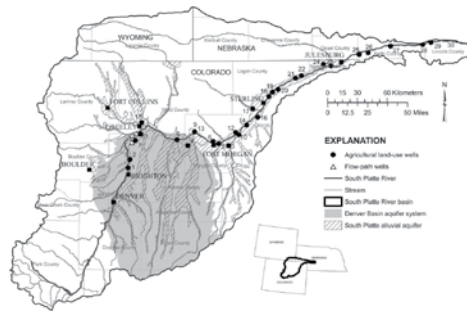


## 2016 tour to Colorado's South Platte basin June 14-16

June 14-16 are the dates for this year's Water and Natural Resources Tour to Colorado's South Platte River basin.

The tour will key on many South Platte basin and Denver metro area issues that effect not only Colorado water use, but downstream water availability and use in Nebraska.

"Basin water use and development in Denver and the surrounding front-range metropolitan area, including ongoing conversion of former agricultural water rights to urban and suburban use as the Denver metropolitan area continues to grow are obviously huge considerations and will be closely examined on tour from a number of different angles," said Nebraska Water Center communicator Steve Ress, one of several tour co-organizers.



Though early in the planning process, organizers say the tour will likely include stops and speakers related to satisfying ever-increasing urban and industrial water demands along Colorado's Front Range; changes in snow-melt runoff caused by recent pine wilt beetle infestations of native pine forests; water demands in the state's growing recreation industry, including ski

industry snow-making and summer white-water rafting; an examination of the 19th century gold rush and mining industry that opened much the area to European settlement and the continuing problems of cleaning up 100-year-old gold-dredging sites; Colorado's state water plan; shared use of basin water under a Nebraska-Colorado compact and many other topics.

Metropolitan and small town water systems, such as Denver Water, will also likely be included in the mix of topics examined.

"We are just beginning to fully explore the full palate of topics and potential tour stops available to us," Ress said. "It will be a very full, diverse, interesting and fun tour."

Much of it will take place in the heart of Colorado's high country.

Registration will be through The Central Nebraska Public Power and Irrigation District (CNPPID) in Holdrege and will likely open May 1. The tour will begin and end in Denver. Tour participants will be responsible for their own travel arrangements to and from the event. All other food, lodging, motor coach expenses and fees will be covered in the tour registration costs. Registration cost has not been set.

In addition to CNPPID and the Nebraska Water Center, tour sponsors include the Daugherty Water for Food Institute at the University of Nebraska, UNL's Institute of Agriculture and Natural Resources and Nebraska Public Power District.

More information will be online at [watercenter.unl.edu](http://watercenter.unl.edu) and [cnppid.com](http://cnppid.com) as it develops.

### Inside

DIRECTOR'S NOTES	2
NEBRASKA WATER CENTER/SNR "WATER AND HEALTH" PUBLIC LECTURES	3
WRAP MEETS	4
GROUNDWATER RISES	5
2015-2016 NWC ANNUAL REPORT	5
CUTTING EDGE RESEARCH	6
SOIL WATER BALANCE	7
WATER TOUR	8-9
SMARTPHONES TO TRACK AGRICULTURAL WATER USE	10
WETLANDS PRESERVATION EFFORTS	11
GROUNDWATER KNOWLEDGE	12
TOOL TO TRANSFORM DATA INTO VALUE FOR FARMERS	13
DRONES FOR AGRICULTURE AND NATURAL RESOURCES MANAGEMENT	14
GLOBAL CONFERENCE	
BACK COVER	



## Research, awards, speaking engagements, new staff position

From the Director  
**Chittaranjan Ray, Ph.D., P.E.**

A great deal has been happening since my last iteration of these “Notes” in the Fall 2015 issue of the Water Current.

We have identified the first set of 12 participants in the Water Advanced Research and Innovation (WARI) Fellowship Program, a joint initiative with India’s Department of Science and Technology and the Indo-U.S. Science and Technology Forum. They were selected from a pool of 79 well-qualified applicants and I traveled to Delhi in November to represent the Daugherty Water for Food Institute (WFI) on a joint selection committee that picked the 12 finalists. Five of these are Ph.D. students and seven are early-career faculty, who will begin their research in water science and engineering at UNL in May. The Indian government is paying the costs of this new program and we see it as the beginning of a great, new international collaboration.

The NWC has awarded and administered five research projects with U.S. Geological Survey (USGS) Section 104b funds. Our advisory board met in October to review these funded projects, and also to discuss future USGS 104b funding initiatives and other NWC outreach and communications projects. This was a very productive and cooperative meeting.

NWC and our Water Sciences Laboratory have received several awards from state and national agencies, including from the Nebraska Environmental Trust for a project on the leachability of chemicals in Nebraska; the Nebraska Department of Natural Resources to fund a graduate assistantship; and the City of Hastings for a Vadose Zone Nitrate Study for the city, as well as other awards from USDA Agricultural Research Service, the University of Missouri, the al-Farabi Kazakh National University in Kazakhstan, and the U.S. Department of the Interior Fish and Wildlife Service.

We are beginning to finalize a new staff position here that will take the form of a research and extension communicator to help connect and keep close contact between UNL Extension and water research entities, NWC, the Daugherty Water for Food Institute (WFI), the state’s natural resource districts and state and federal agencies. The position is being funded one-third each by NWC, UNL Extension and WFI. We expect to have a person hired to fill this new position by summer.

