Xu Li, Ph.D.

Xu Li is an assistant professor in the University of Nebraska–Lincoln Department of Civil Engineering since January 2009. His research interests focus on three principal areas: 1) fate and transport of contaminants of emerging concerns (e.g., steroid hormones, antimicrobials, and antimicrobial resistance genes) in the environment; 2) environmental biotechnology to remove contaminants (e.g., estrogens, perchlorate, and nitrate) from water; and 3) microbial transformation of soil organic carbon in heterogeneous landscapes.  

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Organizers have completed most details for the University of Nebraska’s annual water and natural resources tour, which will leave Kearney for points in Western Nebraska, Northern Colorado and Wyoming on July 15.

The tour will examine the present state of sharing limited water supplies in the North and South Platte River basins in the three states and will include a visit to the U.S. Bureau of Reclamation’s (USBR) North Platte irrigation project in Wyoming.

“The North Platte Project is central to much irrigation, power production and recreational water supplies for western Nebraska,” said Nebraska Water Center communicator and tour co-organizer Steve Ress, “But it is very remote and not easily accessed,

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The Robert B. Daugherty Water for Food Institute at the University of Nebraska has hired Nicholas Brozović, a leading water economist with significant experience in Nebraska and around the world, as its director of policy, effective July 1.

Brozović will join Christopher M. U. Neale, director of research, and Chittaranjan Ray, director of the Nebraska Water Center, as a member of the institute’s senior leadership team. He will also serve as associate professor of agricultural economics within the Institute.

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By the time you read this, our associated Water Sciences Laboratory (WSL, lab) will just be completing a very comprehensive NU Office of Research and Economic Development five-year core facility review. This was a very positive experience for the WSL and its director of operations, Dr. Dan Snow. Dan has been with the WSL since the facility was founded in 1990, having advanced from staff chemist to become the lab’s director and an associate research professor in UNL’s School of Natural Resources. Over the past several years, Dan has made huge inroads into making the lab more self-supporting; adding new analytical equipment; fostering undergraduate and graduate student involvement in the lab; nurturing future scientists; concentrating on new methodologies; growing the lab’s client base; fostering multidisciplinary research collaborations; and increasing the lab’s capabilities for critical groundwater-age dating.

The WSL is a very unique and cutting-edge research facility that few Universities of Nebraska’s size and stature can boast of having. Among the 54 federally mandated Water Resources Research Institutes (of which the Nebraska Water Center is one), only 11 list an associated water science laboratory, and of these, only seven are located within engineering or natural resources-focused units. Additionally, most of the 11 have only standard testing capabilities and are not used for teaching or stretching research boundaries.

The WSL is a very unique and cutting-edge research facility that few Universities of Nebraska’s size and stature can boast of having. Among the 54 federally mandated Water Resources Research Institutes (of which the Nebraska Water Center is one), only 11 list an associated water science laboratory, and of these, only seven are located within engineering or natural resources-focused units. Additionally, most of the 11 have only standard testing capabilities and are not used for teaching or stretching research boundaries.

Clearly, our WSL is one of only a very few like it in the nation.

There will always be funding, income generation, and support issues for the WSL to resolve as it grows and evolves, but the five-year review process left me encouraged that the lab has very strong support from faculty, outside research scientists, clients and UNL administration and will continue to be viewed as a shining example of what a teaching and scientific method-developing research facility can be.

For much more on the WSL’s purposes, capabilities, staff and history, continue reading this issue of the Water Current.

Since coming to UNL last summer, I have begun partnering with faculty members from both within and outside of the state for research funding. One of the most recent proposals we have developed is to the National Science Foundation’s CyberSEES program focusing on the water and energy sustainability issues for agriculture.

I am also collaborating with our colleagues at Colorado State University and Oklahoma State University on a proposal to the USDA on the future of irrigated agriculture on land overlying the High Plains Aquifer.

The Water Center currently has quite a broad range of meetings and events coming up that are in early planning stages, which we want to draw your attention to.

