide," a two-day conference in Chicago last February, to foster dialogue among engineers, planners, scientists, politicians, and others interested in maintaining and increasing water supplies for the region.

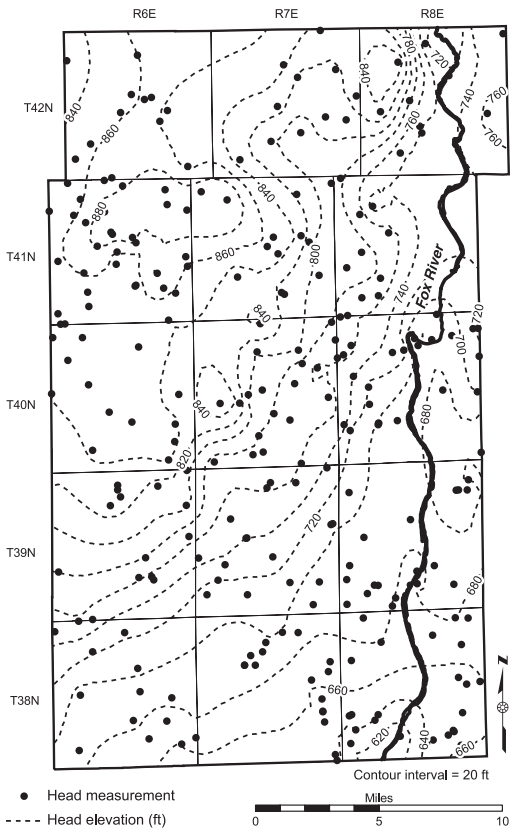
More than 200 attendees from Illinois, Indiana, Michigan, and Wisconsin included representatives from municipalities, government councils, regional planning commissions, state and federal agencies, consulting firms, and universities. Invited presentations discussed policy, and engineering and scientific issues regarding the region's water resources. Illinois Lieutenant Governor Pat Quinn delivered the keynote address. A link to conference presentations is available on the Web (http://www.nipc.org/environment/slmrwsc/conferences/).

Focusing on Kane County

Population and economic growth by 2025 are expected to cause water use in suburban Kane County to increase by more than 45 percent. Because further large-scale diversions of water from Lake Michigan are unlikely, local groundwater resources and the Fox River will need to accommodate this increase. In addition to competition for these resources, climate change and urbanization pose threats, creating a challenge for Kane County water-resource managers. That's why they turned to the Scientific Surveys. Several studies over a 5-year period are focusing on protecting water quality and availability in Kane County. Among the most recent products are several publications.

Water-level (head) maps in an *Interim Report on Shallow Aquifer Potentiometric Surface Mapping* (http://www.sws.uiuc.edu/pubs/pubdetail.asp?CallNumber=ISWS+CR+2005%2D04) can be used to characterize regional flow, identify areas of recharge and discharge, assess regional effects of withdrawals, and provide a basis for comparison with future conditions.

Temporal Changes in Deep Bedrock Groundwater Quality in Northeastern Illinois (http://www.sws.uiuc.edu/pubs/pubdetail.asp?CallNumber=ISWS+CR+2005%2D05) concludes that withdrawals from deep bedrock aquifers in the Chicago region may have increased concentrations of total dissolved solids in some areas, a trend that eventually could limit use of deep bedrock for water supply.



This is the fall 2003 head map for the shallow bedrock aquifer (from ISWS Contract Report 2005-04).

Shallow Groundwater Sampling in Kane County (http://www.sws.uiuc.edu/pubs/pubdetail.asp?CallNumber=ISWS+IEM+2005%2D01) shows degraded water quality in urban portions of Kane County, possibly by road-salt runoff, vehicular exhaust, and industrial discharges. Studies will conclude in 2007.

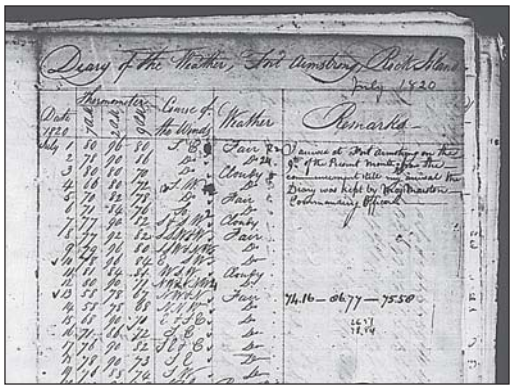
Nineteenth-Century Weather Data

The Midwestern Regional Climate Center is leading an effort to digitize historical daily weather data from 150 priority U.S. stations in a multi-year project with the National Climatic Data Center (NCDC). Digital availability of these records will extend analyses of U.S. climate back to the 19th Century, very useful for determining long-term weather and climate trends and as input data for modeling future trends.

Those daily observations of temperature, precipitation, humidity, cloud cover, wind speed, and other variables were made both as part of the U.S. military record (from forts) and by volunteers under the supervision of various agencies such as the Smithsonian Institution, the Signal Service, and the U.S. Department of Agriculture.

Funded through the National Oceanic and Atmospheric Administration's NCDC Climate Database Modernization Program, scanned versions of the actual weather documents are on line. Data from 50 stations have been digitized, with projected completion of all 150 priority stations within two years. With continued funding, records from the many thousands of other stations available eventually may be digitized for use in various climate research projects.

In an associated project, libraries and historical archives nationwide are helping provide details on how those weather observations

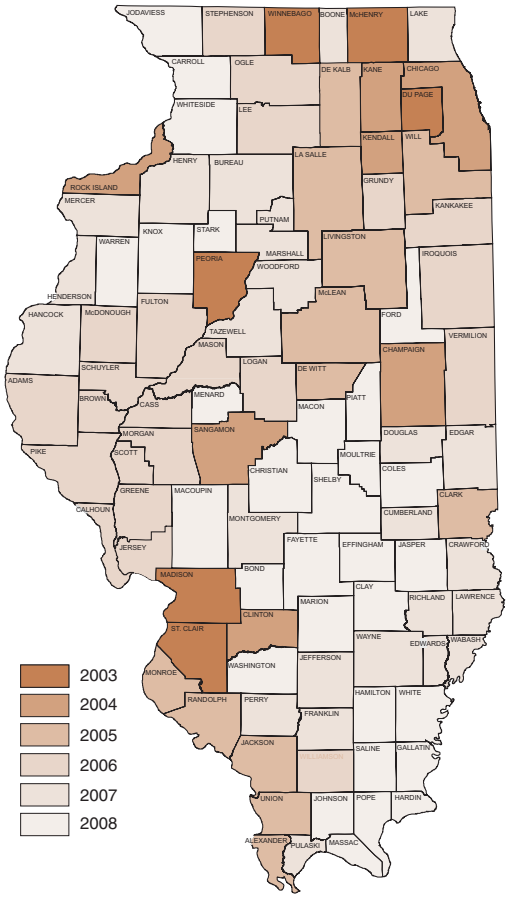


Digital records of historical weather data will be used to determine long-term trends and to model future trends.

were taken, including instrumentation, exposure and time of day, as well as about the observers and their motivations for recording weather. That information is being incorporated into histories for the 150 priority stations, and 28 histories already are on line. Each history begins with the first observations at a station and continues through at least 1948, but most are complete through the present. For additional information, refer to the project Web site (http://sisyphus.sws.uiuc.edu/research/research.htm).

Floodplain Mapping Program

Today, primarily paper maps depict flood hazards in Illinois. These Flood Insurance Rate Maps (FIRMs) are used for regulatory and flood insurance purposes, as well as to identify sensitive riparian corridors. Many of Illinois' FIRMs (and those of other states) are outdated by as much as 20 years and have an average age of 9 years. With Congressional funding, the Federal Emergency Management Agency (FEMA) has launched a billion-dollar, 5-year Map Modernization Program to develop fully digital floodplain maps nationwide. The new maps use geographic information system (GIS) technology and stress local involvement to ensure data incorporated are up to date and accurate.



This is the time line for floodplain map modernization in Illinois.

Recognizing that program participation benefits the people of Illinois by providing State expertise for the best mapping product possible, the Illinois Department of Natural Resources has signed a Cooperating Technical Partnership Agreement with FEMA. The Office of Water Resources and the ISWS are working jointly to prepare floodplain maps for most of Illinois following the new digital standards.

The ISWS is providing the technical expertise to prepare the digital products and conduct new hydrologic and hydraulic flood studies in critical areas. Work began in 2004 to prepare digital maps for five counties in Illinois; over the next 5 years, the ISWS will prepare maps for the majority of counties in Illinois.

Professional engineer Sally McConkey heads the Floodplain Mapping Program in the Center for Watershed Science. Other staff include GIS professional Kingsley Allan; senior engineer Paminder Parmar; and GIS specialists Melony Barrett, Phil Graff, Lisa Verhelst, and Tolga Yilmaz, who each bring a wealth of expertise. Engineers Amanda Flegel and Kostas Aristeidou and four GIS interns joined the team in spring 2005. As more map projects are added, program size is expected to double. More information about FEMA's Map Modernization Plan is available on the Web (http://www.fema.gov/fhm/mm_main.shtm).

Water Survey Measuring/Monitoring Instruments

Infrared and thermocouple sensors on a weather tower measure temperatures within and above a crop canopy of soybeans for comparisons to sensors at the same levels over sod at an adjacent ICN site. Also being measured for similar comparisons is the soil moisture at various depths underground.

Each week Mike Snider removes the sample from the wet deposition collector attached to the raingage at this monitoring station, which is just one of MDN's 90 sites nationwide.

Ruth Ann Nichols prepares PSL samples for arsenic analysis using a graphite furnace atomic absorption spectrometer.

Hydrologists log groundwater levels during an aquifer test at Paris, Illinois.

Josh Stevens uses a YSI 6600 data sonde to measure water quality in Court Creek in the Spoon River watershed. The data sonde can be left in the water to provide measurements every 10 minutes over a 2-week period.

Under supervision of Bob Olson and Ken Hlinka (left to right) an Albrecht Drilling crew installs an observation well for the ICN site at Big Bend.

OFFICE OF THE CHIEF

Extension and Education Activities

Illinois State Water Survey (ISWS) scientists regularly participate in outreach activities that range from working directly with students and teachers to making presentations for various groups or talking with the media to staffing booths and providing displays and materials for State Fair and other public events. All are ways of promoting stewardship of Illinois' natural resources, fostering public understanding and support of environmental programs, or nurturing an interest in science.

Regional, State, and National Science Contests

Annual Science Olympiad (http://www.illinoisolympiad.org/) contests at regional, state, and national levels test teams of students from middle schools or high schools in 23 events spanning chemistry, physics, biology, and environmental sciences. Twelve ISWS staff from different disciplines were involved in various capacities.

Together with University of Delaware scientists, they wrote, prepared, proctored, and scored three-part water-quality exams at the national level, or collaborated with University of Illinois at Urbana-Champaign (UIUC) Department of Atmospheric Sciences faculty to write meteorology tests for middle schoolers at all contest levels, or coached middle schoolers about aquifers in preparation for regional and state contests, or proctored high-school forensics exams, or judged the aquifer event at the national contest.

Students use a home-built salinometer to determine the salt content of two solutions for the National Science Olympiad finals.

Volunteers for the National Science Olympiad stand before the ISWS plaque outside Noyes Laboratory, the site of the water-quality event.

Six of the 16 teams at the regional competition, held at Urbana Middle School in March 2005, participated in the water-quality event, which covered freshwater and estuarine ecology, water treatment, water-resource management, pollution detection/assessment, and aquatic chemical processes. Testing included a written exam, identifying macroinvertebrates and aquatic nuisance plants, and measuring saltwater concentrations with student-built salinometers. Based on

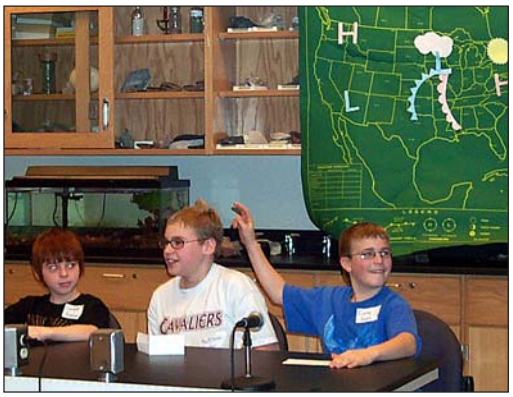
combined test scores from all 23 categories, 75 teams from that competition and others throughout Illinois advanced to the state competition at the UIUC in April 2005.

The UIUC also hosted winning teams from 60 middle schools and 60 high schools nationwide at the National Science Olympiad in May 2005, the first time for these finals in Champaign-Urbana. High-school gold medalists and team champions received four-year undergraduate tuition waivers and middle-school winners received $2,000 annual scholarships contingent upon eventual application/acceptance for UIUC admission. The mission of the Science Olympiad, a nonprofit organization, is to promote and improve student interest in science and improve the quality of science education nationwide.

Other Outreach Efforts

Groups of students and their teachers frequently come to the ISWS for in-house presentations/demonstrations/tours. Earthscope Campers from the Urbana Park District learned about water as a natural resource. Continuing support of the Urbana Middle School *WaterWorks* program entailed sponsoring field trips to the ISWS and the Boneyard Creek, as well as before and after classroom visits to introduce new concepts, review topics covered, and interpret student-collected data.