We have begun planning the joint 2016 Water and Natural Resources Tour with representatives from the Central Nebraska Public Power and Irrigation District. This year’s tour will be in Colorado’s South Platte River basin June 14-16, beginning and ending in Denver. The tour will examine interstate compact issues on the South Platte along with urban, industrial and recreational development on Colorado’s front range that impact basin water flowing into Nebraska, as well as environmental issues such as the recent Pine Wilt Beetle infestation in Colorado and other topics. Our communicator, Steve Ress, Tim Anderson from CNPPID and

tour host Mike Jess made the first planning trip to the area in early December and will likely go there again before an itinerary and registration details for the tour are completely known. Expect registration to begin around May 1. Registration will be through CNPPID in Holdrege and we expect the tour to sell-out quickly.

NWC received approval from the Biological Resources Division of the Organization for Economic Cooperation development (OECD) to sponsor a workshop entitled “Virtual Water in Agricultural Products: Quantification, Limitations, and Trade Policy” and OECD will pay up to 27,000 Euros for the travel of 10 U.S. and international experts. WFI and IANR will provide additional financial contributions and cosponsorship for the workshop.

I am also working with the National Science Foundation for additional funds to support the travel of U.S. junior faculty, students, and postdoctoral candidates to attend the workshop this summer.

In December, I was invited by Colorado State University to give a talk at their Food, Energy, and Water workshop in Arlington, Va. with the idea of building a team to address biofuel issues in the Great Plains. We will see how this proceeds.

I also traveled to Indonesia to join UNL Chancellor Harvey Perlman and his team and to represent WFI for a symposium that UNL organized in Jakarta for the Global Yield Gap Atlas.

With help from WFI’s proposal development coordinator, Karen Hansen, Dan Snow and I submitted a new proposal to the Water Sustainability fund of the Nebraska Natural Resources Commission just before the holidays. We will be anxious to see what becomes of that.

A UNL Conservation and Survey Division drilling crew has started a few boreholes for our Hastings research project. We have a new student (Craig Adams) who earlier worked with UNL School of Natural Resources (SNR) aquatic ecologist Amy Bergin as a technician, and is now beginning to work with Dan Snow and I as an SNR graduate student.

Our spring semester water seminar lecture series began in mid-January. Each of the seven public lectures are part of an overall theme examining “Water and health” and we have some very interesting lectures on tap, from both local and national experts in several research disciplines. We hope you can join us on Wednesday afternoons at Hardin Hall on UNL’s East Campus for one or more of the lectures.

Lastly, you can soon expect to see a 2015-2016 NWC annual report, both in print form and electronically, chronicling the research, programs and events of the past year. Especially notable this past year was marking the Water Sciences Laboratory’s 25th anniversary. We are very fortunate to have this cutting edge research and teaching facility available to our faculty, especially under the able leadership of Dan Snow, who has been with the lab since its very beginnings.

## Nebraska Water Center/SNR “Water and health” public lectures run through April 13

Steve Ress

Seven free public lectures themed on the importance of “Water and health” comprises the University of Nebraska-Lincoln’s spring semester water seminar that began January 13.

The lectures are held roughly every-other-week from 3:30 to 4:30 p.m. Wednesdays through April 13. All lectures will be in the first floor auditorium of Hardin Hall, northeast corner of N. 33rd and Holdrege Sts, on the UNL East Campus.

Lectures are Jan. 13 and 27, Feb. 10 and 24, March 9 and 30 and April 13.

“Water and its links to human and animal health are increasingly evident and increasingly a focus of research and study throughout the University of Nebraska system, so this spring’s lectures are a wonderful opportunity to involve students and the public in some of the latest research on the topic,” said Nebraska Water Center director Chittaranjan Ray. NWC, which is part of the Daugherty Water for Food Institute at the University of Nebraska, has helped organize and offer the annual spring lectures for more than 40 years.

“Water and health are at the forefront of much multidisciplinary NU research, so the lectures should hold broad appeal to both students and the public,” Ray said.

Cosponsoring the seminar with the NWC is UNL’s School of Natural Resources, which also offers the lecture series for student credit, and UNL’s Institute of Agriculture and Natural Resources.

Most of the lecture videos and speaker PowerPoint presentations will be posted at [watercenter.unl.edu](http://watercenter.unl.edu) within a few days after each lecture.

The complete lecture series is as follows:

**January 13**  
Martha Rhoades, research manager, UNL, “Non-Hodgkin Lymphoma, Birth Defects and Water Quality in Nebraska: The Chicken or the Egg?”

**January 27**  
Alan Kolok, professor, University of Nebraska at Omaha and University of Nebraska Medical Center, “Water and Health: Issues and Opportunities.”

**February 10**  
Williams Memorial Lecture: Elizabeth VanWormer, assistant professor of practice, UNL, “Health at the Human-Animal-Environment Interface: Tracing Pathogens from Land to Sea.”

**February 24**  
Norman Uphoff, professor, Cornell University, Ithaca, N.Y., “Improving Food Production for Health in a Water-Constrained World: Opportunities Deriving from Agroecological Knowledge and Experience.”

**March 9**  
Kremer Memorial Lecture: Sandra Banack, senior scientist, Institute for Ethnomedicine, Jackson, Wyo., “Toxic Water: Should We Be Concerned?”

**March 30**  
Mary Ward, senior investigator, Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics (DCEG), National Cancer Institute, Bethesda, Md., “Drinking Water Nitrate and Cancer: What Do We Know and What Research is Needed?”

**April 13**  
Karrie Weber, assistant professor, UNL, “Mobilization of Uranium in Groundwater.”

This newsletter is published with partial financial support from the Department of the Interior; U.S. Geological Survey. The content does not necessarily reflect the views and policies of the Department of the Interior, nor does mention of trade names or commercial products constitute endorsement by the U.S. Government.