Late this summer, probably in August, we will hold a meeting of NWC’s advisory board. This is a very critical 12-member group that meets twice per year to advise us on research needs, particularly in Nebraska; events and programming for facilitating interdisciplinary research; shaping of academic programs; seed grant awards; and outreach activities.

We are also planning an off-campus, one-day faculty retreat in late August or September to help generate some collaborations and synergies for generating research proposals. Even
MEET THE FACULTY

Trenton E. Franz, Ph.D.

Trenton Franz is an assistant professor of hydrogeophysics in the University of Nebraska–Lincoln’s School of Natural Resources and a faculty fellow in the Robert B. Daugherty Water for Food Institute, starting in September 2013. In his research, Franz has gained experience in ecohydrologic modeling of dryland ecosystems; modeling, influenced by the disciplines of hydrology, hydraulics, and savanna ecology; and worked on a field team to collect novel soil moisture measurements with near surface geophysical instrumentation in tropical dryland ecosystems and around continental U.S.

Education:
Ph.D., Civil and Environmental Engineering, Princeton University, 2011.
M.A. Civil and Environmental Engineering, Princeton University, 2008.
M.S. Civil and Environmental Engineering, Princeton University, 2007.
M.S. Civil Engineering, University of Wyoming, 2005.
B.S. Civil Engineering, University of Wyoming, 2004.

Examples of Current Research:

Transcending heterogeneity: towards improved soil moisture scaling laws. In order to feed the growing world population by 2050, the FAO estimates a needed increase of 70 percent in cereal grains, placing a greater demand on dwindling water resources. Irrigation agriculture accounts for 40 percent of global food production, yet it is estimated that 60 percent of the 2,500 trillion liters of water used globally for agriculture each year is wasted through inadequate water conservation, distribution losses, and inappropriate irrigation times and rates. A salient solution is to irrigate only when and where water is needed, but a fundamental cause of excess water use is our inability to quantify soil moisture at the application scales where management decisions are made. Our limited knowledge of how soil moisture is organized across scales not only hampers our ability to better manage agricultural water efficiency but is also a fundamental question in hydrology. The long-term goal is to understand how soil moisture is organized across scales. The goal of this project is to further our understanding of how soil moisture is organized at intermediate scales where water management decisions are made but that have been largely underrepresented due to technologic and practical limitations. To overcome these limitations, the team will incorporate a suite of nested hydrogeophysical observations with different measurement areas/volumes and focus our observations in agricultural irrigation settings, which offer an ideal experimental setting.

Investigators: Trenton Franz (UNL), Derek Heeren (UNL), and Lee Slater (RU)
Funding: NSF Hydrologic Sciences (In Review)

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Prof, Alumnus Team To Further Evaporation Research

By Mekita Rivas, UNL School of Natural Resources

About with insomnia helped Joe Szilagyi answer some long-lingering research questions.

“Last summer I had a brainstorm event at night when I was half-awake and half-asleep,” said Szilagyi, research hydrologist and associate professor in the School of Natural Resources.

For years, Szilagyi wondered whether he could prove or disprove a certain hypothesis in evaporation research. The hypothesis is two-fold: A wetland will maintain a spatially constant surface temperature at any moment, in addition to maintaining a temporally constant surface temperature.

“Nobody knew the answer for the second question,” Szilagyi said.

Based on his previous work, Szilagyi guessed that the answer for both parts of the hypothesis was affirmative.

“But I could never prove it directly with temperature measurements,” he said.

During that nocturnal brainstorming session, Szilagyi realized that center-pivot irrigated crops could provide the direct proof he’d been looking for. The height of the crops, their size and large degree of homogeneity in terms of vegetation type and moisture status were all traits that made them ideal research subjects.

“The only problem was I still did not have any idea how I could take the temperature of the center-pivot irrigated land,” Szilagyi said.

Moreover, the temperature data would have to be remotely sensed. Although satellite-derived temperature data existed, their spatial resolution was too coarse for Szilagyi’s research purposes. The average irrigated crop circle in Nebraska has a diameter of about 700-800 meters — and Szilagyi could only use the half that faced the prevailing wind.