Staff also traveled to hands-on science and math fairs in northern Illinois offered by Heartland Community College for elementary students to staff exhibits or give talks or went to various schools to teach students of all ages. Elementary students learned about different chemistry concepts. A seminar for the environmental ecology class at Parkland College discussed water issues. Presentations on various science topics also were made at teacher workshops/conventions, to other public groups at their meetings, or at informational/educational events such as the State Fair.

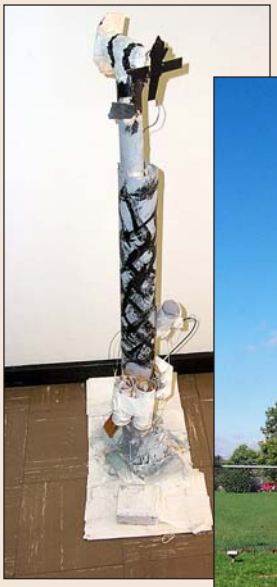


Students prepare to televise their weather forecast after calculating percent relative humidity, wind speed, and wind direction.

Mary LeFaivre describes how she uses math in her profession.

More than 30 staff members provided support for the ISWS State Fair booth, which featured rotations of two interactive educational events daily, the ever popular Hydro-House, and some giveaways. Fair-goers spun the "Water Wheel" to determine a category and then tested their knowledge of groundwater, surface water, or various types of precipitation. Others took the "H_2O Challenge" and found they preferred the taste of tapwater over distilled water, or chose a free raingage and instructions for Rain Check Network participation, or conducted a chemistry experiment to "Test the Waters" for pH and other variables.

Children spin the ISWS "Water Wheel" at State Fair.



As part of educational outreach activities, Dave Kristovich gave a tour of the National Oceanic and Atmospheric Administration Cooperative Observer site to University Primary School students. Sculptures shown are the students' renditions of weather instruments they saw and their interpretations of how they work. Their visit was part of a larger project on water and its importance.

We made the anemometer that tells us how fast the wind is going and to tell us if the tornado's coming. We made it out of cardboard boxes, and wires, and painted all the details. It took a long time to get it to stand up. We used boards on the bottom and taped it so the pole could stand up. We also used blocks and wooden pieces to make it balance. Meena and Abby

I made the rain gauge. The huge bucket collects water, and it measures the water to find out how much it rained. I used small plastic containers, cardboard tubes, and caps of bottles to make the weather instrument. Andrew

Gulf Hypoxia

Reduction of dissolved oxygen to 2 milligrams per liter or less is called hypoxia, which kills many species of desirable marine organisms. Unfortunately, hypoxia is occurring in some of the richest fishing grounds of the United States, bottom waters of the Gulf of Mexico on the Louisiana/Texas continental shelf west of the Mississippi River.

Since measurements began in 1985, Gulf hypoxia has doubled in size, an increase blamed on increased nitrogen loading from the Mississippi/Atchafalaya River basin (MARB), which includes Illinois. Thus, federally coordinated plans for controlling Gulf hypoxia are being made: the first Action Plan was published in 2001, and an updated version is due out in 2006. The 2001 Action Plan recommended reducing MARB nitrogen loading to the Gulf by 30 percent to reduce Gulf hypoxia to one third of its current average size. However, ISWS analysis shows that while average size of Gulf hypoxia has doubled since 1985, nitrogen loading has not increased. Published findings will be provided as input to the 2006 Action Plan.

WARM Program Provides Crucial Data for Illinois

The Water and Atmospheric Resources Monitoring (WARM) Program (http://www.sws.uiuc.edu/warm/) disseminates information from long-term networks across Illinois that monitor climate, soil moisture, flows in streams and rivers, and water levels in reservoirs and groundwater. Those data also document standard conditions, making it possible to categorize severity of extreme events as they occur and their potential impacts on water resources.

The 19 automated Illinois Climate Network (ICN) sites have been monitoring weather and soil surface conditions across Illinois since 1989. Besides creating a historic database, daily data computations generate weather and soil temperature records, and crop pest and growing degree-day information used by agribusinesses to track potential pest development and schedule postharvest applications of nitrogen fertilizer.

Several endeavors during summer 2005 demonstrate benefits/outcomes of the WARM Program. For example, data from the ICN Bondville site are being used to test representativeness of weather and soil moisture conditions over and under a grass canopy (a world standard) with similar measurements from adjacent corn and soybeans fields. Research with the Department of Materials Science and Engineering at the University of Illinois is assessing viability of solar energy in Illinois by combining historic ICN solar radiation data with current photovoltaic technology. Other work will monitor winds from two existing tall towers to determine wind-energy potential in south-central and north-central Illinois, using nearby ICN sites for climatological reference.

The 18-site Soil Moisture Monitoring Network has been collecting nationally unique data for nearly 25 years. Those monthly and bi-monthly data, soon to be merged with continuous ICN observations, are critical for early detection of extreme conditions, such as the 2005 drought, and their potential impacts on water resources.

The 15-site Benchmark Sediment Monitoring program has been collecting weekly suspended sediment data throughout Illinois for nearly 25 years. Research using these data contributes to understanding variations and trends in sediment transported from watersheds for land-management practices and stream restoration.

The ISWS began recording monthly readings from public water-supply reservoirs in 1983, and currently collects data from 35 locations, roughly one-third of all such reservoirs in Illinois and most potable water sources. These data are particularly useful in determining relative severity of impacts and projected water-supply shortages during droughts or reservoir drawdown. Monitoring also provides historical data for examination of reservoir water budgets and supply yields.

Data generated by the 15-site Shallow Groundwater Network have been used to answer inquiries about groundwater conditions throughout rural areas in Illinois for more than 50 years at some locations. Analyses of those data also provide insights about severity and extent of impacts from droughts and other extreme events.

This solar panel supplies power for a soybean field site.

What's New on the Web

The number of ISWS Web site (http://www.sws.uiuc.edu/) users increased by 15 percent in Fiscal Year 2005, the seventh consecutive year of growth. More than 1,571,000 user sessions are a result of site expansion and continual updates with press releases and other news items, publications, downloadable data, and other information.

The State Climatologist's database (http://www.sws.uiuc.edu/data/climatedb/) has been expanded to include 98 more reporting stations and seasonal data for all 117 long-term stations with more than 100 years of records. Annual and monthly data also are available.

Illinois residents can keep abreast of current and past drought conditions and related information for Illinois from a special drought Web page (http://www.sws.uiuc.edu/hilites/drought/). There are links to press releases; monitoring, streamflow, and soil moisture data; and related climate and weather analyses/data.

Work on development of a form for metadata capture is progressing. Eventually, as ISWS databases are completed and catalogued, metadata records will be indexed, fully searchable, and accessible from a point-and-click interface.

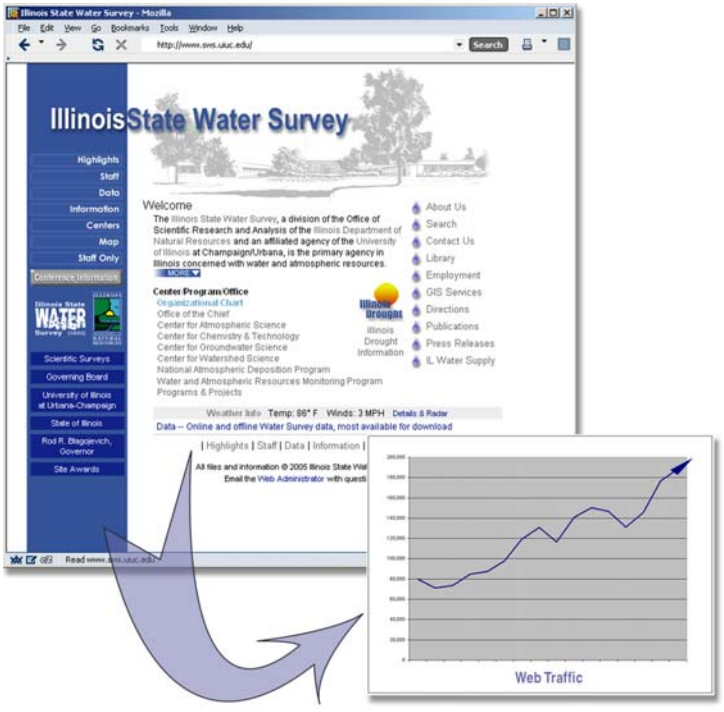
A new weather information page (http://www.sws.uiuc.edu/hilites/drought/) for Illinois is available from the ISWS home page. In addition to temperature and wind speed, wind gusts, wind direction, relative humidity, dewpoint, barometric pressure, solar radiation, 4- and 8-inch soil temperatures, visibility, and links to other information are available. The new weather and climate feed was updated to capture National Oceanic and Atmospheric Administration and National Weather Service data. Look for a 7-day hourly data history page with graphing capability soon.

Additional search criteria were added to the ISWS Publications Database advanced search engine (http://www.sws.uiuc.edu/pubs/advsearch.asp), an improvement further enhancing access to data/information that ISWS scientists include in their publications. Searches by county or even narrowing the focus to publications with abstracts and/or full-text on-line versions are offered in addition to previously searchable categories (title, author, feature, subject, year, and publication type).

An Education/Outreach section (http://www.sws.uiuc.edu/chief/educatoutreach.asp) highlights Surveywide efforts with elementary and secondary students. The site lists ISWS-designed activities such as the interactive Rain Check Network from which children may request a free raingage and then enter their local rainfall amounts into a searchable database. In conjunction with teachers nationwide, the National Atmospheric Deposition Program also has an educational site (http://nadp.sws.uiuc.edu/cal/Educational_Information.htm) for children to participate in an experiment about acid rain.

More ISWS Web pages were updated to reflect the redesign initiated last year (http://www.sws.uiuc.edu/hilites.asp) to increase browser compatability and ease of site navigation. Surveywide content updates also are progressing, including most content from the Center for Atmospheric Science and various updates for other ISWS Centers.

The ISWS site continues to attract new users from more than 1,000 search engines, including Google and Yahoo! Searches usually rank the site among the top 10 results for most popular search engines, sometimes even in one of the top two slots. The Web group includes the Illinois State Water Survey (http://www.sws.uiuc.edu/), the Midwestern Regional Climate Center (http://mcc.sws.uiuc.edu/), and the National Atmospheric Deposition Program (http://nadp.sws.uiuc.edu/).



The ISWS Web site attracts more and more users each year.

Geographic Information Systems

An enterprise Geographic Information System (GIS) strategic plan has been developed for the ISWS. The strategy promotes and facilitates use of GIS technology in water and atmospheric resources research; increases accessibility to accurate geographic information for researchers, decision-makers, and the general public; strives to develop innovative applications for expanding GIS-assisted research; and provides staff with technical assistance and software training. Provision of better GIS services/resources with timely information also will help ISWS staff better serve Illinois residents.

To support GIS activities, the ISWS manages a dedicated GIS server for developing and publishing data. The server provides a high-performance environment for collaboration and data sharing among 50 staff members. Among the resources available to staff are enterprise geodatabases storing more than 230 production datasets, a fully searchable GIS metadata catalog, storage space for staff GIS projects, and electronic documentation for GIS software. In addition to improving data accessibility, a new internal Web site created specifically for ISWS staff also fosters knowledge sharing. Other projects include developing Web mapping applications for sharing data externally and expanding the ISWS map series (http://www.sws.uiuc.edu/docs/maps.asp).

Quality Assurance Program

The Quality Assurance Program at the ISWS oversees quality of data collection and generation, and verifies that data quality and quantity support the intended use. The Quality Assurance/Quality Control (QA/QC) Committee maintains and annually updates the ISWS Quality Management Plan (QMP). That document describes processes and procedures for collecting and reporting environmental data and uses a national consensus standard and guidance documents from other agencies to ensure inclusion of basic elements of quality planning. It encompasses all ISWS environmental data collection and reporting programs that involve research and development, monitoring, laboratory operations on environmental samples, and modeling.

The QA/QC Committee also serves as a resource for staff developing project-specific plans, procedures, or quality system documents. In addition to providing inventories of ISWS QMPs, QA project plans, and standard operating procedures, the Committee's internal Web page contains hot links to relevant topics elsewhere on the Web.

Program Planning and Management

Planning and management of programs, facilities, equipment, budgets, and staff are accomplished through the Water Survey's Strategic Plan. An annual update of the plan, including current year action items, has been completed. This plan will be coordinated with the Department of Natural Resource's Strategic Plan and the evolving UIUC Strategic Plan.

The Scientific Surveys continue to work with the Department of Natural Resources and the UIUC to determine the feasibility of transferring the Scientific Surveys' State-appropriated funds to the University of Illinois as a grant after the appropriation process.

This plan, if implemented, would relieve the Surveys of using separate payroll, purchasing, and accounting systems, providing many efficiencies, and would reduce administration related to these activities.

Capital Project Update

The Water Survey Research Center (WSRC) has been undergoing construction and renovation.

