USGS science for a changing world

IN-KY

Spring-Summer 2016

U.S. Department of Interior
U.S. Geological Survey
Indiana-Kentucky Water Science Center

http://in.water.usgs.gov
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Message from the Director

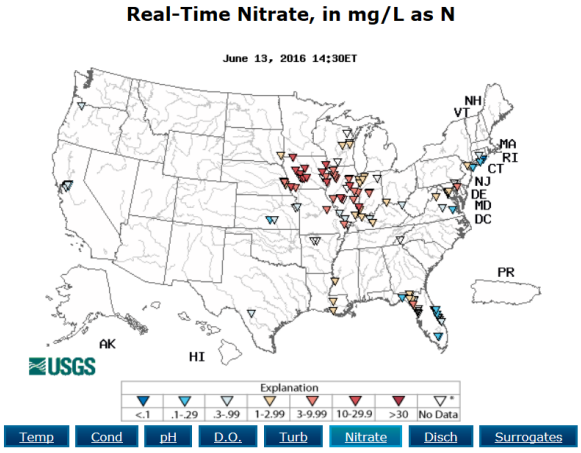
Welcome to the fourth installment or the *"Spring-Summer 2016"* version of the IN-KY Newsletter. I use this format three to four times a year to highlight USGS activities and water-related science going on at the Indiana-Kentucky Water Science Center. We also take advantage of this opportunity to highlight our amazing scientists that work for the USGS.

The highlight of the spring and summer for our Leadership Team was when Mike Griffin (Director), Jeff Frey (Deputy Director), and Pete Cinotto (Deputy Director) traveled to Washington, D.C. in May to meet with the Indiana and Kentucky Congressional delegations. The goals of the visit were to introduce ourselves and the USGS to the congressional staffers, and highlight our ongoing science activities and answer any water-related questions that each office might have received from its constituents. It was a busy time on Capitol Hill as votes were being taken and staffs were getting ready for the Memorial Day recess, but I believe it was a successful trip and we will continue to interact with congressional staffs in both their D.C. and state offices.

IN-KY Science Activities

The USGS, NOAA and other partners are predicting an average "hypoxic or dead zone" for the Gulf of Mexico. Scientists predict that this "area of low to no oxygen that can kill fish and marine life" will be approximately 5,900 square miles this year. The USGS operates more than 2,700 real-time streamflow gages with 60 sites having real-time nitrate sensors within the Mississippi River basin. The Indiana-Kentucky Water Science Center provides data from 15 sites to help track how nutrient loads are changing over time.

You can access this information at the USGS "Water Quality Watch page: http://waterwatch.usgs.gov/wqwatch/.



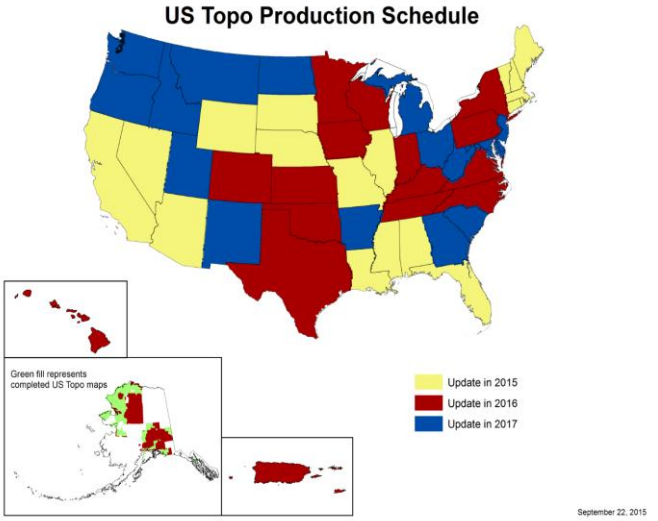
Annual Cooperators Meeting – Hold the Date!!

The Indiana-Kentucky Water Science Center is planning to host its annual cooperator/scientific workshop on **October 5 for its Indiana Cooperators** and **October 6 for its Kentucky Cooperators.** You may attend either session or both. A detailed agenda will be sent out by email and through our social media outlets.