“It seemed like a hopeless situation,” he said.

Hopeless, that is, until he conducted an Internet search the next day.

“I stumbled upon beautiful aerial photography of center-pivot irrigated fields taken with a thermal camera by a company called Cornerstone Mapping,” Szilagyi said. “And guess what — the company was located in Lincoln. I could not believe my luck.”

Szilagyi worried he couldn’t persuade the company to share its

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Xu Li, Ph.D. continued from page 3

**Education:**

Ph.D., Environmental Engineering, University of Michigan, 2008
M.S., Environmental Engineering, Pennsylvania State University, 2003
B.E., Environmental Engineering, Tsinghua University, 2001

**Examples of Current Research:**

Li’s research revolves around microbial communities critical to ecosystem services and human health. The ultimate goal of my research is to understand the link between the structure and function of microbial communities in natural and engineered environments and apply the understanding to optimize microbial activities for ecosystem and human well-being. His current research focuses on three principal areas: 1) fate and transport of contaminants of emerging concern (CECs) in the environment; 2) environmental biotechnologies to remove contaminants from water; and 3) microbial transformation of soil carbon in heterogeneous landscapes.

Li is currently working on several research projects that relate to the microbial aspect of water quality. In one project, he is attempting to identify the potential sources of microbes in Lincoln’s Antelope Creek using DNA sequence libraries. In addition, he is looking into the fate and transport of antimicrobials and antimicrobial resistance bacteria in agricultural environments. This study started with the wastewater and sludge in livestock waste management structures, and evolved to include soil, runoff, and food crops. He studied the feasibility of using a biologically active carbon reactor to remove steroid hormones — 17β-estradiol and estrone — and investigate their degradation characteristics at the molecular, cellular, and community levels using advanced molecular biology tools such as high-throughput sequencing and quantitative proteomics. Finally, in partnership with an ecohydrologist, Li is investigating soil microbial processes that are involved in the global carbon cycle.

**Examples of Past Research:**

In the past, Li has worked on a number of projects in environmental microbiology and environmental biotechnology: (1) the physicochemical processes that govern the initial bacterial attachment to solid surfaces; (2) optimization of bioreactor systems to remove inorganic contaminants nitrate and perchlorate from water; and (3) development and application of molecular techniques to characterize microbial communities in environmental samples.

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**NSF Award Aids Li’s Antibiotic Resistance Research**

By Gillian Klucas, UNL Office of Research and Economic Development

Antibiotic-resistant bacteria are a growing public health threat, infecting at least 2 million Americans each year and killing 23,000. A UNL engineer’s research to understand how bacteria and antibiotics interact in the environment may one day help reduce the danger.

Xu Li, assistant professor of civil engineering, recently earned a five-year, $400,000 Faculty Early Career Development Program Award from the National Science Foundation to continue his research. These prestigious awards, also known as CAREER awards, support pre-tenure faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research.

Hospitals have long been implicated as a major source of antibiotic-resistant bacteria, but antibiotics in the environment now also are recognized as a significant contributor. Human and livestock wastes are considered major sources of the antibiotics in the environment.

Microbes interact with antibiotics differently whether in the gastrointestinal tract, water, soils and other settings, but those interactions are not well understood, Li said. He's using an approach called quantitative proteomics to understand how antibiotics and microbes interact under different nutrient levels and types.

“The overall goal is to minimize both the microbial resistance and the antibiotics — the chemical itself — in the environment,” he said.

Li and his team are using UNL’s Proteomics and Metabolomics Core Facility to determine differences in protein levels within bacterial cultures exposed to different levels of nutrients and antibiotics.

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Tadesse leads $1.6M NASA project to predict drought, flood in Africa

By Kelly Helm Smith, National Drought Mitigation Center

Tsegaye Tadesse, climatologist and remote sensing expert at UNL’s National Drought Mitigation Center, is leading a three-year, $1.6 million, multi-institution NASA-funded project to help predict drought and flood in the Greater Horn of Africa. UNL’s portion of the award is $987,767.