Maintenance/Shop Building Construction

The facility will provide approximately 14,000 square feet of new space housing repair shops (electrical and machine), research laboratories, field staging area, offices, loading dock, mail room, and storage. Much of the site work has been completed, including installation of the drainage system, relocation of buried utilities, and foundation construction. Construction of the new building has progressed slowly, with several false starts. The contractor's revised timetable is that the new building will be available for occupancy in late February 2006.

Mechanical/Electrical System Upgrade and Replacement

The WSRC's centralized boilers and chiller system are being replaced. The electrical distribution system also is being renovated. Work involving replacement of the boilers and chiller system necessitated temporary relocation of the library and some laboratory support functions normally housed in Building 2 of the WSRC, where the boiler room also is located. The boiler room is being equipped with new hot water boilers, new chiller system, and new make up air system for the WSRC laboratory facility in Building 3.

Climate Science Applications for Illinois

Illinois and its economy have substantial vulnerability to weather and climate variations. Several examples illustrate recent studies and product development efforts pursued by the Center for Atmospheric Sciences to help Illinois cope with those variations.

Explaining Record 2004 Crop Yields

Exceptionally high yields of all major crops during the 2004 harvest across Illinois were unusual, which merited study. Statewide corn yields averaged 180 bushels/acre, 16 bushels/acre above the 2003 record, and there were record highs in all nine crop districts in Illinois. Statewide soybean yields averaged 50.5 bushels/acre, 5 bushels/acre above the 1994 record.

It was also the first time in history that all major crops exceeded all prior records in the same year, not just in Illinois but in most of the Midwest as a result of unique conditions across the entire Corn Belt. Record highs for corn and soybeans averaged 7–33 percent above previous yield records in Illinois, Indiana, Iowa, Kentucky, Missouri, Nebraska, and Ohio, with near record yields in Kansas, South Dakota, Wisconsin, and Minnesota.

A major challenge proved to be detecting and defining weather conditions that had made this happen. Clearly, crop experts did not detect critical atmospheric conditions during the growing season, including a summer of temperatures below average and rainfall near average. Yield predictions issued during the growing period and through August failed to anticipate the high magnitude of the corn and soybean yields that actually occurred across the Midwest. This was also true for the sophisticated crop-weather models relying on daily temperature and rainfall data. Predictions and model-generated yields were 7–15 percent under final corn yields for the Corn Belt, and 15–33 percent under final soybean yields for the Midwest. In essence, weather conditions critical to generating record high yields of all Midwestern crops were not detected.

Upon examination of historic climate records, ISWS climatologists experienced with weather-crop conditions found strong

Weather during 2004 was near perfect, resulting in record yields from all major crops in most of the Midwest.

evidence that the number of sunny days that summer were 50–120 percent above average, enhancing photosynthesis in all Midwestern crops. When frequent clear days had occurred in previous summers, temperatures were much above average and rainfall was below average, as in the 1930s. Temperatures in 28 of the 33 summers with frequent clear skies between 1888 and 2003 averaged 1.2–4.5°F above the long-term average.

Summers with frequent clear skies, cool temperatures, and above average rainfall had occurred only in 2004 and 1927. There were many more clear skies in 2004 than in 1927, and rainfall amounts in June and August both years were of different magnitudes. Study of previous summers with cooler temperatures in all three summer months, such as those in 2004, found 26 similar summers between 1887 and 2003. Sky conditions with these cool summers were cloudy, unlike the clear skies in 2004 or any summer over the past 120 years.

The 2004 weather patterns revealed that sunny, cool conditions that year were due to 20 Canadian cold fronts across the Midwest during June–August. Strong high-pressure systems persisting for days followed. Each such intrusion brought temperature decreases of 5–15°F, then several clear days. High-pressure centers dominated the unusual atmospheric circulation and kept many warm, stationary fronts from the Midwest, reducing the number of warm, humid days.

The net effect of this near perfect crop weather was an 11.74-billion-bushel national corn harvest and a 3.15-billion-bushel soybean harvest, more than 10 percent above past record totals and 30 percent above the nation's 1994–2003 average grain production. This increased production at standard prices was $14 billion above average 1994–2003 farm incomes. The U.S. Department of Agriculture reported that the huge harvest, coupled with strong crop prices, resulted in U.S. farm income totaling $73.7 billion in 2004, 25 percent above any prior year.

Average 2004 income for Illinois grain farmers was $92,000, nearly double that in 2003, and $40,000 above the 1999–2003 average. Farmland prices reached $5,000 per acre, and agribusinesses also benefitted. For example, sales of tractors and combines raised John Deere's Third Quarter earnings by 32 percent.

Better in-season monitoring of sky conditions is necessary. If satellite data were used to define sky cover at a county scale, those values could be used to estimate solar radiation for input to sophisticated weather-yield models, resulting in better yield predictions.

Climate Change

The sensitivity of Illinois to climate variability, as noted by the previous examples, underlies a concern about the nature of future changes and trends, with the possibility of substantial economic, environmental, and social impacts. The ISWS continues to study this issue to reduce uncertainties about the future. Key focuses of this effort were development and application of regional climate and air-quality models, development and analysis of historical climate datasets to better understand past changes, analysis of simulations from global models, and study of the potential for carbon sequestration in Midwestern agricultural soils.

Simulations from nine global models were analyzed with respect to their ability to simulate the present-day climate of Illinois and the Midwest. No specific systematic biases characterized all models with one prominent exception: all models simulated drier than observed fall conditions. Atmospheric wind-flow patterns simulated by the models contain essential features of the observed flow, although subtle differences are important to the simulation of climate conditions in Illinois. Several models reproduce many observed features, but no single model is clearly superior to all others, strongly suggesting that multiple models must be analyzed to establish uncertainty bounds for the future climate. Model simulations of the response of the climate to doubled carbon dioxide show substantial warming of 4–12°F in summer and 10–16°F in winter, larger changes than what occurred in the 20th Century. Precipitation changes are mostly positive, but the magnitudes of changes are mostly less than what occurred in the 20th Century.

A puzzling characteristic of Illinois' climate has been the lack of a 20th-Century warming trend when global temperature trends are definitely upward. Analysis of more than 50 new simulations from 18 global climate models shows that trends in this region can be highly variable and often different than global trends. This seemingly contradictory behavior may reflect natural variations. Implications for the future are that there will continue to be considerable uncertainties.

Although global models are an important tool in understanding future changes, research during the past year shows that regional

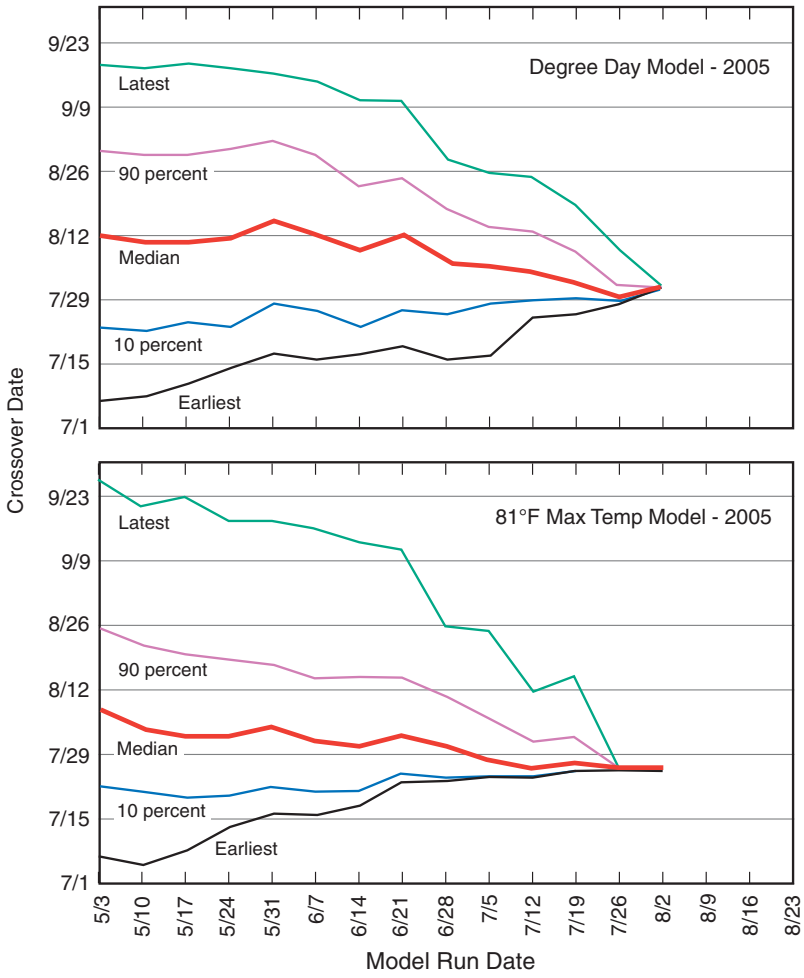
models provide more credible simulations of the climate of Illinois, especially precipitation. The ISWS' regional climate models were improved through inclusion of more accurate land surface conditions, particularly albedo, and more appropriate physical parameterizations. Those changes led to better simulations, particularly related to precipitation. These improved models are being used to simulate the future climate of Illinois.

Exchange of carbon between the atmosphere and land surface has been measured near Champaign since 1997. Data analysis indicates a net positive accumulation of carbon in soils in no-till fields of corn and soybeans in rotation. These data indicate the potential for using no-till practices to sequester carbon in soils, thus reducing carbon emissions as a greenhouse gas that contributes to global warming.

Estimating Risk of West Nile Virus Transmission

Culex restuans, the white-spotted mosquito, and *Culex pipiens*, the northern house mosquito, are believed to maintain the natural transmission cycle of West Nile Virus (WNV) between birds and mosquitoes. The population of northern house mosquitoes, the primary suspect for transmission to humans, is low in spring but becomes the dominant species later in summer, especially in urban areas. "Crossover" is when relative proportions of both species are equal during this transition from early season dominance of *Cx. restuans* to late season dominance of *Cx. pipiens*. On average, crossover occurs in early August. However, there is considerable variability from year to year, ranging from early July to mid-September, which also introduces considerable variation in the risk of WNV infection in a particular year.

Scientists at the ISWS and the Natural History Survey collaborated to investigate how weather affects the crossover data and found that simple models based on temperature can explain much of the variance in the crossover date. Two models were particularly effective: one based on the number of days when the maximum temperature exceeds 81°F, the other based on degree days with a base of 63°F. The models were used to produce a risk assessment analysis to estimate probabilities that crossover will be earlier or later than normal. The study also resulted in a special Web page (http://sisyphus.sws.uiuc.edu/research/westnile/index_anim.htm) for use by public health professionals in Illinois to alert them when WNV is most likely to pose a threat.



These charts show model results for 2005, a year when WNV infections increased following lulls during 2003 and 2004. Models were run weekly starting in early May to provide a probabilistic outlook of the likely crossover date when risk of human infections increases. Early in the season, the possible range of crossover dates is quite large, with both models predicting the second week of August as the most likely date. Because of frequent warmer than normal weather during summer, model predictions shifted to earlier dates as summer progresses. The final estimate of both models was late July, in good agreement with subsequent analyses of field collections of mosquitoes.

CENTER FOR CHEMISTRY & TECHNOLOGY

Serving Illinois and the Nation

Center for Chemistry & Technology (CCT) programs provide support for the analytical needs of researchers at the Illinois State Water Survey (ISWS) and the University of Illinois for projects on groundwater, surface water, public drinking-water systems, private wells, and heating/cooling systems for state facilities. They also help private citizens, state facilities/departments, and small public water systems solve water-related problems in Illinois and throughout the Midwest. Such support and assistance take the form of direct interactions, outreach, and funded research projects addressing critical needs.

Public Service Laboratory

The Public Service Laboratory or PSL (http://www.sws.uiuc.edu/chem/psl/) has been serving Illinois since the ISWS was founded in 1895. Requests for analytical services, advice, and referrals come from private well owners, well drillers, engineers, farmers, university/institutional administrators, equipment dealers, government/public health officials, recreational managers, health care professionals, and concerned citizens. Last year the PSL responded to more than 530 informational requests and analyzed more than 450 samples.

The majority of calls to the PSL are about water quality in private wells.

Private well owners often have questions/problems with stained laundry or fixtures, unusual tastes/odors, plumbing, effectiveness of water treatment, or general quality of household water. Farmers may be concerned about their water supply, especially if they experience a high death rate among livestock or have irrigation problems. Doctors may submit water samples for patients on low-sodium diets, while dentists are more interested in fluoride analyses of water for their patients.

Sometimes, laboratory services can prevent potential problems. For example, the PSL has been helping the Barrington Area Council of Governments (BACOG) determine water quality of aquifers that supply 35,000 residents in municipal and unincorporated areas of Lake, Cook, McHenry, and Kane Counties. Information supplied by the PSL will be used to investigate possible water contamination and consumption issues, to seek project funding, to define law on groundwater withdrawals, and to forecast population growth within BACOG boundaries. Data produced already have proven valuable for land-use and environmental protection issues in several villages.

Citizens interested in using these services contact the PSL to obtain a sampling kit. Considerations in sample analysis include the water source, its use, location, and any problem symptoms. Most samples are scanned for metals, including arsenic, calcium, iron, magnesium, manganese, and sodium. Samples also are checked for hardness, total dissolved solids, pH, alkalinity, color, odor, turbidity, chloride, sulfate, fluoride, and nitrate. Test results and well information are stored in a database used to research water-quality issues throughout Illinois. Solutions to water problems often involve installing a water treatment unit, modifying a plumbing system, or contacting a specialist.