The Indiana-Kentucky Water Science Center appreciates your continued interest, dedication, and support. With the support of our federal, state and local partners, we will continue to deliver on our promise of providing timely and accurate water information to meet the needs of the Nation, especially those in Indiana and Kentucky.

New Maps for Kentucky:

Updated US Topo maps for Kentucky are now available in the USGS Store for free download. One of the main improvements is the inclusion of the U.S. Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) road data. Other important additions include the integration of wetlands layers using data from the U.S. Fish & Wildlife Service National Wetlands Inventory, along with the continued incorporation of "crowdsourced" trail data from the International Mountain Bike Association. The USGS's National Geospatial Technical Operations Center is currently in its third 3-year production cycle to update the conterminous 48 states. Hawaii, Puerto Rico, and the US Virgin Islands also have US Topo coverage. Alaska has been started, and should be complete by 2018.



Long-Term Monitoring of Precipitation Chemistry by USGS in Indiana and Kentucky

You might have heard about "acid rain" as a part of the water cycle that influences surface water quality and ecosystem health. You may be surprised to know that long-term measurements of precipitation chemistry by the USGS in Indiana and Kentucky contribute to the knowledge base about this problem. "Atmospheric deposition" is the term used to describe the transfer of air pollutants to the landscape by precipitation and dry fallout. Acid rain involves atmospheric deposition of sulfur and nitrogen air pollutants which dissolve into the rain and create harmful effects on the environment.

The USGS is a member of the National Atmospheric Deposition Program (NADP), a nearly 40-year collaboration of Federal and State agencies, Tribes, universities, and private entities that operate national monitoring networks for precipitation and air chemistry. NADP uses uniform equipment, standard protocols, central laboratories, and technical committees to maintain these monitoring networks (fig. 1). The goal of the NADP is to produce high quality data that is comparable nationwide. These data are accessible from an open, online, digital archive for use by scientists, educators, and others.

NADP data were cited in more than 200 publications last year, and the NADP data from Indiana and Kentucky are part of a national picture of acid rain spanning over 3 decades.

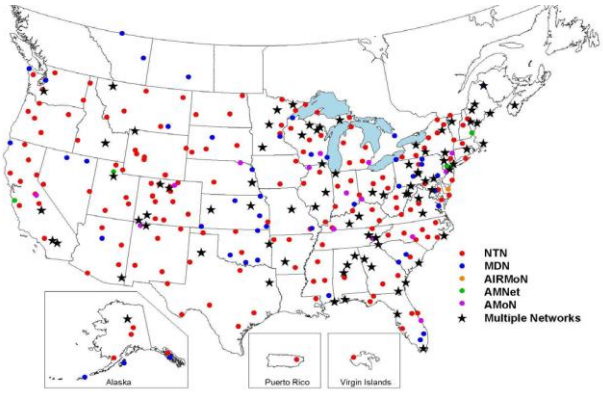


Figure 1 - National Atmospheric Deposition Program network sites, from NADP (2012).

The NADP National Trends Network (NTN) has about 260 sites where digital gages measure precipitation and automated collectors capture weekly precipitation samples for chemical and physical analysis related to acid rain (fig 2). Site operators service this equipment every Tuesday nationwide. For maps and records, NADP uses site identification numbers with the state abbreviation and county code. USGS supports the operation of four NADP NTN sites in Indiana and Kentucky that have been in service for 33 years: IN20 near Huntington, IN22 near Vincennes, KY03 near Mackville, and KY35 near Morehead, plus KY19 in Louisville that has been in service 13 years. Over the years, about 7,500 weekly measurements have been made at these five sites. Other NADP agencies support five more NTN sites at Porter and Lafayette in Indiana and Mammoth Cave, Lilley Cornett Woods, and Lake Barkley in Kentucky.

Figure 2 - Automated precipitation collector (left) and digital precipitation gage (right) at an NADP site

The long records of weekly data from the NTN documented a large-scale change in precipitation chemistry related to the control of sulfur oxide air pollution. For example, annual average precipitation in most of the eastern USA was acidic (less than 5 pH units) in 1985, but became less acidic (greater than 5 pH units) by 2014 (fig. 3).

