ILLINOIS STATE WATER SURVEY

SUMMARY REPORT

The mission of the Illinois State Water Survey is to characterize and evaluate the quality, quantity, and use of the atmospheric, surface water, and groundwater resources of Illinois.

The Illinois State Water Survey is a division of the Institute of Natural Resource Sustainability at the University of Illinois.

Water Survey series publications can be viewed at: http://www.isws.illinois.edu.pubs/isearch.asp

Champaign, IL
September 2009

Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7463
(217) 244-5459
www.isws.illinois edu

ILLINOIS

Water use and management issues first addressed by the Illinois State Water Survey (ISWS) decades ago are still critical today, impacting the health of Illinois citizens, the economic development of communities, and the preservation of natural resources. Air pollution, flooding, shrinking wetlands, and potential water shortages are among the challenges ISWS scientists continue to examine, using innovative technology and scientific data to find new solutions to long-term problems. Emerging issues present new opportunities for ISWS to initiate research projects and provide needed services.

Every day, ISWS scientists make significant strides in their efforts to solve society's challenges and understand how best to use water resources. Survey research endeavors and services in 2009 reflect a continuing commitment to evaluate the quality, quantity, and use of water supplies in Illinois, the Midwest, and the nation. This commitment is showcased in the following research and public service highlights.

Center for Atmospheric Science

Climate Modeling

For the past 10 years, the Center for Atmospheric Science (CAS) has been developing the multi-scale Integrated Earth System Model (IESM), designed to provide credible information on climate and natural resources, including their variability, change, and impact.

The modeling program seeks to address four key scientific issues: 1) the causes of historical variability of climate, ecosystems, air quality, and water quality; 2) the potential future changes in frequency and intensity of severe weather and climate events; 3) the potential future changes in air quality, water quality, and agricultural productivity; and 4) quantitative assessment of the societal implications.

As a central part of the IESM, the high-resolution regional climate model that the ISWS has developed provides a unique approach to improve projections at regional-local scales. A recent study has demonstrated that climate model downscaling significantly reduces general circulation models' present-climate biases and narrows inter-model differences in simulating present and future climates.

The complex modeling system is being developed by sharing expertise and personnel with other institutions and even countries. Scientists at ISWS and in China have enhanced the Weather Research and Forecasting–Chemistry model by incorporating improved pollution emission data to develop simulations of surface nitrogen dioxide, ozone, and sulfur dioxide concentrations. The model performance, as evaluated against the best available data, is comparable to or better than others published. Techniques and model development accomplished through such collaborations with China and other institutions will improve models used to understand and predict pollution concentrations in the Midwest.

Impacts of Climate Extremes

CAS Scientists investigate the economic, environmental, and societal impacts of major climate anomalies, such as the 1995 heat wave, the unusually productive 2004 growing season, and the record-breaking wet and stormy year in 2008. This information is useful for estimating impacts of predicted future climate changes.

Recently published analyses of 2008 weather revealed that unstable atmospheric conditions produced 17 heavy rainstorms during January–July 2008, and communities and farms in 33 Illinois counties had major damages. September 2008 flooding in northeast Illinois caused $155 million in damages to the Chicago urban and suburban areas. Local, state, and federal government costs for 2008 exceeded $350 million.

Still, the agricultural sector benefitted from the odd growing season conditions. Corn yields were the second highest on record, and soybean yields were the third highest due to optimal summer and fall weather conditions.

Snow amounts in northern Illinois (2008/09) were 10 to 25 inches above normal. Sixteen persons were killed and thousands were injured during a series of winter storms.

Two Reports of Investigation were published in 2009 detailing the unusual weather conditions and subsequent impacts of 2008: *2008: A Record Wet and Stormy Year in Illinois*, ISWS RI-117, and *The Severe Winter of 2008-09 in Illinois*, ISWS RI-118.

Midwestern Regional Climate Center (MRCC)

Established at the Illinois State Water Survey in 1988, the MRCC is one of six Regional Climate Centers (RCC) in the country. The RCCs are cooperative programs administered by the National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data, and Information Service and the National Climatic Data Center. The MRCC works closely with NOAA, the National Weather Service, state climatologists, and other agencies and groups in providing climate services to users throughout the Midwest.