The PSL staff also provide education/outreach for Illinois residents, students, water

Kaye Surratt prepares samples for metals analysis.

professionals, and other groups at the Illinois State Fair, Illinois and National Science Olympiad tournaments, Illinois Environmental Health Association Educational Conference, Exposition of the Illinois Association of Groundwater Professionals, and an annual career conference for 8th graders. As part of Earth Week activities, PSL staff helped area Cub Scouts learn about "Waterways of the USA." In-house demonstrations were part of ISWS tours for Urbana Middle School students in the *WaterWorks* program or students from the Anita Purves Nature Center. Montessori Elementary School students learned about data collection by collecting stream samples, and then PSL chemists analyzed the samples and shared the results with students.

Institutional Water Treatment Program

The Institutional Water Treatment Program (IWTP) provides unbiased, professional water treatment expertise to more than 100 state facilities and has been doing so since 1949. The program serves the State of Illinois by helping participating facilities realize annual cost savings of chemicals, fuel, and water, and also by prolonging equipment life. During the past year, IWTP staff responded to more than 900 requests for information and assistance, made nearly 400 site visits, and analyzed more than 3,800 samples in the field.

Western Illinois University

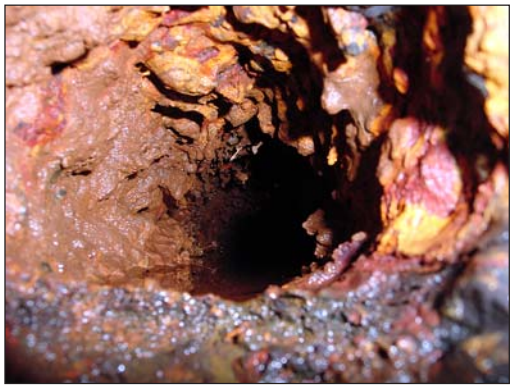
Feedwater that supplies the steam boilers at Western Illinois University (WIU) in Macomb is 70–80 percent condensed steam (condensate), pure water with low dissolved mineral content (>20 microsiemens per centimeter or µS/cm conductivity). Because of steam losses in the system, softened water provides the remaining water requirements but has a high dissolved mineral content (350 µS/cm conductivity). Resulting boiler feedwater has a conductivity of about 100 µS/cm.

Aside from decreasing flow and increasing pipe corrosion, accumulated mineral deposits in the feedwater pipe over 10–20 years of operation can dislodge and damage equipment. High-conductivity feedwater also necessitates blowdown of water from the boiler at a rate of 2 percent of total feedwater to bring in fresh water and keep boiler conductivities at reasonable levels. Treatment chemicals and heat energy also are lost during blowdown so blowdown reduction has the potential to save significant amounts of both.

Upon recommendations of ISWS staff, WIU is implementing use of reverse osmosis technology to treat softened water, which will result in very low-conductivity water (20 µS/cm) that is much purer and more like condensate. This will greatly reduce the potential for mineral deposits in the feedwater pipe and reduce the blowdown rate in the boiler to 0.5 percent, decreasing fuel consumption for the boiler plant by $50,000 annually, savings that will pay installation costs for the new equipment within two years.

Dwight Correctional Center

Potable water supplied to the Dwight Correctional Center is subject to forming mineral deposits that corrode piping, fixtures,



This close up shows scale deposits in a 4-inch diameter feedwater line at Western Illinois University.

Dwight Correctional Center has three cold distribution water softeners.

and equipment. Hardness of the untreated water is about 350 milligrams per liter (mg/L), which requires softening and blending with hard water to maintain hardness at 60–90 mg/L, the first step in reducing the potential for mineral deposit formation. Then addition of chemicals can reduce corrosion.

A new plant with three softeners was brought on line in 2002, but water hardness from the softeners was inconsistent. Expected hardness was less than 5 mg/L, but results ranged from 2–350 mg/L, something plant personnel could not explain. After testing all parameters, ISWS personnel worked with institutional staff to correct the problems. This year consistent blended water of 60–90 mg/L conductivity was produced. Addition of corrosion control chemicals should increase equipment and piping life significantly, and dramatically reduce maintenance costs associated with equipment down time and repairs.

Midwest Technology Assistance Center

One of the most pressing regulatory issues facing many public groundwater supplies in Illinois and across the nation is protecting the public from high arsenic concentrations in contaminated drinking water when the federal drinking water standard for arsenic drops from 50 micrograms per liter (µg/L) to 10 µg/L in 2006. Private water supplies are not subject to regulations, but high arsenic concentrations do occur in many private wells. Chronic exposure to high arsenic concentrations can cause cancer and other diseases.

Consequently, the Midwest Technology Assistance Center (MTAC) for Small Public Water Systems (http://mtac.sws.uiuc.edu/) has funded four arsenic research projects. As one of eight Centers throughout the United States, MTAC receives annual funding from the U.S. Environmental Protection Agency and provides grants or direct funding that allow state and university researchers to work on key areas for small water systems.

Projects include optimizing iron addition for arsenic removal at existing facilities, examining conditions that may control arsenic release into groundwater supplies, and tracking arsenic concentration variability in relation to time and pumping procedures. A new technique with greater potential for arsenic removal than existing methods also is being examined and shows great promise after pilot testing at a small public system in Illinois. The method will be refined further after additional testing at other facilities.

But arsenic isn't the only focus of MTAC research. Water quality at surface-water intakes is being evaluated with watershed modeling. Comparative performance measures being developed will improve technical, managerial, and financial capacity of small systems. Drought planning for small systems is another important area being assessed.

Diverse outreach projects have included workshops to train small system operators in use of financial benchmarking tools to assist in rate setting, cross-connection control seminars, and assistance with how to conduct system terrorism vulnerability assessments required by federal regulations. Small system operators/administrators received free phone consultations about conducting the vulnerability assessments and developing their respective vulnerability assessment plan.

A CD-ROM software program also was developed and distributed to help them develop their own source water protection plans. Other ongoing projects are addressing security protocols, monitoring technology, and complex management/restructuring issues facing small systems.

Small water systems and their operators/administrators from all over the state have benefitted from MTAC programs and products. With funding received in the most recent federal fiscal cycle, MTAC will continue addressing technical, managerial, and financial capacity development needs of small water systems across the Midwest.

Groundwater Science in Service of Illinois

Among the many benefits from programs/projects conducted by the Center for Groundwater Science (CGS) at the Illinois State Water Survey (ISWS) are assessments of potential groundwater supplies for small water users in rural areas and for large users, providing scientific groundwater expertise for specific needs of other agencies and for use in planning and managing groundwater resources throughout the state.

Securing Safe, Adequate Groundwater Supplies for Illinois

Groundwater availability assessments are tailored to user needs. For example, assessments for domestic users in rural areas generally involve reviewing historical well records near the property of concern and then making judgments about anticipated well depth, yield, and water quality. Assessments for large users, such as industries/communities seeking millions of gallons of water per day (mgd), require more detailed site-specific information to ensure supply adequacy and safety. Recently, the communities of Port Byron and Paris sought CGS assistance.

Port Byron

Sampling of a subdivision well in 1995, and subsequent sampling of nearby domestic wells in Rock Island County detected >50 micrograms per liter (µg/L) of arsenic in groundwater northeast of the Village of Port Byron, considerably higher than the 10 µg/L arsenic standard for drinking water. Although using the same aquifer, Port Byron's two municipal wells are not contaminated so the most viable solution was to connect the affected wells to that supply. Port Byron officials, however, were concerned that increasing their supply capacity to meet subdivision water demands also would increase potential for arsenic migration into village wells.

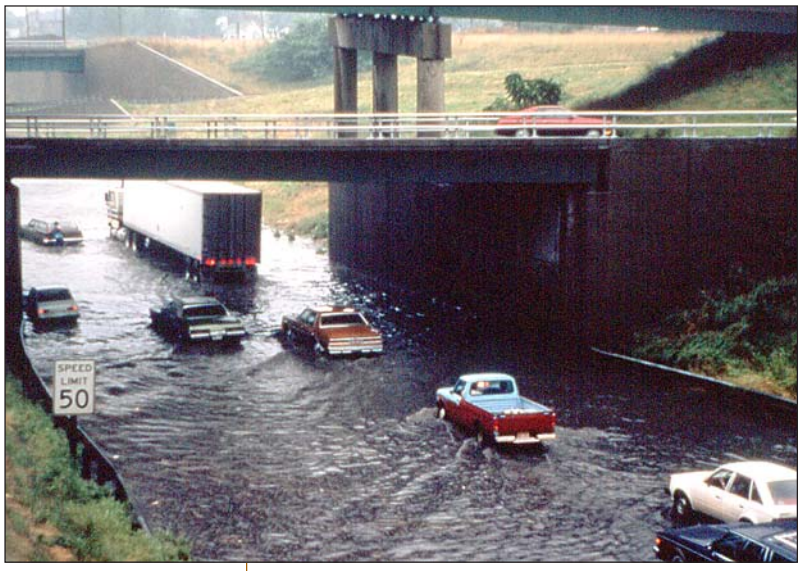
Using groundwater sampling and computer modeling, scientists assessed the potential for safely increasing the Port Byron supply. Sampling both village wells and domestic wells immediately east and south showed very low arsenic levels (~1 µg/L) throughout the area so locations south of the village wells appeared ideal for construction of a new well that would avoid the area of high contamination and reduce potential arsenic migration toward village wells.

A computerized groundwater flow model was used to evaluate 40-year capture zone configurations for various pumping scenarios. Modeling showed a northward shift in capture zones of both existing wells with addition of the third well 1000–2000 feet south, but not into the zone of concern. The new well is being drilled for connection to the village system.

Paris

The City of Paris, Clark County, contacted the Scientific Surveys for assistance with developing a groundwater supply to supplement existing reservoir supply. Illinois State Geological Survey electrical earth resistivity surveys showed that areas in Big Creek valley several miles south of town

Bob Olson (left) and Steve Burch set up a datalogger to record groundwater levels during an aquifer test for Paris, Illinois.



This flooded highway in East St. Louis after a heavy rainstorm resembles what would happen within minutes if the IDOT dewatering system failed.

offered development potential for the 200 gallon per minute (gpm) supply. Test drilling confirmed deposits of water-bearing sand and gravel near the confluence of an unnamed eastern tributary and Big Creek.

Subsequently, CGS scientists conducted a 7-day aquifer test to monitor levels in the pumped well, five observation wells, and Big Creek (see photo). The test well was pumped at a constant rate of 200 gpm. Data analysis revealed that the shallow aquifer can sustain the desired supply despite impermeable bedrock located 400 feet southwest. Paris officials have shifted their focus to the Wabash River Bottoms because they want a larger supply, 3 mgd.

Highway Dewatering Wells near East St. Louis

The Illinois Department of Transportation (IDOT) uses 54 high-capacity wells to maintain water-table elevations below highway roadbeds in the East St. Louis area. Dewatering systems at five sites are in the alluvial valley of the Mississippi River in the American Bottoms. Usually about one-third of the wells operate simultaneously, pumping an average of 20 mgd. Should the wells fail, pavement along the deepest portions of the highway (for example, the Tri-Level Bridge on Interstate 70) would flood virtually within minutes (see photo).

Condition and efficiency of several dewatering wells became suspect in 1982 on the basis of data collected and reviewed by IDOT staff. Since 1983, IDOT and the CGS routinely have assessed well operation and conditions to determine probable causes of well deterioration, and to evaluate rehabilitation procedures used. The CGS scientists regularly measure groundwater levels in area observation wells to monitor overall performance of the dewatering system, step-test wells before and after rehabilitation to determine well efficiency, and monitor well rehabilitation procedures to document techniques, processes, and effectiveness. Long-term ISWS efforts provide IDOT engineers with scientific assistance to maintain a safe highway system for hundreds of thousands of daily travelers.

Planning for Water Supplies

Water-resource planning and management require a firm understanding of water use (withdrawals) and resource availability. Comparison of groundwater withdrawals and estimated potential yields of aquifers can help identify areas in which regional supply problems could occur. Such a comparison for Year 2000 determined township use-to-yield ratios for Illinois' three main aquifer types: sand-and-gravel overlying bedrock, shallow bedrock within 300 feet of land surface, and deep bedrock at greater depths.

Groundwater Use

The ISWS has been collecting water withdrawal and availability data for Illinois since the early 1940s, primarily in northeastern Illinois, Peoria-Pekin, and East St. Louis, regions with extensive development of water resources. Documentation of annual withdrawals for all of Illinois began in 1978 under CGS general oversight.

The original Illinois Water Inventory Program (IWIP) database of water-using facilities was created by compiling responses to a letter sent to industries in the Illinois Manufacturers' Association Directory, through public supply records of the Illinois Environmental Protection Agency (IEPA), and historical ISWS files. The IWIP list of facilities is updated continually using IEPA records and reports of high-capacity wells sent to the ISWS by drillers, county health departments, and county Extension offices.