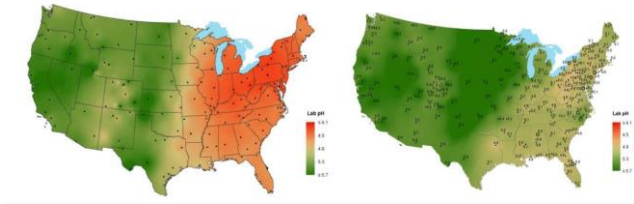


Figure 3 - National Atmospheric Deposition Program maps of precipitation pH, 1985 (left) and 2014 (right).

Continued –

As the graphs of precipitation pH and sulfate deposition from the IN20 site show, the rise in pH was accompanied by the decline in sulfate (fig. 4). The work of the NADP and the USGS at monitoring sites in Indiana and Kentucky is not finished, even with the improvements in acid rain.

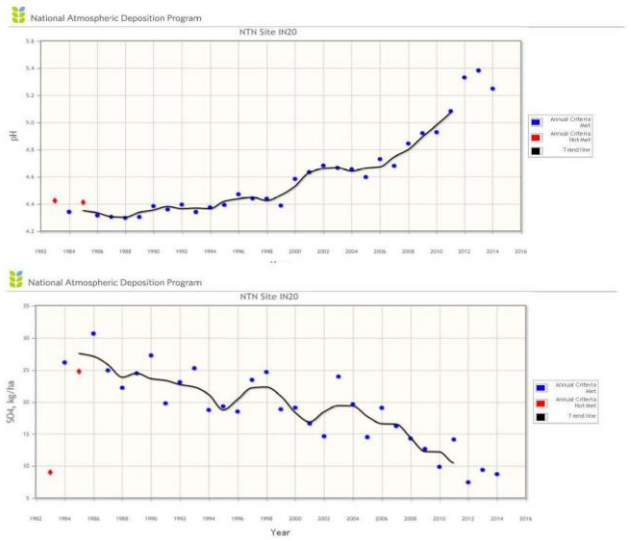


Figure 4 - Graphs of pH in precipitation and sulfate wet deposition at site IN20, 1983–2014.

Nitrogen oxides and ammonia in the air continue to contribute wet and dry atmospheric nitrogen deposition that is not diminishing like sulfate. Nitrogen wet deposition data from the NTN, combined with data on nitrogen dry deposition from an NADP companion network, show areas where atmospheric nitrogen deposition could negatively affect ecosystem health (fig. 5). Public and scientific inquiry about global air pollution and its effects will continue, and the reliable data from the NADP and the USGS will continue to be an important part of the discussion.
For more information, visit http://nadp.sws.uiuc.edu/NADP/

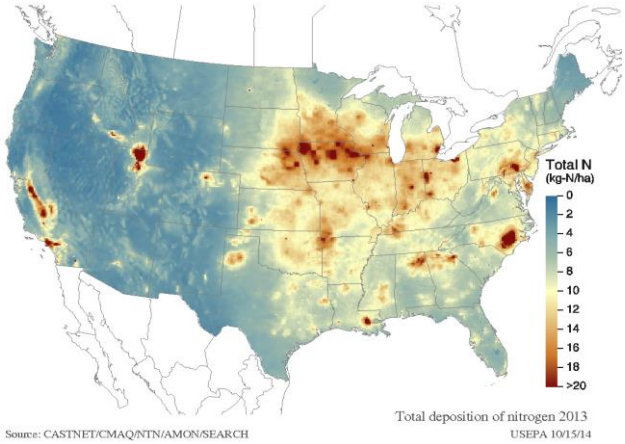


Figure 5 - Map of total (wet plus dry) atmospheric nitrogen deposition in 2013, from EPA (2014).

For further information contact **Marty Risch**, USGS Research Hydrologist, NADP 2015 Executive Chairman at 317-600-2763.