Researchers will investigate which prediction methods work best for the Greater Horn, especially in light of an evolving climate, and will work with decision makers to produce seasonal forecasts that they can use.

Droughts and floods can have devastating impacts in the region, even when early warning systems are in place, Tadesse said. In 2010, drought caused widespread famine that affected 11.5 million people, even though forecasters had predicted the drought well in advance.

The research team will work with local representatives of disaster relief and food security agencies, extension agents, the Famine Early Warning System and others to see what type of forecasts would be most useful, Tadesse said.

Researchers will focus on developing forecasts at time and space scales that correspond to decision makers’ needs. They will also see whether existing tools will allow them to go beyond predicting a wetter season than usual to anticipating an extreme event such as a flood using ground observation and remote sensing information.

Although they are looking for locally relevant patterns, the scope of the inquiry will include global weather patterns.

“Droughts and floods are mainly caused by large-scale ocean-atmosphere-land circulation patterns,” Tadesse said. “If we understand how those interactions are working and their time lag, then we can improve predicting what’s going to happen at local to regional scale.”

Researchers will examine large-scale teleconnections for predictive power in the study region, including the El Niño Southern Oscillation, the Pacific Decadal Oscillation, sea surface temperatures in the Indian Ocean, and predictors associated with the Indian monsoon.

The team will also examine state-of-the-art techniques based on

USGS Technical Announcement:

Assessing Nutrient Inputs to the Nation’s Estuaries and Great Lakes

Nutrient enrichment of our nation’s streams, lakes, and estuaries is widespread and can contribute to harmful algal blooms, increasing costs for drinking water and causing declines in ecosystem health.

Maps and tables describing the major sources and watershed inputs of nutrients to the Great Lakes and estuaries along the Atlantic coast, Gulf of Mexico, and the Pacific Northwest are now available online. These new maps and the data tables highlight the major sources of nutrients and the areas within a watershed that contribute the largest amounts of nutrients to 115 estuaries along the coastal areas and from 160 watersheds draining into the Great Lakes.

The data can serve further uses. For instance, water resource managers interested in a particular stream or estuary can use the online, interactive decision support tool to estimate how changes in nutrient inputs (source, type, and amount) affect nutrient loads at a downstream location.

A new reporting feature within the tool provides summary information on the amount and source of nutrients from upstream states or major hydrologic regions. For instance, output from the new tool shows the amount of nitrogen contributed from each of the 31 states that drain from the Mississippi River Basin into the Gulf of Mexico.

“This innovative combination of national maps and an online decision support tool provides unparalleled access to water-quality modeling information,” said Jerad Bales, USGS acting associate director for Water. “It can be used to improve nutrient reduction strategies and inform nutrient policies across the nation.”

These maps and data tables were produced using the USGS Spatially Referenced Regressions On Watershed attributes (SPARROW) nutrient models to explain spatial patterns in stream nutrient loads in relation to human nutrient inputs and natural processes and sources.

Successful management of our nation’s waters requires an integrated approach that includes both monitoring and modeling to understand the affect, source type, input amounts, and performance of management activities on nutrients in local streams and ultimately in our Nation’s estuaries.

Additional information on USGS nutrient monitoring and modeling activities by the National Water-Quality Assessment Program is available online.

Online, go to http://www.usgs.gov/newsroom/article.asp?ID=3811#.Uwza8_idVg0
Harnessing the Data Revolution: Ensuring Water and Food Security From Field to Global Scales

Water for Food 2014 Global Conference

Mark your calendars for the sixth annual global Water for Food Conference Oct. 19-22 in Seattle, Wash., USA. The conference will be held at the Hyatt Regency Bellevue, with an evening banquet hosted at the Bill & Melinda Gates Foundation.