**Director**  
Chittaranjan Ray, Ph.D., P.E.

**Director of Laboratory Services,**  
Water Sciences Laboratory  
Daniel D. Snow, Ph.D.

**Editor**  
Steven W. Ress

**Designer**  
Taylor DeMaro

**Nebraska Water Center**  
Robert B. Daugherty Water for  
Food Institute  
University of Nebraska  
2021 Transformation Drive, Suite 3220  
P.O. Box 886204  
Lincoln, NE 68588-6204  
Phone: (402) 472-3305  
e-mail: [sress@nebraska.edu](mailto:sress@nebraska.edu)



NebrWaterCenter



NebraskaWaterCenter



## WRAP meets at historic Ferguson House

Steve Ress

The University of Nebraska's Water Resources Advisory Panel (WRAP) convened at Lincoln's Ferguson House, across from the State Capitol, on January 20, to talk about a wide range of water and natural resource issues. An open house and guided tours of the historic mansion followed the meeting.

Ron Yoder, Associate Vice Chancellor of the University of Nebraska's Institute of Agriculture and Natural Resources (IANR), personally thanked the group for their much valued continuing support and input on water and natural resources issues involving NU. "Input from this panel and our other stakeholders has a profound impact on how we do things," Yoder said.

He noted that IANR has hired 106 new faculty members since January 2012, as a part of a faculty growth initiative and is looking at growing by another 34 positions during the current academic year. This growth leads to new research, collaborations, and opportunities to grow graduate programs, while creating unique undergraduate research opportunities.

Two of the recent faculty hires are groundwater hydrologists, both located on the UNL campus in Lincoln, a recently hired watershed hydrologist is also located in Lincoln, and two irrigation engineers have been hired, one at the Panhandle Research and Extension Center in Scottsbluff and the other at the West Central Research and Extension Center in North Platte, he said, noting these and other water faculty hires are

making it possible to do more detailed work in analyzing water balances in the state's watersheds.

Daugherty Water for Food Institute Founding Executive Director Roberto Lenton briefed members that WFI's first five-year report had been published and was available, and updated WRAP on some of its new global work, including a drought monitoring project in conjunction with UNL's National Drought Mitigation Center, the WARI program that is bringing Indian Ph.D. students and post docs to UNL and progress on the "Thirsty Land" film project.

Lenton also updated WRAP on the coming April 24-26 annual global conference that will be held at Nebraska Innovation Campus (NIC) and will focus on public and private sector collaborations.

Yoder noted that six candidates had been interviewed as potential replacements for Lenton as WFI executive director and that NU Vice President and IANR Harlan Vice Chancellor Ronnie Green is expected to announce a hire for that position sometime in February.

Nebraska Water Center Director Chittaranjan Ray told WRAP members that NWC, WFI and UNL Extension have teamed to hire a new research and extension communication specialist position that will be housed within the NWC. The person hired will help with liaison between NU water interests and its many government and private sector stakeholders.

He also updated WRAP on a number of research proposals that have been submitted or are pending, commented on an upcoming February research faculty retreat, noted that NWC would host its water symposium and water law conference at NIC in October and said the annual water tour will be in the South Platte river basin in Colorado in June.

Chuck Hibberd, Dean and Director of UNL Extension, shared a proposed grouping of counties into "Crops and Water Extension Educator" areas, along similar lines as the state's natural resource districts. The proposed grouping areas could include 30 extension educators expert in crop and water disciplines to cover the state.

Several WRAP members gave updates, including Mark Brohman of the Nebraska Environmental Trust on requests for funding from the environmental savings account, (\$58 million in requests for \$19 million in available funds) and Nebraska Department of Natural Resources Director Jeff Fassett on requests for water sustainability funds.

Following these and other WRAP member updates, Associate Professor Mehmet Can Vuran, UNL Department of Computer Science and Engineering, presented on the "Internet of Underground Things," and Carrick Detweiler, an assistant professor in the same department, presented on "Rapid Water Sampling with Unmanned Aerial Vehicles."



Mehmet Can Vuran

## Report shows groundwater level rises following years of decline

Aaron Young

The 2015 Nebraska Statewide Groundwater-Level Monitoring Report reveals that much of the state is beginning to recover from the 2012-2013 drought.

From the spring of 2014 to the spring of 2015, water levels began to rise following significant declines resulting from extended period of drought from early 2012 through the summer of 2013. Above normal precipitation for much of Nebraska combined with better water use practices accounted for the rises in water levels. The average water level change from spring 2014 to spring 2015 was a rise of 0.53 feet. Although these one-year

rises are good, many parts of the state remain below 2012 levels.

Eastern Nebraska saw some of the largest rises in groundwater levels, with some wells recording rises of ten to fifteen feet. Rises in these areas are the result of above average precipitation, and reduced need for irrigation pumping. Other notable areas of groundwater level rises of one to more than 10 feet occurred in the central Panhandle, Perkins, Custer and Dawson counties, in addition to localized areas throughout the state.

These maps represent conditions as of late March and Early April 2015, and do not take into account some of the record setting precipitation events that were experienced in eastern Nebraska in spring and summer of 2015. It is expected that in the spring of 2016 we will continue to see water levels rise throughout much of Nebraska as we have seen in the spring of 2015, particularly in eastern Nebraska where flooding was common.

Groundwater-level monitoring began in Nebraska in 1930. The Conservation and Survey Division in UNL's School of Natural Resources has produced the annual reports and maps since the 1950s.

Statewide groundwater-level monitoring reports depict the change in water levels from spring to spring at different time scales. The reports study the rates of drawdown and recharges measured in regional wells, and give a general depiction of the current state of groundwater levels on a yearly basis.