Until funding was terminated in June 2005, withdrawal data were collected annually from forms customized for each major water user in the state and submitted voluntarily. Quantity of withdrawals, both surface water and groundwater, generally were categorized as "public water supply," "self-supplied industry" (such as power generation, manufacturing, and mineral extraction), and

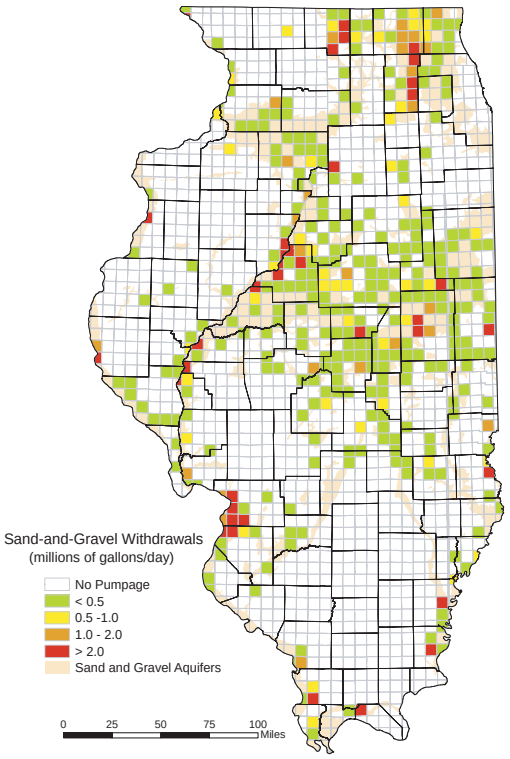


Figure 1. Sand-and-gravel withdrawals, by township.

"other" (withdrawals for fish and wildlife management areas and irrigation). Township-aggregated groundwater withdrawals from the sand-and-gravel, excluding irrigation, are shown (Figure 1).

Groundwater Availability

Groundwater availability historically has been expressed as potential yield developed from the three main aquifer types in Illinois and is the maximum amount that can be withdrawn continuously without creating critically low water levels or exceeding recharge. Statewide potential yield estimates developed and published in the late 1960s mapped recharge rates using gallons per day per square mile (gpd/mi^2); for example, a recharge rate of 100,000 gpd/mi^2 equals 2.1 inches/year.

Because those maps still provide the best statewide estimates of groundwater availability for Illinois, paper versions were scanned, enlarged on screen, verified using real-world coordinates, and digitized with geographic information system (GIS) technology. With the addition of township boundaries for Illinois, it was possible to compute and map total potential yield, based on total area from individual potential yield polygons within each township.

Comparing Groundwater Use and Aquifer Yield

Use-to-yield ratios then were computed and mapped. A high ratio, values >0.9, suggests an area with existing or impending groundwater availability problems. Such ratios occur for sand-and-gravel aquifers (Figure 2) in much of Illinois: extreme northwest, including the East Dubuque area; northeast (Fox River corridor); central (LaSalle, Peoria, South Pekin along the Illinois River, and Normal); east central (Champaign and Danville areas); southeast (EJ Water District, Newton Lake Conservation Area, and Mt. Carmel); southwest (surrounding MetroEast area); and far south along the Mississippi River.

A similar use-to-yield map for the deep bedrock aquifers (Figure 3) clearly identifies townships not served by Lake Michigan in northeastern Illinois. Other areas further west and south, such as Rockford in north-central Illinois, also appear.

Comparing withdrawals and potential aquifer yields in a GIS format is a useful technique for focusing on areas of existing or potential stresses but cannot supplant local studies, particularly those incorporating

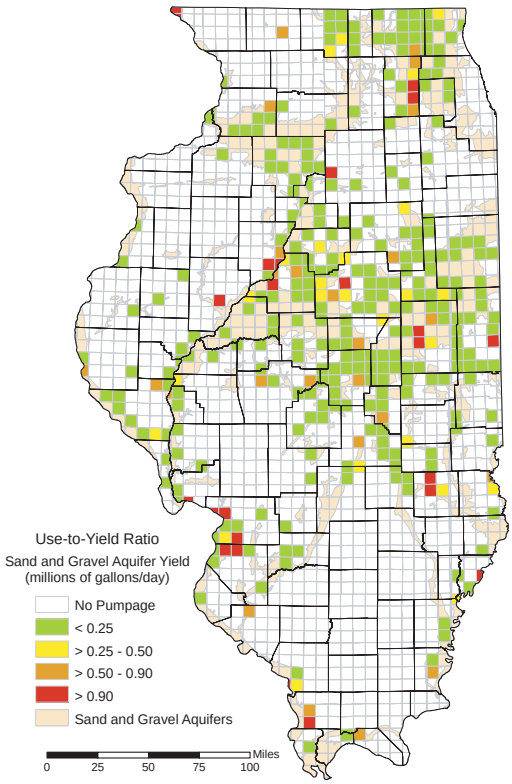


Figure 2. Sand-and-gravel aquifer use-to-yield ratios, by township.

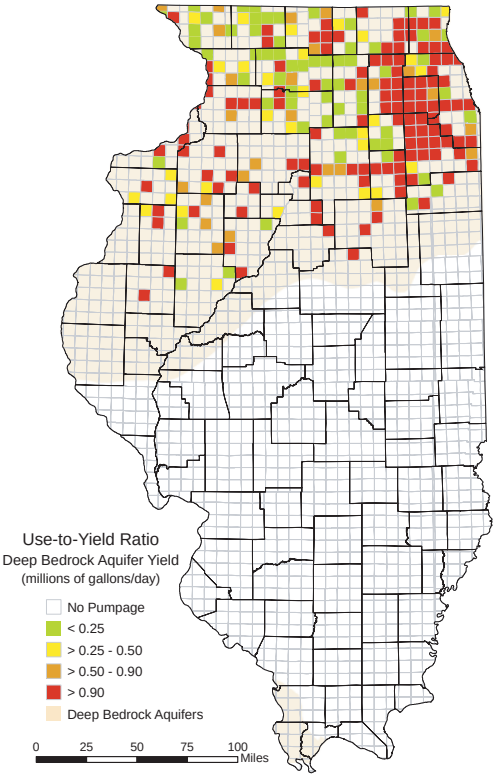


Figure 3. Deep bedrock aquifer use-to-yield ratios, by township.

detailed information for groundwater flow modeling to assess local conditions accurately. For example, GIS unduly may highlight areas of large, relatively isolated, withdrawals within an extensive aquifer, such as the Mahomet aquifer near Champaign. Effects of such pumpage will be spread across a larger area than in just the townships where the wells are located, smoothing the ratio. However, other areas can be identified in the Fox River valley, Peoria, Lewiston, and Normal where the aquifer is confined to a narrow valley, multiple pumping wells occur within a small area, or withdrawals exceed estimated recharge. Certainly, areas with multiple townships exhibiting high use-to-yield ratios clustered together (e.g., the deep bedrock aquifer of northeastern Illinois) should signify locations warranting additional research, data collection, and planning. Further explanation of the techniques and findings can be found on line (http://www.sws.uiuc.edu/pubs/pubdetail.asp?CallNumber=ISWS+CR+2004%2D11).

Watershed Science Serving the State and the Nation

Center for Watershed Science (CWS) research serves the citizens of Illinois and the nation in many ways. Continued CWS monitoring and analysis of the availability and quality of surface water throughout Illinois is a key focus to ensure adequate, clean water for domestic and industrial use, and for healthy ecosystems. Stream and watershed assessment and restoration, an important focus since the 1980s, include not only some of the leading national stream restoration projects, but also stream and watershed restoration projects from the Waukegan River in northeastern Illinois to the Cache River in southern Illinois.

The Floodplain Mapping Program is a major new program established at the CWS with funding from the Federal Emergency Management Agency (FEMA) through the Office of Water Resources (OWR) at the Illinois Department of Natural Resources (IDNR). Staff work cooperatively with both OWR and FEMA to prepare digital floodplain maps for Illinois under FEMA's Map Modernization Program (see feature story).

Monitoring Water Availability and Supply

The citizens of Illinois rely on various sources for water supply, including Lake Michigan, aquifers, reservoirs, and rivers and streams. Drought conditions periodically limit the quantity of water available for supply from sources other than Lake Michigan. Population growth and increased water use also can deplete existing supplies, which often becomes obvious only during droughts.

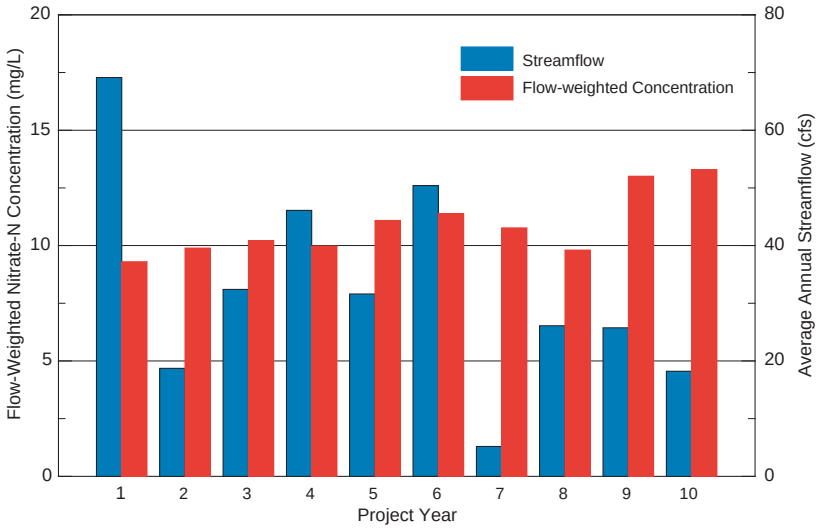
In cooperation with the IDNR OWR, the CWS historically has evaluated the adequacy of public supplies from surface water, with the ultimate goal of providing a safe, dependable supply. These studies identify public systems at risk of shortages during severe drought, thus helping communities identify when to develop additional supplies or other mitigative measures prior to onset of drought.

Water levels in one-third of public water-supply reservoirs are monitored monthly to determine both the seasonal range of normal water levels and threshold levels that identify the possibility of drought-related concerns. During times of drought in Illinois, such as the burgeoning drought condition in 2005, the Illinois State Water Survey (ISWS) is the lead agency for climatic and hydrologic information used to interpret and forecast progressive drought conditions and the potential for water shortages in Illinois.

Developing and maintaining reliable water supplies also requires assessment of surface water availability by studying spatial and temporal variation in streamflow to determine yields for streams and reservoirs throughout Illinois. Because frequency data on streamflows are available from a limited number of streamgages, regional hydrologic relationships must be developed with modeling to estimate conditions at supply intakes and other ungaged sites throughout the state.

Information on flow frequency is necessary to define water availability for in-stream flow uses, such as maintaining flows for aquatic habitat and fisheries, recreation, and navigation. Information on flow quantity is crucial for implementation of water-quality regulations and overall health of Illinois' rivers and streams.

Long Duong and Joy Telford collect geomorphological field data on Partridge Creek above the juncture with the Illinois River. Different sites have different features and responses to processes controlling channel evolution and stage.



This graph shows flow-weighted nitrate-N annual average streamflows at Big Ditch, a tributary in the Lake Decatur watershed.

City of Decatur Water Supply

An excellent example of the ISWS' commitment is long-term collaboration with the City of Decatur over the last 70 years to ensure a clean and adequate water supply for Decatur and surrounding areas. Issues related to water quality, reservoir capacity, or drought currently are addressed by the ISWS. Then those data are used by the City of Decatur, which depends on Lake Decatur, an impoundment on the Sangamon River, for its supply for drinking water and food processing. Consequently, reservoir capacity has been an important aspect of lake management for Decatur since lake construction in 1922.

Several CWS-conducted sedimentation surveys have determined that Lake Decatur has lost a third of its capacity from 1922 to 1983 from excessive erosion of bluff watersheds draining directly to the lake and the lakeshore. As a result, the City of Decatur instituted an aggressive lakeshore protection program, provided funding for watershed management specialists in Macon County, and created its own dredging program. Storage capacity and flow-frequency analyses have continued to assist the city more effectively manage lake pool levels to minimize drought impacts on drinking-water supplies.

The quality of drinking water in Lake Decatur has been compromised by frequent and periodic nitrate-nitrogen (nitrate-N) levels that exceed the Clean Water Act minimum concentration of 10 milligrams per liter. Since 1993, the CWS has been monitoring and analyzing nitrate-N concentrations in the Lake Decatur watershed to provide city staff with scientific data necessary for managing their water supply.

Recently, the U.S. Environmental Protection Agency's Targeted Watershed Grants program selected the Lake Decatur watershed as one of 14 watersheds for 3-year monitoring of nitrogen and phosphorus levels to determine effects of volunteer-based, economic land management by farm operators. A consortium of research teams, including the CWS, will conduct that research.

Selection was based primarily on CWS data showing the complexity of controlling nitrate-N concentrations in an intensively cultivated watershed. Study results will have regional and national implications for resource management programs to reduce nutrient loading.

Stream and Watershed Assessment and Restoration

The ISWS has basic and applied research experience in watershed and stream assessment, analysis, and restoration. In fact, the CWS has been a significant contributor to scientific advancements and is recognized in Illinois and the nation as a leader in this field. The CWS Stream and Watershed Assessment and Restoration Program advances earth sciences research and finds innovative solutions for contemporary watershed and stream problems. The goal of the program is to protect and improve the quality and quantity of water resources while protecting public infrastructure, enhancing habitat, and sustaining ecological diversity.