In 2009, MRCC staff met with Illinois Natural History Survey entomologists to discuss coordinated West Nile virus research examining mosquito population characteristics and weather and climate data. The MRCC has been running two temperature-based models to predict the crossover dates when *Culex pipiens*, carrier of the West Nile virus, becomes the dominant mosquito species in the Midwest region. This year, the National Weather Service Model Output Statistics (MOS) 10-day forecast of maximum and minimum temperatures has been incorporated into the West Nile virus crossover day prediction program. The MOS data are used for the period after the year-to-date daily maximum and minimum temperatures for Urbana, Illinois. Climatological maximum and

minimum temperatures are employed following the period of the MOS 10-day forecasts through the end of summer.

The MRCC also has played a critical role in the national Climate Data Modernization Program, developing quality-control techniques that are now routinely used on data that increases the climate record by many decades. In the early 1800s, U.S. Army forts recorded daily weather observations. In the mid to late 1800s, volunteer observer networks were managed by the Smithsonian Institution and the U.S. Department of Agriculture. These data are digitized, quality controlled by MRCC staff, and then placed into the historical climate record for the U.S.

State Climatologist Office

The Illinois State Climatologist, located at the Illinois State Water Survey, is the primary source for Illinois climate information and services. The State Climatologist distributes information through an extensive Web site, and handles requests by phone, letter, fax, and e-mail. In addition, the State Climatologist is available to give talks to a wide range of audiences, issues press releases, and grants interviews to the media. The State Climatologist works with a wide range of clients, including students, teachers, homeowners, engineers, lawyers, other scientists, farmers, as well as federal, state, and local officials.

The State Climatologist also conducts research on climate topics that affect Illinois. Research results appear in Survey publications, scientific journals, and on the Survey Web site. Topics include historical climate trends, drought, El Niño and La Niña, heavy rainfall, summer heat, tornadoes, and winter storms.

A considerable amount of Illinois climate information can be found on the State Climatologist's Web site at www.isws.illinois.edu/atmos/statecli.

Center for Chemistry and Technology

Midwest Technology Assistance Center (MTAC)

The MTAC serves small public drinking water systems, seeking to increase their capacity to provide a safe and reliable source of drinking water at a reasonable cost. MTAC has recently launched a major new project designed to be a "one-stop shop" for small system operators.

The MTAC Cybercollaboratory (www.smallwatersupply.org) will provide a complete resource for water-related regulations, information, and industry news. Documents and resources from around the country will be catalogued and available through this portal. This Web-based resource will take a collaborative approach to help small system operators solve their problems, access information and experts, and share their expertise with others. There will be online education materials, webcasts with experts in areas of topical interest, and links to providers of training, materials, and direct assistance. The site will host interactive discussion forums and peer networking to help operators find answers to their own problems and offer solutions to help others. Small system operators can subscribe to e-mail or blog updates of issues important to them. Feedback from operators using the site will help to define additional services to respond to their needs.

Public Service Laboratory (PSL)

The PSL was established in 1895 to monitor the water quality in various waters of Illinois in response to Typhoid outbreaks around the country in 1893. Since that time, the Illinois State Water Survey has continued to offer Illinois citizens a free mineral analysis of their water. To date, the PSL has analyzed more than 230,000 samples. During the past 100+ years, the PSL's focus has changed to address the most pressing needs. Arsenic analysis is currently a major concern for private well owners due to the attention focused on the issue by the lowering of the federal drinking water standard from 50 to 10 micrograms per liter. Illinois has dozens of public water supplies and hundreds of private wells that are potentially susceptible to high arsenic concentrations.

Typical analytical determinations performed on samples submitted to the PSL include metals, anions, pH, dissolved solids, and alkalinity. When the analysis is complete, a report detailing the analytical results is forwarded along with a letter that explains the results of the analysis and any staff recommendations for addressing the problems. If the analysis indicates a potential health hazard, the individuals are referred to the appropriate state agency or assistance provider.

The PSL continues to be a cornerstone of the public service component of the ISWS, and is a truly unique program that provides a valuable resource for the citizens of Illinois. The program continues to adapt to meet the needs of the people of Illinois, and will be proactive in addressing new issues in a timely manner.