The reports also compare historical trends of regional water levels over extended periods of time. Collecting data is a collective effort between the United States Geological Survey, U.S. Bureau of Reclamation, Nebraska Natural Resources Districts and Central Nebraska Public Power and Irrigation District.

The 2015 Nebraska Statewide Groundwater-Level Monitoring Report is available for purchase from the Nebraska Maps and More Store on the first floor of UNL's Hardin Hall at 33rd and Holdrege Streets for \$5.00. The book can also be purchased online at [marketplace.unl.edu/nemaps](http://marketplace.unl.edu/nemaps) and [amazon.com](http://amazon.com). To place an order call (402) 472-3471. Maps and other groundwater information can be viewed online at [go.unl.edu/groundwater](http://go.unl.edu/groundwater).

## 2015-2016 NWC Annual Report

A full-color report of the Nebraska Water Center (NWC) and Water Sciences Laboratory's (WSL) activities and accomplishments during the past year is now available free and online.

The report recounts the many accomplishments of the NWC and WSL during the past year in areas of research, support for University of Nebraska research faculty and staff, education and outreach programming, and communications. It also details unique Nebraska-based programs and projects sponsored or conducted by NU's Robert B. Daugherty Water for Food Institute.

The report is dedicated to the 25th anniversary of the WSL, which was founded as a core analytical research facility for the University of Nebraska in 1990. Since then, the lab has remained on the cutting edge of technical services and expertise for researchers in an array of analytical and isotopic methods, as well as helping develop new scientific methodologies and helping train the next generation of scientists.

The annual report can be viewed online at [watercenter.unl.edu](http://watercenter.unl.edu). Print copies of the publication are available free, while they last, by emailing [sress@nebraska.edu](mailto:sress@nebraska.edu)



# Twenty-Five Years on the Cutting Edge of University of Nebraska Research

Kim Hachiya

At its purest form, water is two parts hydrogen to one part oxygen. But water craves other elements and particles, which also are deeply attracted to water. Sometimes these chemical marriages are benign or beneficial, other times they can be problematic, even detrimental.

For 25 years the Water Sciences Laboratory at the University of Nebraska-Lincoln has sussed out these chemical alliances, and in doing so established itself as one of the nation's premiere laboratories in answering the question of "what's in the water?"

The lab was founded in 1990 with funding from the Nebraska Research Initiative, which was established by the Nebraska Legislature to promote research in critical areas. Since then, it has become what the university calls a "core research facility" that does work with researchers and scientists in a number of disciplines across colleges and campuses.

The lab's scientists provide technical services and expertise in analyzing contaminants in water using high-tech instruments. That concept of "expertise" is the critical feature, said Chittaranjan Ray, who directs the University of Nebraska Water Center, of which the Water Sciences Laboratory is a key player.

While the instruments – mass spectrometers, gas or liquid chromatography and other analyzers – run the samples, it's the design of the experiments and the creation of the processes that develop the samples, and analysis of the findings that differentiate this lab from others, Ray said.

"The human brain is more important than the machinery," Ray said. "The real difficulty is coming up with the methods of separating the samples and compounds; it's the design of the experiment, each of which is unique. In academic research, there is a lot of trial and error. In our lab, the scientists are also training students in the methodologies. And it's a beautiful collaboration with faculty and students that also builds the university's research capacity and research portfolio."

"Of the 54 U.S. water centers, just 14 have water sciences labs," Ray said. "Nebraska's is one of the biggest and best because of the chemists, interns, students and number of collaborators across so many disciplines."

Lab director Dan Snow has been affiliated since the beginning in 1990, when



## New research on estimating soil water balance

Isidro Campos Rodríguez

Robert B. Daugherty Water for Food Institute (WFI) postdoctoral researcher Isidro Campos is the lead author of a paper recently published in the professional journal *Agricultural Water Management*.

Campos' paper analyzes the application of soil water balance models based on remote sensing data for irrigation assessment. Soil water balance models are simple, precise and operative approaches to assess irrigation necessities in cultivated lands. But the application of these models to some crops is limited by our narrow knowledge about the soil properties related with water retention and actual soil depth explored by the roots.

In this paper, the authors assume that these characteristics are unknown for some canopies, as is the case of cultivated

vineyard, but the model can be calibrated by using a limited set of surface evapotranspiration experimental values. This calibration is site specific, and after that, the model can be applied in predictive scenarios for irrigation and water stress assessment. The paper can be found online at [www.sciencedirect.com/science/article/pii/S0378377415301712](http://www.sciencedirect.com/science/article/pii/S0378377415301712)

This publication was authorized by researchers of the WFI at the University of Nebraska-Lincoln, University of Castilla-La Mancha (Spain), Andalusian Institute of Agricultural and Fisheries Research and Training (IFAPA) and Chilean Institute for Agronomic Research (INIA) in the framework of the project CERESS, funded by the Spanish Science and Innovation Ministry, co-funded by FEDER.

he was a Ph.D. candidate in chemistry. Snow's research contributed field and laboratory methods to the WSL's first big project, the Management Systems Evaluation Area (MSEA).

The MSEA analyzed thousands of groundwater samples from areas near Shelton to understand how different irrigation practices affected groundwater quality and contamination. Dozens of scientific papers emerged from the studies.

Many of these studies showed that water-conserving irrigation practices not only saved water, Snow said, but they also improved groundwater quality without negatively affecting crop yields.

Subsequent studies suggest that water and fertilizer management practices could be contributing to high rates of naturally occurring uranium in ground water, Snow said. A current federally funded study with UNL scientist Karrie Weber is investigating the specific mechanisms connecting nitrate, irrigation and uranium mobilization.