Bathymetric Surveys of Geist and Morse Reservoirs in Indiana

Figure 1- Norbit Multibeam System

The Indiana-Kentucky Water Science Center has partnered with Citizens Energy Group to collect new bathymetric data for Geist and Morse Reservoirs in Indiana. This cooperative project will be compared with the previous bathymetric surveys of Geist and Morse Reservoirs collected in the mid-1990s. The objective is to compare the old and current bathymetric surfaces to determine potential sedimentation amounts and rates. Taking advantage of the latest technology, the bathymetric surfaces are being surveyed with a multibeam echo sounder. The Norbit multibeam system (fig. 1) is capable of collecting 256-512 points of data at each sounding or ping within a 178 degree swath width, which allows for the creation of a high density point-cloud surface (fig. 2) where the multibeam system is used. Initial field collection of the multibeam data on Geist and Morse Reservoirs (fig. 3) were completed in April and May 2016. The current study will span four years and also include the reevaluation of small areas of the reservoirs where dredging has occurred. The final bathymetric products will be merged with existing LiDAR data to create one seamless surface of the reservoirs and surrounding land features.

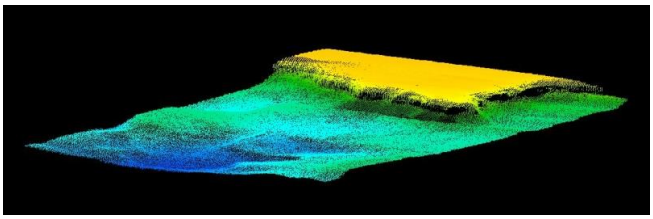


Figure 2 - Sample Point-Cloud Multibeam Data

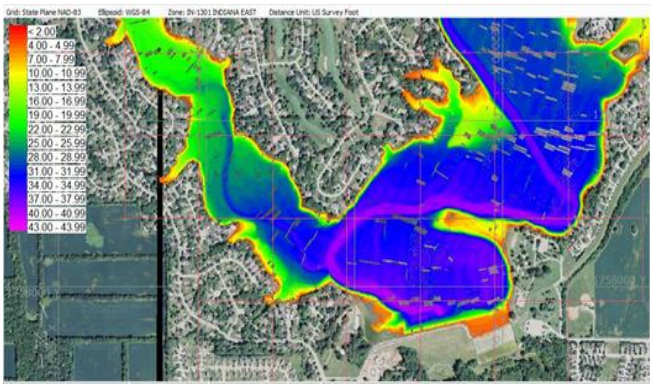


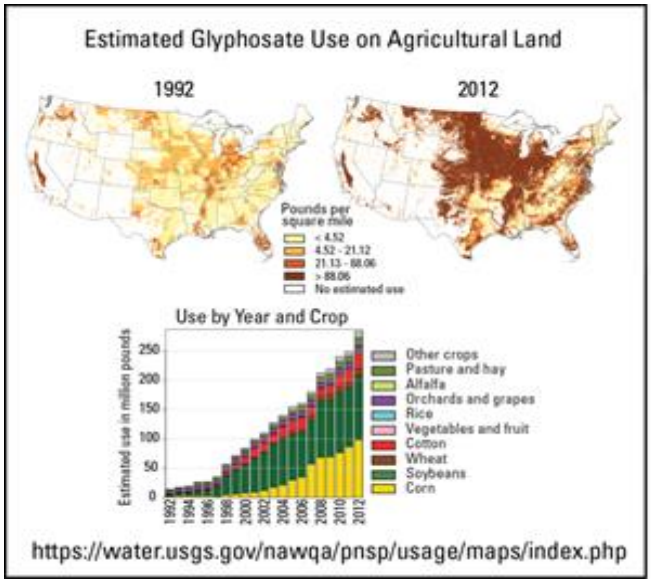
Figure 3 – Raw Field Collection Depths for Morse Reservoir (note old stream channels of Cicero and Hinkle Creeks)

For further information contact **Zach Martin**, Hydrologist, at 317-600-2732.