Center for Groundwater Science

Water Supply Planning

The availability and sustainability of an adequate and dependable water supply is essential for a society's public, environmental, and economic health. This important understanding led to the initiation, under direction of Executive Order 2006-01, of a pilot program for comprehensive regional water supply planning and management. Two areas were selected for pilot planning: an 11-county region in northeastern Illinois and a 15-county region extending across east central Illinois. For each region, consultants developed water demand scenarios to the year 2050. Because such predictions are uncertain, various assumptions were used to present a range of plausible future water needs. The

ISWS and the Illinois State Geological Survey were charged with analyzing the impact of the future demand scenarios on available water resources.

Groundwater and surface water models were prepared specifically to examine the impacts of future demands on aquifers, streams, and reservoirs within the two regions. The "models," computer programs that solve sets of interrelated equations representing water flow in aquifers and streams, provide insights on the effects of current and future groundwater and surface water usage and stressors, such as drought, and provide a rational basis for developing policy and management strategies pertaining to water resources development. Model development for northeastern Illinois benefited greatly from previous support provided by Kane County.

Modeling results indicate that for east central Illinois, surface reservoir capacities are insufficient to meet increasing demands under drought conditions, and potentially limiting drawdown impacts on the Mahomet Aquifer will be experienced in the Champaign County area. For northeast Illinois, Lake Michigan will continue to be the major water source; however, it cannot be relied upon to solve supply shortfalls beyond its current service area. The deep bedrock aquifers beneath northeast Illinois are being pumped at unsustainable rates. Shifting groundwater withdrawals to shallow aquifers is important but not without problems, as increasing shallow groundwater withdrawals will impact wetlands and streamflow. Analysis suggests the Fox River can provide additional water to meet future demand. Water conservation is likely to be another key factor to reducing the need for additional water.

Groundwater Quality in Northeastern Illinois

Although water supply planning studies are focused on water quantity, water quality is an important consideration in northeast Illinois' water future. Using the voluminous historical data available in ISWS' archives supplemented with new data collection, scientists in the CGS are taking a close look at groundwater quality and quality trends in the region's aquifers.

The water supply studies mentioned in the previous section suggest that continued growth in deep aquifer pumpage is not sustainable. This implies other sources of water will be needed, including shallow groundwater. However, a CGS study designed to examine historical shallow groundwater quality data shows changes have occurred in water quality due to urbanization activities in the Chicago metropolitan area. Dissolved solids levels have been increasing regionally since around 1960, primarily due to road salt runoff. The largest increases were observed in the western and southern collar counties of DuPage, Kane, McHenry, and Will. About one-quarter of samples collected from public supply wells in the Chicago area in the 1990s or later had chloride concentrations greater than 100 milligrams per liter (mg/L) (35 percent in the western and southern collar counties), compared with median values of less than 10 mg/L prior to 1960. The greater increase in concentrations in the western and southern collar counties compared to Cook and Lake Counties is likely due to both natural and anthropogenic factors, including the presence of more significant and shallower sand and gravel deposits and less curbing of major highways and streets.

CGS scientists are concerned that continued and growing use of the deep aquifers will be accompanied by deteriorating water quality. There is evidence of temporal increases in concentrations of dissolved contents in deep groundwater. Large groundwater withdrawals may be inducing groundwater movement from adjacent units or downdip areas containing high concentrations of dissolved solids. ISWS archived data were used systematically to examine temporal trends in water-chemistry data for deep bedrock aquifers in northeastern Illinois. Most data suggest that concentrations of major ions and total dissolved solids (TDS) are not increasing in wells open to deep bedrock aquifers in most of northeastern Illinois. There are some locations where concentrations of some ions and TDS are increasing, including the major pumping centers at Joliet and Aurora.

Radium (Ra) and barium (Ba) concentrations already are elevated above drinking water standards in deep bedrock aquifers in parts of northern Illinois. However, many deep wells in the region are open to multiple aquifers, thus clouding the determination of which aquifer or aquifers may be the source of the Ra and Ba. The Midwest Technology Assistance Center (MTAC) provided funds to assist in identifying and sampling wells open only to individual deep bedrock aquifers in the Chicago region to better understand the source of these naturally occurring contaminants. Results suggest the Ironton/Galesville aquifer may have elevated levels of Ra and Ba compared to other deep bedrock aquifers. The presence or absence of sulfate is the primary control on whether or not Ra and Ba can accumulate in the groundwater.