These and other projects exemplified what Snow calls applied science —

looking for ways to control or minimize negative impacts for future water users.

Twenty-five years ago, the lab was testing mostly for the herbicide atrazine and for nitrates. Since then, instruments have become more sensitive and can test for myriad other contaminants at far smaller concentrations. This is where the lab scientists' abilities to create methods that exploit the instruments' capabilities, become critical and evident.

Many of these studies are done at the request of Nebraska's Natural Resource Districts, who are charged with managing Nebraska's groundwater. "NRDs want to know where to best spend their resources," Snow said, "so knowing the source of problems helps to prioritize."

Snow, Ray and Cassada said the lab has contributed knowledge to the field of "emerging contaminants," which include algal toxins, explosives, petrochemicals, pharmaceuticals, estrogens, antibiotics and illegal drugs. The lab scientists also have developed protocols to analyze for contaminants in foods and food components.

The Nebraska lab is testing for neonicotinoids, a type of insecticide chemically similar to nicotine with controversial environmental impacts.

While much of the lab's funding comes from Nebraska Research Initiative, Ray said long-range plans include developing a business model that encourages entrepreneurship and frees the lab's five scientists to collaborate with their university research colleagues. By exploiting their knowledge in the development of experiment protocols and methodologies, Ray said, these scientists can be more efficient.

"I'm very fortunate to have been able to work with faculty and students in so many disciplines during my career," Snow said "Natural resources, geosciences, life sciences, engineering, economics. I get to dabble in a lot more interesting things than if I were in just one department. It's enjoyable to meet and work with so many different viewpoints of water."

*(Editor's Note: For more information on the WSL, request a copy of the 2015-2016 Nebraska Water Center annual report by emailing [pliedle@nebraska.edu](mailto:pliedle@nebraska.edu) or access the report online at [watercenter.unl.edu](http://watercenter.unl.edu)).*

# Planning June's tour to the South Platte basin in Colorado

NWC photos by Steve Ress



Helping plan the summer water and natural resources tour to Colorado: Tim Anderson of The Central Nebraska Public Power and Irrigation District (left) and tour guide Mike Jess.



Water operations and water banking at the MillerCoors brewery in Golden, Colorado will likely be part of the tour.



Scenic Frisco, Colorado is near the ski slopes of Breckenridge and Keystone.



Mine "tailings," or debris (right) from commercial gold mining more than a hundred years ago are still very much in evidence in the Colorado mountains west of Denver. The industry spawned many of the communities now known for skiing and tourism.



In many parts of Colorado, the Pine Wilt Beetle has reduced forests by up to 80 percent, creating areas of deadfall and altering runoff water flows in the process.



Dillon Reservoir near Frisco, Colorado is a key component in Denver Water's extensive infrastructure.



NCAR's Eileen Carpenter (right) demonstrates weather research principles to Mike Jess at the Boulder, Colorado center.



Internationally famous architect I.M. Pei designed the National Center for Atmospheric Research (NCAR) Mesa Laboratory near Boulder, Colorado. The cutting edge research center opened 50 years ago.



An abandoned gold mine near Breckenridge, Colorado is a visible reminder of an industry that helped develop much of the mountain area of Colorado west of Denver. The stones in the foreground are debris, or "tailings," from the mine.



## Tang's expertise furthers wetlands preservation efforts

Troy Fedderson

Zhenghong Tang

Research by the University of Nebraska-Lincoln's Zhenghong Tang is helping conserve key south-central Nebraska wetlands that provide habitat for millions of migratory birds.

An expert in environmental planning and geospatial data science, the associate professor in the College of Architecture's community and regional planning program works with federal, state and local officials to generate detailed wetland profiles. The work is used to direct restoration projects within the region, which is known as the Rainwater Basin, and educate the public about its importance.

"The Rainwater Basin has been named by the federal government as one of the 10 most important wetlands in the nation," Tang said. "Protecting these wetlands is important globally because they provide habitat to more than 250 bird species and they are a key resting and feeding place for migratory birds, including the Sandhill cranes.

"Protection is also of regional importance because these wetlands help with flood mitigation and water quality improvement, and bring in millions of tourism dollars every year."

Since 2010, Tang has received more than \$821,000 in grant funding from the Environmental Protection Agency and Department of the Interior to further research into the wetlands. The awards include a recent \$100,000 EPA grant that will allow Tang's research team to use ground-penetrating radar to map sediment profiles across 93 wetland watersheds within the basin.

"Because the Rainwater Basin is a closed system, sedimentation is a key issue," said Ted LaGrange, wetland program manager for Nebraska Game and Parks Commission and a collaborator on Tang's research. "There are no outlets to the basin, so sediments that are transported in build up. Over time, that causes the basin

to become shallower and they can't support habitats needed by the birds and other wildlife."

Traditionally, soil scientists have been tasked with using specialized drills to collect sediment profiles in the wetlands. Tang's research will use ground-penetrating radar to pass over the wetlands, generating sediment profiles — from the surface to the clay layer — electronically. The process is expected to speed up the data collection and use fewer resources compared to drilling.

"Drilling is time consuming and involves the use of a lot of labor and energy," Tang said. "By using ground-penetrating radar, I believe we can provide more accurate underground profiles about sediments quickly and efficiently. It also will allow us to get into areas of the wetlands that are not accessible to drills."

If successful, the profiles will be used to direct restoration projects — primarily through removal of sediments — within the basin.