The ISWS is conducting geomorphological and biological assessments at a watershed scale; developing, adapting, and testing restoration designs and approaches; and providing planning guidance and outreach

efforts that advance adoption and use of innovative natural resource management approaches and conservation practices. Services include conducting aerial and field-based watershed/stream assessments and developing innovative conservation practices and management approaches that mitigate erosion and sedimentation impacts at a watershed scale.

Staff assess watershed land-use patterns and water-quality trends; document stream channel stability, including changes in channel form and flows; document changes in habitat conditions (biological indices) and causative factors of landscape disturbance; and develop and demonstrate innovative restoration practices that address those factors, thereby restoring or naturalizing watersheds, streams, and stream segments.

The ISWS collects data on streamflow, precipitation patterns, stream and watershed geomorphological forms, channel adjustments, physical habitat, macroinvertebrates, and fisheries statewide. Noteworthy projects include the Embarras River, Cache River, Spoon River, Hall Creek, Waukegan River, Panther Creek, Cox Creek, Blue Creek, North Creek, Court Creek, Hickory Creek, and many other watersheds in Illinois.

For example, the ISWS designed and installed structures to counteract channel downcutting in an effort to save "Wetlands of International Importance" in southern Illinois, the Cache River wetlands. Channelization of the Cache River and other alterations to the natural hydrology, habitat fragmentation, and excessive erosion have been issues that local, state, and federal interests collectively have been trying to combat for years.

The CWS developed designs of riffle/pool structures, sited the 25 structures, and supervised their construction using 29,000 tons of rock. The structures naturalize streamflow and prevent erosion of the channel bed, which further protects the adjacent, rich wetlands from being drained.

Pools behind the riffles dissipate energy and decrease sediment amounts and overall water pollution contributed from stream erosion. The riffles also provide habitat for macroinvertebrates and other aquatic species, and oxygenate water to further improve overall water quality. Implementation of these and other restoration efforts has helped guarantee preservation of this great natural resource for future generations.

The CWS also cooperates with many public and private planning and management organizations and individuals (federal, state, local, and nongovernment) to apply knowledge about physical systems to improve restoration designs, conduct project evaluations, provide data for adaptive management, and evaluate overall performance of restoration projects.

Such assessment approaches and restoration practices are applicable anywhere in the nation with similar climate, landscape, and

This is the Cache River site before (top), during (middle), and after (bottom) installation of riffle/pool restoration structures.

land-use practices. The ISWS continues to study and review more effective methods to monitor streams and watersheds, including use of advanced sensory equipment for water-quality and geomorphic analyses.

For example, the ISWS recently adapted several field-based data collection protocols to collect geomorphological data systematically for different Illinois landscapes. The process and data are being used to assess stream channel stability in tributary streams in the Illinois River basin, and there are on-going discussions with other IDNR Offices and Illinois agencies about incorporating some of these data into their field data collection routines.

The Illinois Environmental Protection Agency (IEPA) is funding these assessments and restoration projects that evaluate habitat, sediment transport, channel stability, and water-quality changes in both rural and urban landscapes. Field staff at IEPA also are considering using these revised geomorphological assessment protocols for their own internal assessments.

City of Decatur-owned 154-foot dredging equipment removes sediment on Lake Decatur. Photo courtesy of City of Decatur staff.

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

Responding to Emerging State and National Issues

The National Atmospheric Deposition Program (NADP) serves Illinois and the nation by providing data and information about chemicals in precipitation, and by responding to emerging issues of regional and national importance. Significant progress has been made on issues with implications for the Illinois agricultural community and policy-makers, and on an initiative to find and identify plant pathogens in rain.

Chemical Climate Change

Climate change is measured by long-term trends in temperature, humidity, cloud cover, and other weather-related parameters, but chemicals in the atmosphere also exhibit long-term trends. The NADP tracks these trends by measuring the acids, nutrients, base cations, and mercury in precipitation, which captures and deposits these chemicals from the mixture of gases and particles in the atmosphere. Precipitation chemistry trends reflect air chemistry trends, which result from the combined effects of natural and human-induced pollutant emissions, physical and chemical transformations in the atmosphere, and weather.

Recent work based on NADP precipitation chemistry data points to chemical climate change resulting from long-term trends in sulfate, which is acidic, and ammonium, which is a nutrient and nonacidic. This change is most evident in the central and western United States, including Illinois. Ammonium found in precipitation enters the atmosphere as a gas. When the concentration of sulfate exceeds that of ammonia in the atmosphere, both chemicals combine to form tiny chemically stable aerosols that can travel hundreds or even thousands of kilometers before being deposited. When there's more ammonia than needed to react with all of the sulfate, however, the remaining ammonia reacts with nitric acid vapor, forming unstable particles that readily revert to gaseous ammonia and nitric acid vapor, depending on temperature, relative humidity, and other variables. Ammonia and nitric acid vapor are very reactive and tend to be deposited close to their source, changing the dynamics of transport distances and deposition processes.

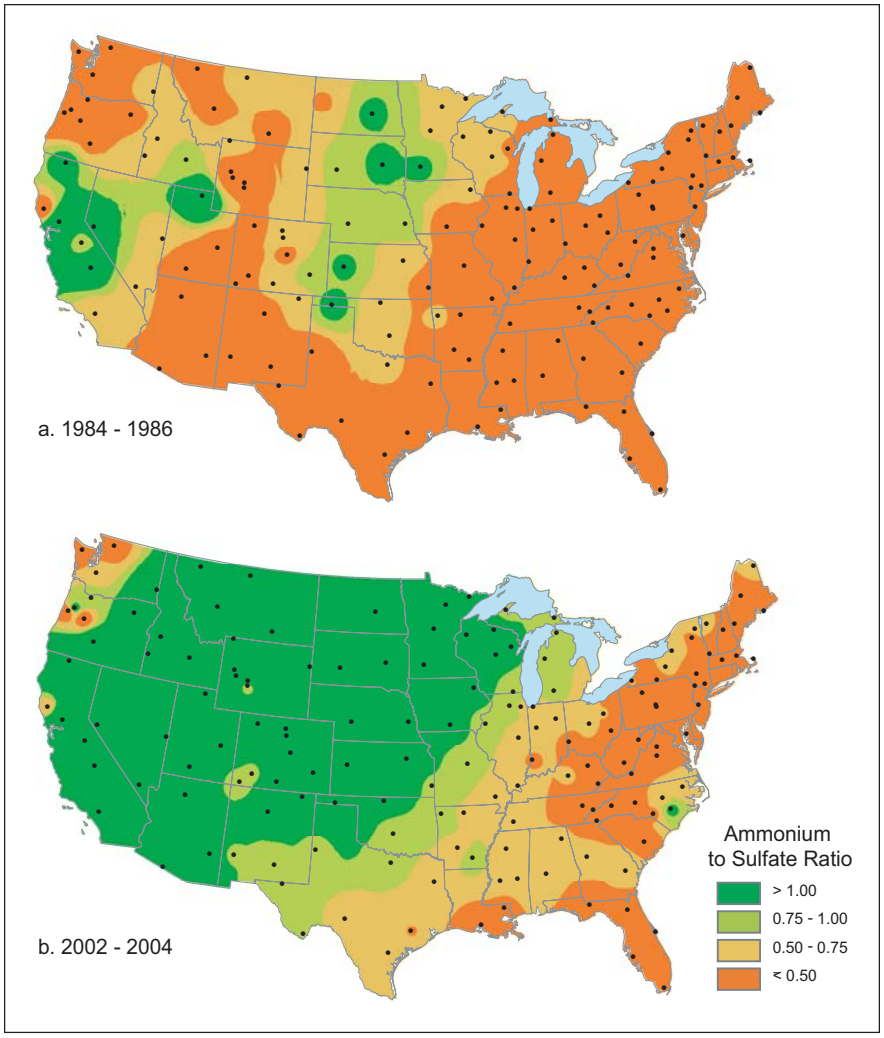
Average ratios of ammonium to sulfate over two periods (see maps) demonstrate this chemical climate shift, which reflects significant sulfate decreases and ammonium increases over the last 19 years. Sulfate contributes to acidic deposition, and sulfate decreases have lowered the frequency of acid rain. Deposition also contributes sulfur required by some agricultural crops. Ammonium deposition stimulates plant growth, especially in nitrogen-limited systems, but it also can alter structure and diversity of native plant communities. Additional research is needed to help scientists assess the impacts of this chemical climate shift on air quality in Illinois and the nation, and long-term NADP data and information can be invaluable in these assessments.

Rust in Rain

Rusts are fungal diseases that infect every major agricultural crop except rice. Should collaborative methods prove effective, NADP sites could serve as part of an early warning system of rust in rain, information that the U.S. Department of Agriculture (USDA) could use to advise farmers nationwide about timing of fungicide applications to maximize crop protection.

The USDA Animal and Plant Health Inspection Service announced that Asian soybean rust (ASR) had been found on leaf samples from a research farm in southern Louisiana in November 2004, the first reported occurrence in the continental United States. This report jump-started an aggressive campaign to determine whether this was an isolated event.

Teams of federal, state, and local officials scouted thousands of acres and sent suspected samples to the National Plant Germplasm and Biotechnology Laboratory in Beltsville,



Chemical equivalent ratios of average ammonium to sulfate concentrations in NADP/NTN samples reflect significant sulfate decreases and ammonium increases over time.

Maryland, where scientists tested for ASR using sophisticated genetic analyses. Those tests detected ASR in samples from Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, South Carolina, and Tennessee, raising concerns about the potential for its spread to Illinois, the largest soybean-producing state in the nation. Previously, crops in Asia, Africa, and South America had been infected, reducing soybean yields as much as 60 percent and substantially increasing production costs.

Ideal conditions for infection include temperatures of 15–25°C accompanied by 6 or more hours of continuous leaf wetness. Infection causes premature defoliation of soybean stalks, which reduces not only number of pods and seeds per pod, but also soybean size, and weight. Economic losses from infection were negligible in the United States in 2004 because the growing season was virtually over and more than 95 percent of the soybean crop had been harvested. A leading hypothesis for introduction of ASR is spore deposition during rainstorms.

Because clouds and rain readily capture spores, NADP scientists initiated a pilot project over the 2004 growing season to test for wheat stem rust spores in precipitation samples from its National Trends Network (NTN), well before the report of ASR in Louisiana. The NADP's Central Analytical Laboratory modified its procedures slightly to filter whole rain samples from the 22 sites selected. Filters were dried in a desiccator, sealed individually in Petri dishes, and sent to the Cereal Disease Laboratory (CDL) at the University of Minnesota for analysis. Plant geneticists at the CDL used polymerase chain reactions that made it possible to detect DNA sequences from wheat stem rust genes if present on the filter membranes.

Genetic evidence of wheat stem rust spores was found in rain samples from 19 NTN sites in a north-south band from Texas to North Dakota and Minnesota. Spores were

detected from late May through the end of July several weeks before field reports of the onset of wheat stem rust at observation plots in Kansas, Nebraska, Minnesota, and North and South Dakota.

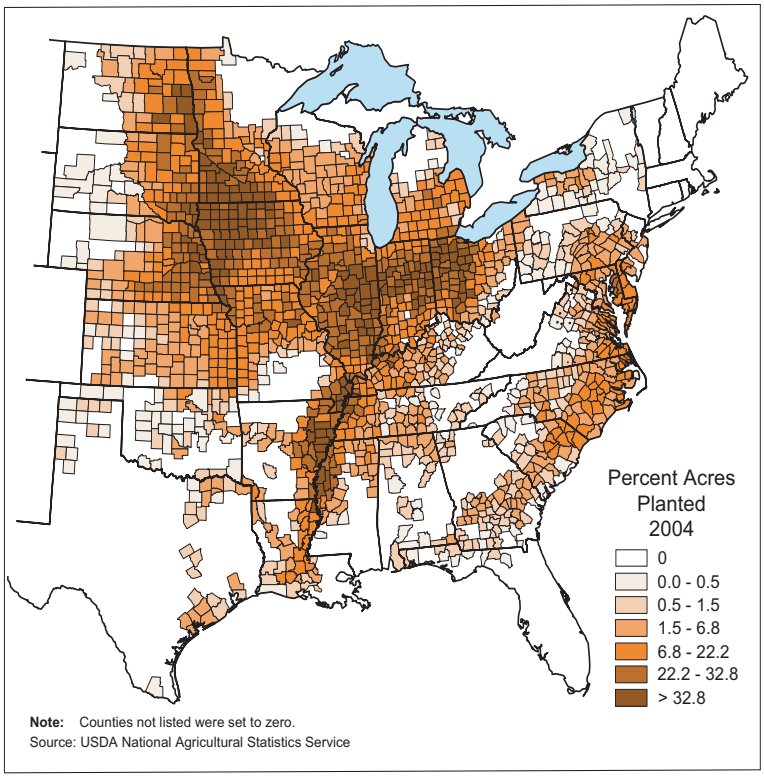
Similar to ASR, wheat stem rust spreads by release of spores into the atmosphere. These uredinispores, less than 50 microns in size, can remain airborne for hours or days as winds carry them hundreds or even thousands of kilometers before they return to earth in precipitation (wet deposition) or during dry weather (dry deposition). Infection spreads by dry deposition near the source, but wet deposition is the most likely method at greater distances. Convective storms, such as typical Midwestern summertime thunderstorms, draw the dispersed spores into clouds and raindrops for deposition onto plant surfaces at rates depending on spore concentration and rainfall amount.