Employee Spotlights

Dr. Nancy Baker

Nancy has been a Hydrologist and Geographic Information Systems (GIS) Specialist for the USGS for 32 years with 25 of those years in Indiana. She currently compiles county-level agricultural pesticide use estimates for the U.S. as part of the National Monitoring and Stream Assessment (NMSA) team. Her role on the team is to use GIS tools to enhance the understanding of how landscape characteristics and hydrologic setting affect transport processes and pathways of agricultural chemicals and to investigate the effectiveness of management strategies on water quality and ecosystem conditions.



In 2001, Nancy became Lead Scientist for the White River -- Miami River Agricultural Chemical Transport (ACT) team as part of the National Water Quality Assessment Program (NAWQA). She also became involved in several national endeavors including compilation of data for inclusion in the Heinz Center *State of the Nation's Ecosystems 2008* report and the EPA's *Report on the Environment*.

In 1991, Nancy relocated to the Indiana Water Science Center as part of the NAWQA Cycle I, White River Study team. She provided GIS support as well as participated in data collection, data analysis and interpretation, and documentation of results.

Dr. Tanja Williamson

Tanja started working for the USGS as an intern in the Pennsylvania Water Science Center in 1990 – after her sophomore year in college. She was supervised and mentored by Ed Koerkle – a serendipitous event that truly showed her how to be a great scientist. Ed worked to keep her busy, made sure she learned about the breadth of science going on in the office, and welcomed her back for every semester break for the next two years – all while working diligently at his MiniTab terminal. Tanja's training for the USGS started when she took an introductory geology course her freshman year in college and was reminded of how much it had interested her as a kid. Her favorite elementary school field trip was to the rocks and minerals museum at the university – but it had never occurred to her that she could do this for a living. Her undergrad is in geology, complete with a summer field camp that took her from State College to Alta, Utah and many places in between. This was probably when she realized that the landforms themselves are what held her interest. She focused on geomorphology for her Masters Degree. She was in California, where one can travel the landscape and follow the hydrology from the mountains to the desert or ocean in a few hours. She researched the Holocene (the last 12,000 years) development of the headwaters of the Mojave River in the San Bernardino Mountains near the San Andreas Fault. One of the many tools she used to add to the chronology of events for this area was a soil chronosequence – looking at the relative age of soils on different landforms. This opened up a new world to her and suddenly what was viewed as "dirt" became a rich record of history and source of information. So, after finishing her Master's, she switched over to the soils department and earned a PhD in Soil and Water Science. She worked in the San Gabriel Mountains looking at watersheds that, in the 1960s, had been purposely converted from native shrubland (chaparral) to grassland in order to increase water availability for the downstream population (Los Angeles). It didn't work – turns out one of the grasses (Veldt Grass) was as adept at extracting water from the soil as the shrubs. But, the soils and the hillslopes were significantly different between chaparral and grass watersheds – a change that had happened in only 40 years! This was the start of her research focus on more current hydrologic and landscape processes, involving human decisions that alter the landscape.

Continued –

Tanja's current research is two-fold. She spends most of her time working on hydrologic models that are used for resource management planning, including water-use, landscape restoration, and agricultural resilience. Her contributions have focused on improving what we know about how soils information is obtained and translated for hydrologic models – this enables her to look at larger basins or new areas where there are no historical observations. She has been able to use regional hydrologic modeling to research different ways of estimating potential and actual evapotranspiration – this is key to understanding soil-water availability for agriculture and ecosystems as climate continues to change.

Veldt Grass along California Coast - This photo from Montana de Oro State Park, near Morro Bay, shows how this invasive species moves into native-shrub areas.

A second realm of her research focuses on the importance of conservation agriculture. This is a broad topic with two specific aspects. First, understanding sediment source and how it relates to land management – suspended sediment is frequently associated with nutrient concentrations. Second, how water is stored and moved through agricultural landscapes – this includes soil-water storage, tile drains, and agricultural ditches. Both of these research avenues give more information about the amount, energy, and path of water as it moves across a landscape. This is critical to identifying areas where conservation management can make the most difference as well as how far this management extends in time and space.

Stream channel in Appalachia – The permanence of streamflow in this channel helps determine how it is protected. Ongoing research is aimed at using hydrologic modelling to determine the length of the stream that has seasonal streamflow.