"Projects led by Dr. Tang have been used to assess the health and condition of the Rainwater Basin," LaGrange said. "His work has helped us prioritize our restoration actions and what we do to improve the condition of the wetlands. He has been a great collaborator in helping us improve conservation in the Rainwater Basin."

For Tang, the research allows the chance to expand his expertise in geospatial technologies while also giving back to Nebraska.

"It's wonderful to fill the technology gap for federal and state wetland managers by providing more accurate wetland geospatial databases," Tang said. "It's also great knowing that my work is helping further sustainable land practices and preserving the environmental quality of these wetlands for future generations."

## Using smartphones to track agricultural water use

Alison Ogden

Ayse Kilic



This fall scientists at the University of Nebraska, with partners at Google Inc., the University of Idaho and the Desert Research Institute, introduced the latest evolution of METRIC technology—an application called EEFLUX, which will allow anyone in the world to produce field-scale maps of water consumption.

METRIC processes satellite images to make digital maps, and is currently being used by water managers in 15 states to track agricultural water use. EEFLUX will put this information directly into the hands of farmers by allowing them to check water-use maps in near real-time on any mobile device that has web access.

"The use of satellite imagery provides the means to monitor the agricultural water consumption over every square foot of land surface," said Ayse Kilic, a professor in the department of civil engineering and school of natural resources at the University of Nebraska.

That imagery comes from the Landsat satellites, whose thermal band data allows water specialists to measure the amount of water evaporating from the soil and transpiring from a plant's leaves—a process called evapotranspiration (ET).

This process cools the plant down, so irrigated farm fields appear cooler (bluer) in infrared satellite images. The spatial resolution of Landsat's thermal imagery, combined with the Landsat data for other spectral bands, allows experts and farmers alike to see water consumption for individual fields.

"With Landsat 7, the Landsat user community began to see the importance of thermal infrared data for water management,"

said Jeffrey Masek, Chief of the Biospheric Sciences Laboratory at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "So in 2009 the Thermal Infrared Sensor (TIRS) was added to the Landsat-8 mission payload.

Water managers can track the effectiveness of various water conservation projects with METRIC because it provides a new level of detail: from field to field, crop to crop, and year to year. Also, Landsat satellites have collected thermal data since 1984 so that water consumption under existing conservation practices can be compared with that occurring more than 30 years ago.

"It's really helped us from a time-frame perspective," said Duane Woodward, an engineering hydrologist at the Central Platte Natural Resource District of Nebraska. "1997, for example, was one of the first ET years. We did 2002, 2007, 2011, and now we're doing 2013. So you really want to look at how its changing year in and year out."

METRIC was developed by remote sensing analysts Bill Kramber and Tony Morse, from the Idaho Department of Water Resources, who in the early 2000s teamed up with Rick Allen, from the University of Idaho, to develop a more holistic solution to water management.

So far, METRIC'S latest application, EEFLUX, has been introduced to the California Department of Water Resources, the California Water Control Board, and the World Bank. "Having water consumption maps produced quickly on Smartphones has been everyone's dream," said Kilic. "In two years time we hope to see all farmers watching their fields from their phones and scheduling irrigations. EEFLUX is making Landsat the evapotranspiration satellite."

**CATALYTIC COLLABORATIONS**  
Building Public-Private Partnerships for Water and Food Security

waterforfood.nebraska.edu

April 24–26, 2016  
Nebraska Innovation Campus | Lincoln, Nebraska, USA

UNIVERSITY OF Nebraska

Water for Food GLOBAL CONFERENCE



Jesse Korus



Troy Gilmore

## Researchers aim to advance NE groundwater knowledge, expertise

Mekita Rivas

As groundwater becomes an increasingly hot topic in Nebraska, UNL's School of Natural Resources is poised itself to be at the forefront of groundwater research and analysis.

The school recently welcomed two groundwater hydrologists to its faculty: Troy Gilmore and Jesse Korus.

"Nebraska has vast water resources," Gilmore said. "But there are many challenges to ensuring that water is available when needed, and that it is of appropriate quality for its intended use."

Gilmore comes to UNL from North Carolina State University, where he earned his doctorate in biological and agricultural engineering. His appointment is split between SNR and the Department of Biological Systems Engineering.

"With these appointments, I have an opportunity to collaborate on projects from a whole-system perspective," Gilmore said. "I am also excited to be a part of the Conservation and Survey

Division in SNR, which has historically been an important resource for citizens and stakeholders interested in the source, quantity and quality of groundwater in Nebraska."

Gilmore's research focuses on quantifying the availability of water resources, particularly in western Nebraska, and on supporting the effective and efficient management of those resources.

"Availability is dependent on both water quantity and quality," Gilmore said. "My first projects will quantify groundwater recharge rate and quality to assess the impact of changes in irrigation management. I will also investigate the interaction of groundwater with streams and rivers."

In his new role, Gilmore said a primary objective is establishing relationships between stakeholders and scientists in Nebraska – a sentiment echoed by Korus.

"It is a challenge to stay on top of the complex, rapidly-evolving water issues across the state," Korus said. "So it is important to stay connected with stakeholders and to monitor the status of research needs by attending meetings, conferences and making phone calls."

Korus frequently worked with stakeholders across the state in his previous position as a survey geologist in the Conservation and Survey Division. He earned his doctorate from UNL's Department of Earth and Atmospheric Sciences earlier this year.

As a groundwater hydrologist, Korus studies both groundwater and the heterogeneous materials through which groundwater flows.

"Understanding aquifer heterogeneity is key to understanding patterns of groundwater flow, stream-aquifer connections and the effects of pumping on water supplies," Korus said. "I use basic field work, borehole drilling and geophysical techniques to understand the basic 'structure' of aquifers. This information is critical to sustaining a long-term supply of water in a changing world."