Success of the wheat stem rust project demonstrated that disease spores could be detected in NTN samples, leading to a similar ASR project launched in May 2005. The wheat rust detection method was adapted for ASR. Filters from 124 of NADP's 250 sites are sent weekly to the CDL for analysis. Samples are from states with significant soybean acreage (see map) and sites in Puerto Rico and the Virgin Islands.

Midwestern farmers and scientists are focusing on precipitation as the culprit in spreading ASR because the fungus does not survive temperatures below freezing. Except for southernmost Texas and Florida, and coastal areas in Gulf states and southern California, which all occasionally experience a rare freeze in atypically cold winters, ASR is unlikely to survive typical U.S. winters. A viable source of inoculum to infect the new crop is hundreds to thousands of kilometers away from the large soybean-producing areas in Illinois and the upper Midwest.

Well-timed applications of fungicides for ASR can reduce soybean yield loss, depending on plant stage and application method. Knowing when the crop has been exposed to inoculum is important if growers are to make cost-effective decisions about fungicide applications. Detecting ASR spores in rain would be invaluable for an effective warning system heralding potential long-distance movements of the disease. Spore measurements also could be used for evaluating computer models that simulate transport and deposition of ASR spores and spread of the disease.

Results of the ASR project will be sent to the USDA, which will combine those data with observations from observation plots, commercial soybean growers, and computer model predictions to study ASR spread and seasonal cycle during the 2005 growing season. The disease is expected to retreat annually to southernmost parts of states bordering the Gulf of Mexico, Mexico, Central America, and the Caribbean, where overwintering could occur in legumes, including cultivated and volunteer soybean plants and kudzu, an invasive species throughout the southeastern United States.



This map shows land acreage (by county) planted in soybeans in 2004.

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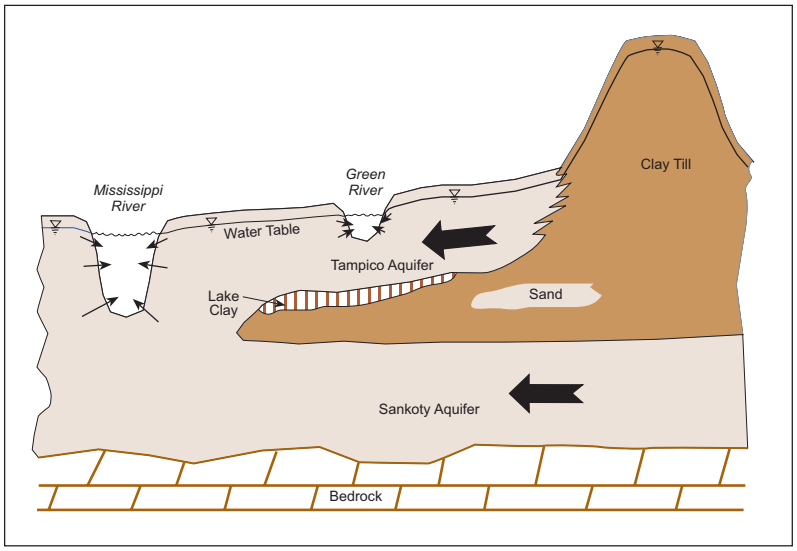

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The path guides visitors to the Hydro-House and other ISWS activities in the tent at State Fair.

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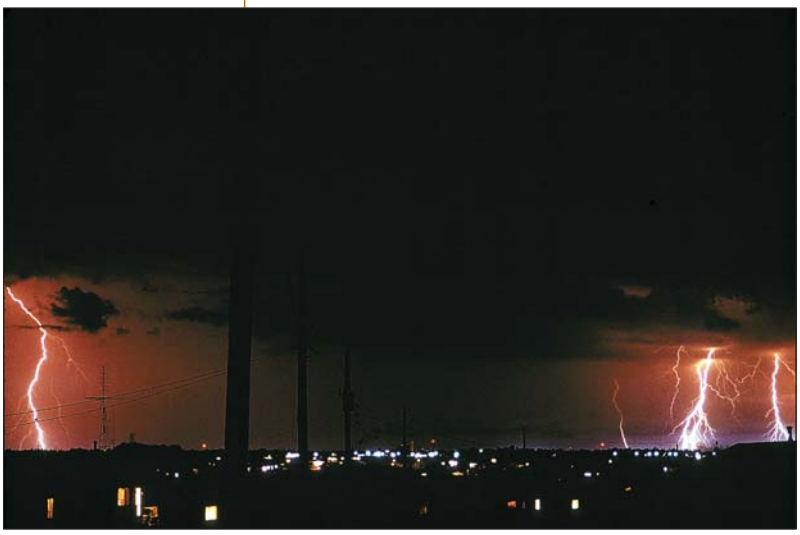

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Some 4th graders make non-Newtonian fluid (slime) using a white glue and borax solution at a hands-on science fair.

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Rogers, A., D.J. Allen, P.A. Davey, P.B. Morgan, E.A. Ainsworth, C.J. Bernacchi, G. Cornic, O. Dermody, E.A. Heaton, J. Mahoney, X-G. Zhu, E.H. DeLucia, D.R. Ort, and S.P. Long. 2004. Leaf Photosynthesis and Carbohydrate Dynamics of Soybeans Grown Throughout Their Life-Cycle under Free-Air Carbon Dioxide Enrichment. *Plant, Cell & Environment* **27**:449–458.

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This photo shows a clean water filter (far left) and two others that contain sediment or iron from private wells. The PSL can help solve those problems.

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Wittig, V.E., C.J. Bernacchi, X. Zhu, R. Ceulemans, P. DeAngelis, B. Gielen, F. Miglietta, P.B. Morgan, and S.P. Long. 2005. Gross Primary Production Is Stimulated for Three *Populus* Species Grown under Free-Air CO_2 Enrichment from Planting through Canopy Closure. *Global Change Biology* **11**(4):644-656.

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Center for Chemistry & Technology

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Center for Groundwater Science

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Kirk, M.F., T.R. Holm, J.H. Park, Q.S. Jin, R.A. Sanford, B.W. Fouke, and C.M. Bethke. 2004. Bacterial Sulfate Reduction Limits Natural Arsenic Contamination in Groundwater. *Geology* **32**(11):953–956.

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Mark Anliker records the pumping rate from an orifice tube during a step test of the IDOT dewatering well near East St. Louis.

Scientists sponsored a field trip to the Boneyard Creek for students in the Water Works *program at Urbana Middle School.*

Center for Watershed Science

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Wesolowski, D.J., L.M. Anovitz, P. Bénézeth, A.A. Chialvo, D.A. Palmer, P. Fenter, L. Cheng, N.C. Sturchio, Z. Zhang, M.J. Bedzyk, J.D. Kubicki, M.V. Fedkin, S.N. Lvov, D. Sykes, P.T. Cummings, M.K. Ridley, M.L. Machesky, M. Predota, and A.V. Bandura. 2004. Temperature-Effects and Structure at the Rutile-Water Interface. *Proceedings, 11th International Symposium on Water-Rock Interaction.* Saratoga Springs, NY, pp. 775–779.

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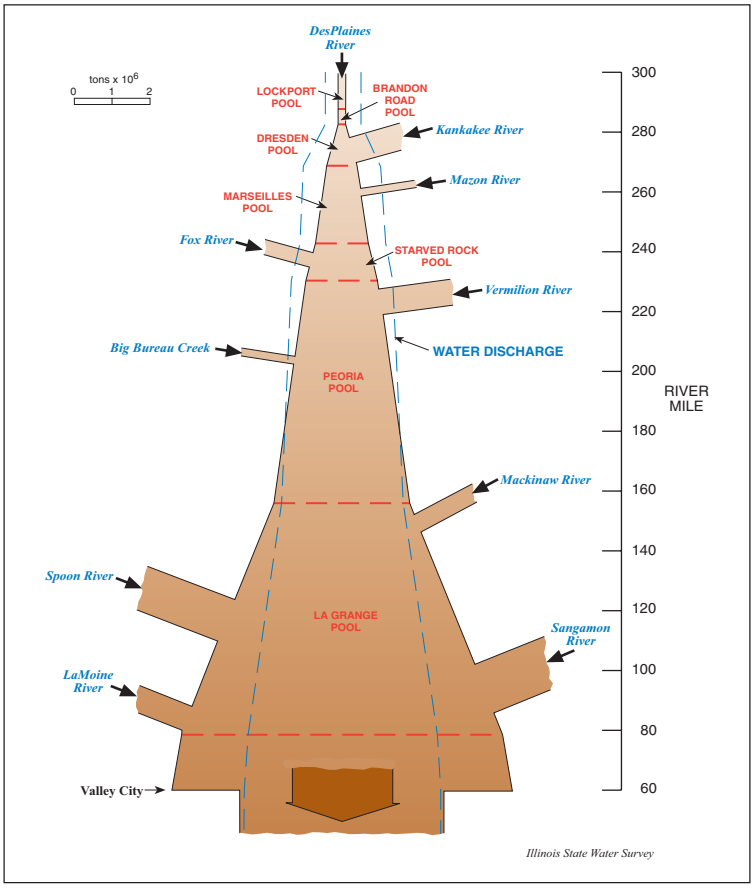
Zhang, Z., P. Fenter, L. Cheng, N.C. Sturchio, M.J. Bedzyk, M. Predota, A. Bandura, O.J.D. Kubicki, S.N. Lvov, P.T. Cummings, A.A. Chialvo, M.K. Ridley, P. Benezeth, L. Anovitz, D.A. Palmer, M.L. Machesky, and D.J. Wesolowski. 2004. Ion Adsorption at the Rutile-Water Interface: Linking Molecular and Macroscopic Properties. *Langmuir* **20**(12):4954–4969.



This diagram shows the estimated water and sediment budget for the Illinois River, 1981-2000 (adapted from ISWS Contract Report 2004-13).

Two students take the written water-quality exam at the state-level Science Olympiad.

National Atmospheric Deposition Program

Lehmann, C.M.B., V.C. Bowersox, and S.M. Larson. 2005. Spatial and Temporal Trends of Precipitation Chemistry in the United States, 1985–2002. *Environmental Pollution* **135**(3):347–361.

Lehmann, C.M.B., V.C. Bowersox, V.C., and S.M. Larson. 2005. Trends in Sulfur and Nitrogen Species at Collocated NTN-CASTNET Sites. *Proceedings of the Air and Waste Management Association 98th Annual Conference*, Pittsburgh, PA, Paper 1301, CD-ROM.

Lehmann, C.M.B., V.C. Bowersox, and S.M. Larson. 2004. Spatial and Temporal Trends of Precipitation Chemistry in the United States. *Proceedings of the Air and Waste Management Association 97th Annual Conference*, Pittsburgh, PA, Paper 546.

Lehmann, C.M.B., N. Latysh, and C. Furiness. 2004. *Discontinuation of Support for Field Chemistry Measurements in the National Atmospheric Deposition Program (NADP/NTN).* NADP Data Report 2004-02. NADP Program Office, Champaign, IL (also on line).

Lehmann, C.M.B., and G. Wetherbee. 2005. Developing Data Quality Objectives for the National Atmospheric Deposition Program. *Proceedings of the Air and Waste Management Association 98th Annual Conference*, Pittsburgh, PA, Paper 1304, CD-ROM.

NADP. 2004. *NADP 2004 - Technical Committee Meeting and Scientific Symposium.*NADP Proceedings 2004-01, NADP Program Office, ISWS, Champaign, IL (also on line).

NADP. 2004. *National Atmospheric Deposition Program 2003 Annual Summary*. NADP Data Report 2004-01. NADP Program Office, ISWS, Champaign, IL (also on line).

Equipment and samplers for various ISWS programs/projects and those for other agencies, universities, and groups monitor air quality, precipitation chemistry, long-term climate, meteorological variables, atmospheric visibility, solar physics, and continuous particulates at this field site at Bondville, Illinois. The rural site is available for use by all researchers as a service through the State of Illinois and the University of Illinois at Urbana-Champaign.