Agricultural ditch with land retirement along the channel - This 10-m wide strip of retired land decreases sediment movement to the stream and helps stabilize the stream channel.

Studing Acid Mine Drainage Issues in the Daniel Boone National Forest

In 2015, the IN-KY WSC began a partnership with a new federal cooperator, the USDA Forest Service. Managing the Daniel Boone National Forest is the primary responsibility of the Forest Service in Kentucky. The Daniel Boone National Forest spreads across 21 counties in southern and eastern Kentucky, containing over 708,000 acres. It is managed for multiple uses: recreation, timber, wildlife, minerals, and water. Several of the watersheds in the Daniel Boone National Forest have degraded water resources, mostly from improperly reclaimed coalmines and Acid Mine Drainage (AMD) (fig. 1).

Figure 1- A stream in Wildcat Branch watershed impaired from Acid Mine Drainage

Mac Cherry, a hydrologist for the IN-KY WSC is the project chief for the multi-year project which is investigating surface water/ groundwater interactions in three abandoned mine-land watersheds. Each watershed was mined in a combination of different manners (surface/underground/contour) and present unique challenges to the Forest Service, particularly from the geology. The unique geology results from a combination of natural karst (fig. 2) and man-made underground mine portals. The underground mine portals alter the natural surface water/groundwater interaction, discharging groundwater from seeps along the mountainside (fig. 3).

Figure 2 - A natural sink resulting from karst geologic features

Figure 3 - A seep conducting groundwater from an underground mine portal to the surface

The project aims to define the baseflow, gaining/losing reaches, and determine the relative contribution of the tributaries in each watershed. A real-time surface water gage was established at Rock Creek near Yamacraw (03410590) in July 2015. The study watersheds are in different steps of reclamation within the bounds of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Two USGS Scientific Investigations Reports are planned for 2017. Upon project completion, the FS will use the information to augment the completion of various CERCLA assessments and reports.

For further information contact **Mac Cherry**, Hydrologist, at 502 493-1912.

New USGS Streamgage Aims to Protect Hoosier Lives, Property

A new streamgage recently installed by the U.S. Geological Survey, Indiana-Kentucky Water Science Center in the city of Linton, Indiana, will provide continuous, real-time streamflow and water level data in an area that has demonstrated a need for reliable flood warning and flood-related data. Devastating floods hit Linton, approximately 40 miles south of Terre Haute, in April 2013. The new USGS streamgage on Bee Hunter Ditch will aid emergency personnel by providing valuable information needed to make decisions on evacuations and assist with infrastructure protection when water rises. The information from the gage will be transmitted hourly for use in flood forecast models of Greene County, support decisions by local emergency managers for road closures and allow residents to monitor conditions from their homes at any time. Funding for this gage is provided in cooperation with the Indiana Department of Transportation.

Recent Publications

Flood-inundation maps for the East Fork White River at Shoals, Indiana
Scientific Investigations Report 2016-5036
https://pubs.er.usgs.gov/publication/sir20165036

Flood-Inundation Maps for Sugar Creek at Crawfordsville, Indiana
Scientific Investigations Report 2016-5043
https://pubs.er.usgs.gov/publication/sir20165043

Groundwater quality from private domestic water-supply wells in the vicinity of petroleum production in southwestern Indiana
Open-File Report 2016-1081
https://pubs.er.usgs.gov/publication/ofr20161081

Classification of ephemeral, intermittent, and perennial stream reaches using a TOPMODEL-based approach
Journal of the American Water Resources Association
https://pubs.er.usgs.gov/publication/70159917

Hydrologic data and groundwater-flow simulations in the Brown Ditch Watershed, Indiana Dunes National Lakeshore, near Beverly Shores and Town of Pines, Indiana
Scientific Investigations Report 2015-5141
https://pubs.er.usgs.gov/publication/sir20155141

The role of dynamic surface water-groundwater exchange on streambed denitrification in a first-order, low-relief agricultural watershed
Water Resources Research
https://pubs.er.usgs.gov/publication/70161863

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