Currently, Korus is investigating the geological origins and hydrogeological frameworks of buried valleys – ancient valleys now covered by sediment. These valleys are common in Nebraska and host important aquifers throughout the state, Korus said.

When it comes to the future of groundwater in Nebraska, both researchers are thinking big.

"I plan to establish a highly reputable research and extension program aimed at understanding the High Plains aquifer system," Korus said. "SNR's historical connections with Natural Resources Districts, state agencies, well drillers and other organizations across Nebraska will help me build key connections and collaborations."

"Within five years I would like to be an asset to the people of Nebraska and beyond," Gilmore said. "I want to provide the necessary expertise in groundwater hydrology to address critical questions of water resource management."

## Tool uses climate forecasts and crop modeling capabilities to transform data into value for farmers

Dana Ludvik

The world's changing climate creates great uncertainty when it comes to agricultural decision-making. Computer models containing a sea of high-tech data on crops and climate present challenges in transforming terabytes into real solutions on the ground. A new tool developed by a University of Nebraska-Lincoln researcher in collaboration with the private sector has the ability to transform trillions of model realizations into a simple website platform that will help farmers reduce risk and optimize production while using water and other resources more efficiently.

CropClimate, available to the public at [www.cropclimate.org](http://www.cropclimate.org), was developed by Guillermo Baigorria, assistant professor in the UNL School of Natural Resources and Department of Agronomy & Horticulture and a Robert B. Daugherty Water for Food Institute Faculty Fellow. The interactive website uses state-of-the-art technology in climate-, soil- and crop-modeling to link the effects of environmental conditions, weather and crop yield history and field management to develop more resilient crop production systems. The platform offers insights that will enable farmers to tailor some of their pre-planting management practices, such as crop land allocation, variety selection, planting dates, insurance selection, etc., according to the upcoming seasonal climate forecast. The website is fully operational to support decision-making for corn and soybeans in Nebraska. Some tools are functional for the entire U.S., while others need to be added to certain states following the initial launch.

The Water for Food Institute at the University of Nebraska hosted a free, public seminar on CropClimate on Jan. 15 at the Nebraska Innovation Campus where Baigorria gave an overview of the tool's capabilities and benefits, along with

a demonstration on how to use it. The event is archived at [youtube.com/user/WaterForFood](https://youtube.com/user/WaterForFood).

Baigorria has been working toward the launch of the data-intensive project, which requires 180 computer processors to run, for the past several months. He said he is confident the tool will help take some of the guesswork out of agricultural decision-making.

"Many growers make pre-planting decisions based on instinct, such as when to plant, how much land is assigned to a given crop, which cultivar to use or the insurance they buy," said Baigorria. "CropClimate's user-friendly format and extensive climate information can empower farmers, lenders, policymakers, seed and agrochemical companies, insurance companies and other stakeholders to make more informed decisions."

The website allows users to plug in various scenarios that will help them analyze the probability for highest yield, he said.

"The platform gives us the ability to translate an enormous amount of sub-county-level data on climate, soil and crops into field decisions that may significantly increase production, reduce risk and bolster our ability to take advantage of climate projections."

Roberto Lenton, founding executive director of the Water for Food Institute said this is the kind of innovation that supports the institute's mission to ensure water and food security. "The work of our Faculty Fellows is essential to advancing our understanding of the complexities involved in water use in agriculture. To have a free, web-based program that

provides farmers with factual data to improve their yields and reduce water use is truly groundbreaking."

The project, which includes research, extension and education components, has reached an international scope. In parallel with the launch of its core model based in the U.S. in January, Baigorria expanded the platform's capacity internationally, beginning with Peru and Brazil, through a partnership with the International Consortium for Categorical Climate Forecast Applications. Baigorria is awaiting UNL approval to begin in Indonesia. Additional countries will have an opportunity to replicate the tool in the future.

### About Guillermo Baigorria

Guillermo Baigorria's research focuses on helping agricultural decision-makers use climate information more efficiently. He combines his multi-disciplinary background in meteorology, agronomy, and soil science and land evaluation to develop user-friendly software tools to project crop yields based on complex climate modeling forecasts. He has developed geospatial weather generators, automated categorical forecast systems, as well as extended geo-statistic and principal components methods for analyzing the impacts of climate variability and climate change in agriculture.

Baigorria is the principal investigator for the CropClimate initiative, an interactive tool that uses state-of-the-art knowledge in climate-, soil-, and crop modeling to link the effects of environmental conditions and management to develop more sustainable crop production systems. Data from CropClimate.org set the basis for the forthcoming International Consortium of Categorical Climate Forecast Applications.

Prior to joining UNL in 2012, Baigorria worked as an assistant research scientist and postdoctoral research associate at the University of Florida. Baigorria has a doctorate in soil science from Wageningen University in the Netherlands. He also holds a master's degree in crop production and a bachelor's degree in meteorology from Universidad Nacional Agraria-La Molina in Peru.



# NU-AIRE pushes boundaries on drones for ag management

Steve Ress

Drones are seemingly everywhere. They fire our imagination and spark our love of technology. Lots of people seem to want one, but few of us know much about them or what they can and cannot do.

In a relatively unexplored but nonetheless expanding commercial market for unmanned aircraft systems, or UAS's.... drones to most of us, research indicates that agriculture could eventually account for 70 percent of their business use, according to University of Nebraska-Lincoln agricultural engineer Wayne Woldt .

“Their use in expanding precision agriculture, managing agricultural systems and gathering critical data needed by producers could be limitless and is just now being explored,” the longtime

UNL Department of Biological Systems Engineering and School of Natural Resources water resources engineer said.