ADJUNCT & EMERITUS APPOINTMENTS

Adjuncts to University of Illinois at Urbana-Champaign

Office of the Chief
Derek Winstanley, Department of Geography

Center for Atmospheric Science
James Angel, Department of Geography
Stanley Changnon, Department of Geography
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

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 Plant Pathology
The Pennsylvania State University
University Park, PA

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
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
Nani Bhowmik, Principal Scientist Emeritus, 2001
Shundar Lin, Senior Professional Scientist Emeritus, 2001
Harry Ochs, Principal Scientist Emeritus, 2002
Mark Peden, Senior Professional Scientist Emeritus, 2002
Kenneth Beard, Principal Scientist Emeritus, 2003

CONTACTS

Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7495
(217) 333-2210
Fax: (217) 333-6540
URL: http://www.sws.uiuc.edu/

Office of the Chief

Chief: Derek Winstanley, (217) 244-5459

Executive Administrative Assistant to the Chief: Debbie Mitchell, (217) 244-5459
Assistant Chief for Administration: Joyce Changnon, (217) 333-0448
Biogeochemical Cycles: Ed Krug, (217) 244-0877
Computer Services Coordinator: Doug Ward, (217) 333-8887
Editor: Eva Kingston, (217) 244-7270
Fiscal Records, Grants/Contracts; Equipment Inventory: Betty Strom, (217) 244-4521
Fiscal Records, State: Janice Smith, (217) 333-4978
Geographic Information Systems: Chris Jennings, (217) 244-0904
Grants/Contracts Coordinator: Becky Bennett, (217) 244-3533
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Librarian: Patricia Morse, (217) 333-4956
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Quality Assurance & Site Safety Coordinator: Mary LeFaivre, (217) 333-5902
Water & Atmospheric Resources Monitoring Program: Bob Scott, (217) 333-4966
Web Developer: Kevin Merrifield, (217) 333-0688

Center for Atmospheric Science

Director: Kenneth Kunkel, (217) 244-1488

Aerosol Chemistry: Allen Williams, (217) 244-0373
Agricultural Meteorology: Carl Bernacchi, (217) 333-8048
Air Quality, David Gay, (217) 244-0462
Boundary Layer Meteorology/Precipitation Physics: David Kristovich, (217) 333-7399
Climate Modeling: Xin-Zhong Liang, (217) 244-6864
Climate Variation & Change/Climate Impacts: Stanley Changnon, (217) 244-0494
Cloud Chemistry: Allen Williams, (217) 244-0373
Global Climate Change: Kenneth Kunkel, (217) 244-1488
Midwestern Regional Climate Center: Steve Hilberg, (217) 333-8495
State Climatologist: James Angel, (217) 333-0729
Toxic Pollutants: David Gay, (217) 244-0462

Center for Chemistry and Technology

Director: Kent Smothers, (217) 333-6167

Internal Analytical Services/Public Service Laboratory: Dan Webb, (217) 244-0625
Midwest Technology Assistance Center: Kent Smothers, (217) 333-9321
Water Analyses: Brian Kaiser, (217) 333-9234
Water Treatment Services: Mark Brooks, (217) 333-7313

Center for Groundwater Science

Director: Allen Wehrmann, (217) 333-0493

Arsenic Studies: Tom Holm, (217) 333-2604
Geochemistry: Walt Kelly, Coordinator, (217) 333-3729
Groundwater Availability: Allen Wehrmann, (217) 333-0493
Groundwater Modeling: Doug Walker, (217) 333-1724
Groundwater Quality: Walt Kelly (217) 333-3729
Lake Calumet Studies: George Roadcap, (217) 333-7951
Mahomet Aquifer: Allen Wehrmann, (217) 333-0493
Midwest Technology Assistance Center: Steve Wilson, (217) 333-0956
Northeastern Illinois: Scott Meyer, (217) 333-5382
Outreach, Service, & Education Coordinator: Ken Hlinka, (217) 333-8431
Pesticides: Steve Wilson, (217) 333-0956
Water Levels: Ken Hlinka, (217) 333-8431
Well Design & Rehabilitation: Robert Olson, (217) 333-8700
Well Records: Susie Dodd-Casey, (217) 333-9043

Center for Watershed Science

Director: Mike Demissie, (217) 333-4753

Field Data Collection: Jim Slowikowski, (217) 244-3820
Floodplain Mapping: Sally McConkey, (217) 333-5482
Hydraulic Models: Yanqing Lian, (217) 333-1495
Hydrologic Models: Deva Borah, (217) 244-8856
Illinois Rivers Decision Support System: Chris Jennings, (217) 244-0904
Lake Sedimentation Surveys: Bill Bogner, (217) 333-9546
Nonpoint Source Pollution: Laura Keefer, (217) 333-3468
River Hydraulics: Mike Demissie, (217) 333-4753
Sediment Monitoring: Rich Allgire, Southern Illinois University, Carbondale, (618) 201-4030
Sediment Quality: Mike Machesky, (217) 333-9322
Sediment Transport: Mike Demissie, (217) 333-4753
Surface Water Information: Bill Saylor, (217) 333-0447
Surface Water Resources System: Vern Knapp, (217) 333-4423
Surface Water Supply: Vern Knapp, (217) 333-4423
Water and Wastewater Treatment: Gary Peyton, (217) 333-5905
Water Quality: Mike Machesky, (217) 333-9322
Watershed Hydrology: Vern Knapp, (217) 333-4423
Watershed Monitoring: Laura Keefer, (217) 333-3468
Watershed Processes: Mike Demissie, (217) 333-4753
Watershed Restoration and Rehabilitation: Bill White, Peoria, (309) 671-3196, Ext. 207

National Atmospheric Deposition Program

Head & NADP Coordinator: Van Bowersox, (217) 333-7873

Assistant Coordinator & Central Analytical Laboratory Director: Karen Harlin, (217) 244-6413
Assistant Coordinator for Toxics: David Gay, (217) 244-0462
Database and NADP Web Site Manager: Bob Larson, (217) 333-9008

HONORS

Kingsley Allan
Certified GIS Professional and President-Elect, Illinois GIS Association

Carl Bernacchi
Chair, Global Change Session, American Society of Plant Biologists Annual Meeting

Nani Bhowmik
Elected Diplomat, Water Resources Engineer, American Academy of Water Resources Engineers, American Society of Civil Engineers

Deva Borah
President, American Society of Civil Engineers, Central Illinois Section - East Branch

Van Bowersox
Invited Reviewer, "Atmospheric Response to Past Emission Changes," *2004 Canadian Acid Deposition Science Assessment*

Mark Brooks and Chuck Curtiss
Conference Co-Chairs, 57th Annual Illinois Institutional Chief Engineers Workshop

Joyce Changnon
Chair, State Universities Retirement System Members Advisory Committee

Stan Changnon
Author, American Meteorological Society, 2005 Book of the Year, *Weather and Railroads*; and Specialist for National Academy of Sciences study of the Mississippi River and Illinois River

Karen Harlin
Chair, National Atmospheric Deposition Program Network Operations Subcommittee

Steve Hilberg
Chair, Planning Committee, Midwest Extreme and Hazardous Weather Conference, American Meteorological Society, Central Illinois Chapter

Dave Kristovich
Associate Editor, *National Weather Digest,* National Weather Association

Mike Kruk
President, American Meteorological Society, Central Illinois Chapter

Ken Kunkel
Member, National Academy of Sciences Committee,"Review of the U.S. Climate Change Science Program's Synthesis and Assessment Product on Temperature Trends in the Lower Atmosphere"; and Chair, Advisory Committee, Weather and Climate Impact Assessment Science Strategic Initiative, National Center for Atmospheric Research

Robert Larson
Chair, National Atmospheric Deposition Program Data Management and Analysis Subcommittee

Christopher Lehmann
Chair, National Atmospheric Deposition Program Quality Assurance Advisory Group; Invited Member, Technical Advisory Board, Department of Civil Engineering, College of Engineering, Valparaiso University; and Session Chair, "Atmospheric Deposition Studies" and "Quality Systems Approaches and Tribal Air Quality Issues to Environmental Monitoring," 98th Annual Air and Waste Management Association Conference, Minneapolis, MN

Xin-Zhong Liang
Invited Presenter, National Aeronautics and Space Administration Jet Propulsion Laboratory seminar on regional modeling development

Momcilo Markus
Recipient, 2004 Editors Award, American Society of Civil Engineers

Sally McConkey
Elected Chair, Illinois Association for Floodplain and Stormwater Management

Doug Walker
Conference Co-chair, Straddling the Divide: Water Supply Planning in the Lake Michigan

Area, Chicago, IL, February 2005; and Associate Editor, *Ground Water*

Dan Webb
Recipient, Certificate of Appreciation for conducting water-quality event, Urbana Middle School Science Olympiad, March 2005

Dan Webb, Lauren Sievers, Ruth Ann Nichols, Kaye Surratt, Mary LeFaivre, and David Gay
Recipients, Certificate of Appreciation for conducting water-quality event, Illinois Science Olympiad, April 2005; and Judges, same event, National Science Olympiad, May 2005

Al Wehrmann
Co-Chair, 50th Midwest Ground Water Conference, Urbana, IL, November 2005

Derek Winstanley
Appointed Member, Groundwater Strategy Advisory Group of the Openlands Project and the Chicago Metropolitan Planning Council

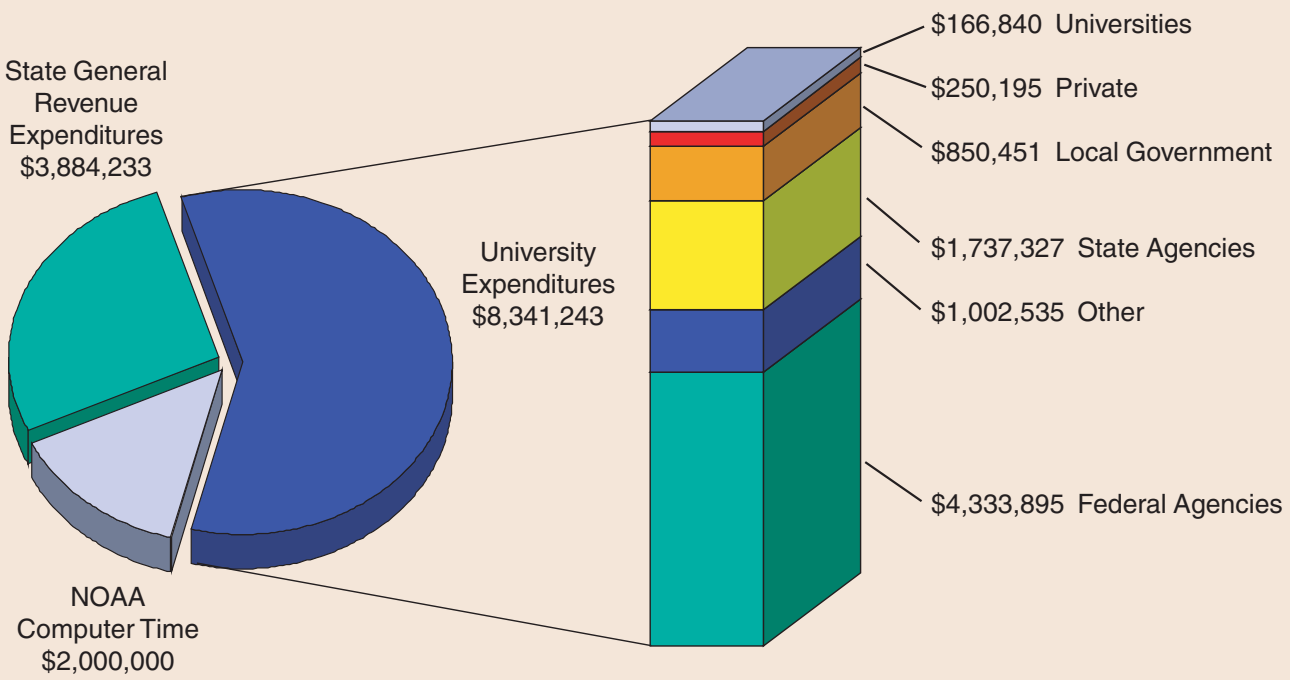
Special Recognition

Walt Kelly was selected for the 2005–2006 Fulbright Scholar Program in South Africa. The Fulbright Program, founded in 1947, is the U.S. government's flagship academic exchange effort and sends 800 U.S. faculty and professionals abroad annually. Starting in January 2006, Kelly, a groundwater geochemist, will spend 6 months collaborating on research focusing on microbial quality of groundwater in rural regions and teaching at the University of Fort Hare and Western Cape University.

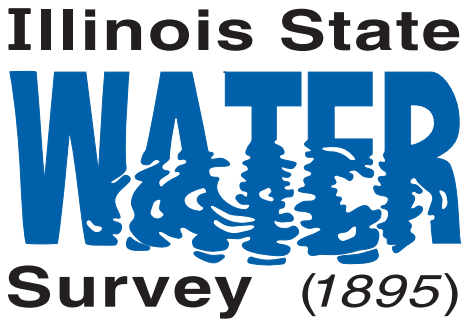
Ken Kunkel was selected as Fellow of the American Meteorological Society. The honor is in recognition of outstanding contributions to the atmospheric or related oceanic or hydrologic sciences, or their applications, during a substantial period of years. Kunkel has been with the ISWS since 1988, engaged in a range of basic and applied climate research and services.

Momcilo Markus was selected as Faculty Fellow of the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign (UIUC). His research is on data fusion, data mining, pattern recognition and regional classification of water-quality data in the Midwest. In addition to financial support, Faculty Fellows have access to NCSA's high-performance computers, visualization and virtual reality environments, data analysis software, and other advanced information technology tools, as well as opportunities to collaborate with NCSA staff. The Faculty Fellows program is funded by NCSA and the Office of the Vice Chancellor for Research, UIUC.

FINANCIAL STATEMENT, FY 05



Total Expenditures $14,225,476


Illinois State
WATER
Survey (1895)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