Center for Watershed Science

Floodplain Mapping and Hazard Identification

Flooding is the single most predictable natural disaster as flood-hazard areas can be identified through hydrologic and hydraulic modeling. Identification of flood-hazard areas is fundamental to the protection of life and property. In 2004 the Illinois Department of Natural Resources (IDNR) signed a Cooperating Technical Partnership (CTP) agreement with the Federal Emergency Management Agency (FEMA) to convert flood-hazard maps of the State of Illinois to a new digital standard. The Illinois State Water Survey (ISWS) and the IDNR Office of Water Resources (OWR) launched

a joint effort to prepare and maintain these essential flood hazard maps for the State.

The success of Map Modernization in Illinois is clearly documented by the number of counties that will have Digital Flood Insurance Rate Maps (DFIRMs) through the Map Modernization Program. By the conclusion of Map Modernization in 2011, 80 percent of the counties in Illinois will have high quality digital flood maps covering 97 percent of Illinois' population and 82 percent of the land area. (Note that totals include McHenry, Peoria, Madison, and St. Clair Counties, which were contracted with private companies in 2003.) In 2009, the State of Illinois received the Association of State Floodplain Managers' (ASFPM) Tom Lee State Award for Excellence; the floodplain mapping effort was one of five Illinois floodplain management programs recognized by this award.

In 2008, the Illinois State Water Survey signed an independent CTP agreement with FEMA. The ISWS Hazard Identification and Mapping Program will continue to improve the inventory of floodplain maps and data and work to communicate flood risk to the public through FEMA's new initiative called Risk MAP, 2010-2014.

Fox River Watershed Investigation

In a multi-phase water quality study of the Fox River in northeastern Illinois, researchers are addressing significant watershed issues by implementing a watershed-scale investigation, which includes data collection, model development, and water quality monitoring. Coordination and funding for these research activities are provided by the Fox River Study Group (FRSG), representing a diverse coalition of local stakeholders. The ultimate goal of the project is to provide to stakeholders a suite of science-based tools for use in planning efforts so that sound decisions can be made to help protect and improve the overall health of the Fox River.

The first two phases of the project have been completed. These efforts provided stakeholders with a synthesis of recent water quality studies in the study area, a comprehensive database of environmental data (water and sediment quality, biology, and habitat), a catalog of geospatial data, and recommendations for monitoring and modeling. Phase II provided a suite of computer simulation models developed using the existing data (HSPF and QUAL2K models).

Intensive data collection designed to close existing data gaps identified in Phase I & II will provide the data necessary for model calibration and validation. This two-year monitoring effort focuses on gathering data during storm events to determine the loadings of specific constituents contributed by various tributary watersheds and transported in the Fox River.

Phase III, scheduled to begin in January 2010, will use the newly collected monitoring data to (1) finalize the models calibration, (2) update the models with the latest climate and land use information, and (3) use the updated models to simulate future watershed conditions under various development and management scenarios. The project information is available at http://ilrdss.isws.illinois.edu/fox/.

National Atmospheric Deposition Program

The National Atmospheric Deposition Program (NADP) is a monitoring program that provides data to support informed decisions on air quality issues. NADP operates three networks that monitor precipitation chemistry at more than 350 sites. Data can be retrieved from the NADP Web site, http://nadp.isws.illinois.edu.

National Trends Network (NTN)

The NTN is the largest North American network that provides a long-term record of precipitation chemistry across the United States. Its 250 sites are located far from urban areas and point sources of pollution. Each site has an automated precipitation collector and gage to gather samples only during rain or snowfall.

Weekly samples are collected and are sent to the Central Analytical Laboratory (CAL) at the Illinois State Water Survey for analysis. The CAL measures free acidity specific conductance, and calcium, magnesium, sodium, potassium, sulfate, nitrate, chloride, and ammonium ions. Approximately 13,000 samples were processed in 2008.

Mercury Deposition Network (MDN)

The objective of the 110-site MDN is to develop a national database of weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition. The data are used to provide information on spatial and seasonal trends in mercury deposited to surface waters, forested watersheds, and other sensitive receptors. The network collected 5,800 samples in 2008. Mercury concentrations are measured at a concentration below 1 part per trillion.

Atmospheric Integrated Research Monitoring Network (AIRMoN)

The seven-site AIRMon Network collects precipitation samples daily or within 24 hours of a storm event. In 2008, 1,200 samples were collected. This information can be used to determine the effectiveness of emissions controls mandated by the federal Clean Air Act and to evaluate the potential effects of new emission sources on vulnerable wilderness areas.