Woldt has always been interested in finding answers to seemingly complex engineering challenges and drones, or UASs, seem to be one answer in getting oncoming technology into the hands of the researchers and producers that can make the most of it.

Trouble is, at this time, not just anyone can go fly a drone as a part of their business enterprise.

“Except for some very limited uses and altitudes for what most people call recreational or hobby UASs, the FAA (Federal Aviation Administration) says you have to have a private pilot’s

license to operate unmanned aircraft for any commercial purpose, including agriculture,” Woldt, who’s been a licensed private pilot for years, said.

“It is highly likely that those regulations will change in the near future, with projected release of new unmanned aircraft regulations for commercial flight in June of 2016. It is expected that the new regulations will require an Unmanned Aircraft Operators Certificate that can be obtained by passing an exam administered by the FAA. The rules are constantly being examined and reevaluated, but for now a (pilot’s) license is required for commercial UAS flight” he said.

Working with students and fellow private pilots, including a retired Nebraska Air National Guard fighter pilot, Woldt has assembled a small but dedicated cadre at UNL that are currently using two drones to expand the borders of what is known on how UASs can be used to help agriculture and natural resources, with an initial focus on water management. In addition, Woldt seeks to

collaborate with other University of Nebraska faculty to advance a wide array of unmanned aircraft research opportunities.

“There is an immediate need to form a critical mass, and nexus of UAS-based research and development at UNL, to explore and solve fundamental science and engineering challenges of UAS for agricultural and natural resources use, as new regulations are developed. Other universities are working on this as well, but we’re “holding our own” in terms of agricultural applications,” Woldt said.

He and his small but dedicated group fly both a large, fixed wing UAS that resembles a scale glider with a wingspan of 11 feet and an electric motor for extended flight duration of almost two hours, and an eight-motored “octocopter” that would not look out of place in a Star Wars movie.

Both are used to test fly equipment and sensors, many of which are developed and or adapted locally in Woldt’s “Nebraska Unmanned Aircraft Innovation, Research and Education (or NU-AIRE) laboratory on UNL’s East Campus.

“Through NU-AIRE we are providing the leadership to develop research and education efforts around many UAS development needs for their practical use in agriculture and management of water and natural resources,” Woldt said. These include, but are not limited to:

- Crop and optical sensors for agricultural applications (precision agriculture)
- Sensor technologies for natural resource management (hydrologic observatories)
- Contributions to agricultural resilience under climate variability (enhanced real time data for dynamic management)
- Crop scouting, ranch and livestock management opportunities (cattle tagging and tracking)
- Water management applications for flood assessment and irrigation management
- Soil moisture and vegetation type/index (stage of growth of crop)
- Remote sensing platform with multi-spectral sensors
- Standards and performance verification in support of agricultural industry
- Policy, law, and regulation development and analysis (air space use, privacy)
- Management and application of pesticides (crop dusting)
- River tracking, riparian status, and water area coverage (changes in rivers, ecosystems, ponds)
- Communications and data transfer systems protocols and standards (wireless/cell phone)

“We are just beginning to seriously explore what UASs can do for agricultural and natural resources management. As a vehicle for those purposes, the technology is just in its infancy. The UAS market could double in the next few years with potentially explosive growth in the next decade, coupled with advances in the aircraft and sensors themselves, so this is clearly an area we need to invest time and research efforts into.

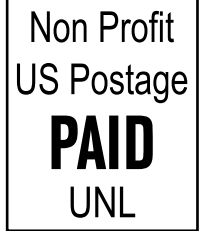
“For the sake of the state’ agriculture industry and natural resources management, we need to stay ahead of this new technology. It offers an unparalleled opportunity to place sensors, robotics and advanced information systems at desired locations on a near real-time basis, for improved efficiency of agricultural operations,” Woldt said.



**Water for Food**  
 ROBERT B. DAUGHERTY INSTITUTE  
 NEBRASKA WATER CENTER  
 at the University of Nebraska

★ [watercenter.unl.edu](http://watercenter.unl.edu)  
 f [facebook.com/NebraskaWaterCenter](https://facebook.com/NebraskaWaterCenter)  
 t [twitter.com/NebrWaterCenter](https://twitter.com/NebrWaterCenter)  
 y [youtube.com/NebraskaWaterCenter](https://youtube.com/NebraskaWaterCenter)





## 2016 Water for Food Global Conference presents the power of partnerships

The seventh annual Water for Food Global Conference will focus on the powerful impact that can be achieved through public-private partnerships in water for food research, technology and project development. Together, we are working to improve efficient water management and increase global food supply to meet the needs of an expected world population of 10 billion by 2050.

Organized by the Robert B. Daugherty Water for Food Institute at the University of Nebraska, the international conference will include plenary sessions, concurrent sessions, keynote speakers, side events and workshops:

- Irrigation research and technology, including remote sensing and apps that help farmers target water usage to maximize yields.
- Agricultural solutions in both crop development and management; and livestock
- Information technology in a variety of water and food productivity sectors

- Food processing advancements
- Public health and its important role in water and food security
- Keynote presentations from some of the world's leading voices in water and food security
- Special events, such as the premier of "Thirsty Land," a documentary on the drought affecting the western and southwestern portions of the U.S.; student poster competition; photography exhibit and competition; farm-to-table dinner; field trip options
- Networking opportunities with faculty, students, ag producers, business leaders, policy makers and thought partners

Learn more and register today: [waterforfood.nebraska.edu/2016-water-for-food-global-conference/](http://waterforfood.nebraska.edu/2016-water-for-food-global-conference/)