Organized by the Robert B. Daugherty Water for Food Institute at the University of Nebraska, this event brings together experts from around the world to discuss how advances in science, technology and policy will help the world efficiently use its limited freshwater resources to increase global food security. Each year, the event attracts roughly 500 industry, academic and policy leaders and features a mix of plenary addresses, panel discussions, case studies, poster competitions and more.

The 2014 theme is “Harnessing the Data Revolution: Ensuring Water and Food Security from Field to Global Scales.”

Data and analytics are increasingly used by private and governmental sectors to make decisions regarding food and water. Conference presentations and panel discussions will focus on the changing landscape of data, analytics, modeling and visualization — as well as how to capitalize on this ongoing data revolution to ensure a water and food secure world. Tools, such as the University of Nebraska–Lincoln’s Global Yield Gap and Water Productivity Atlas, will also be unveiled at the conference.

Seattle, a hub for major data and technology organizations, is the ideal place to hold a conference on using data to ensure water and food security.

Support for the 2014 conference is provided by the Gates Foundation, Robert. B. Daugherty Charitable Foundation and University of Nebraska.

For more details and how to register go to http://waterforfood.nebraska.edu/2014-water-for-food-conference/#sthash.fzFaIunS.dpuf

Ray Publishes Low Cost Emergency Water Purification Technologies

Natural disasters, such as floods, tsunamis, hurricanes, and earthquakes, affect over 226 million people every year. The occurrence of these natural disasters has been increasing every year due to the effect of extreme weather events and higher populations living in areas vulnerable to natural hazards.

Developing a guideline for emergency water treatment becomes even more important as the number of natural events continues to increase. Simple and low cost technologies have been developed to provide ways to treat water, ranging from point of use (POU) treatment to small scale (SS) community treatment. During times of natural disasters, POU and SS technologies offer applicable ways for providing clean and safe water.

This guide to emergency water treatment has been developed based on current research, products, and field studies to create an expeditious and easy process for choosing which technology is most appropriate in each emergency situation.

Initial, rapid response for water treatment should have the following characteristics:

- Portable
- Low cost
- Light weight
- Ease to use or requiring minimal training
- Requiring minimal or no external power

A solution for long term response should have the following characteristics:

- Ability to support a community or large population
- Able to purify large volume of water
- Parts that do not require frequent replacements
- Does not require complex training to operate
- Uses easily available power sources

This is a valuable resource for Environmental Engineers, Civil Engineers, Environmental Engineering Technicians and Civil Engineering Technicians.

We are excited to announce the launch of the new North Central Region Water Network — a 12-state collaboration between Extension water resource professionals and university, federal, state, NGO and industry partners. We are a new organization, but built on decades of USDA-funded regional work in the Great Lakes and Heartland Regions, and North and South Dakota.

We seek to:

- Increase connectivity and learning among university professionals and our partners engaged in water-related research, education, and management.
- Strengthen the resource base available for Extension education. Extension provides a critical bridge between applied research and the people, organizations, and communities that can use that research to strengthen decision-making.
- Generate measurable environmental and social impacts in the short and long-term.

We hope you will get to know us better. Please visit our website, contribute to our blog, and participate in our upcoming webinar series. You may also want to join our mailing list for the latest news about our network. Be sure to read Extension Director Liaison Rick Klemme's introduction to the Network and request for your participation.

We look forward to UNL faculty building connections to this network and to participating faculty in the North Central Region. This is an opportunity to build our regional connections on water issues.

If you have interest in water issues, we strongly encourage signing up for the regional network's email list, participate in the speed networking webinar series, and monitor the Network's other activities.

Chuck Hibberd, Rick Koelsch
UNL Extension
Nebraska’s State Representatives to the Network

Links:

Website: NorthCentralWater.org
Rick Klemme’s Introduction: NorthCentralWater.org/introduction
The Current Webinar Series: NorthCentralWater.org/the-current
Mailing list: go.wisc.edu/alnj3u

Tadesse NASA Research continued from page 5

on climatology, remote sensing, environmental modelling and other forecast methods that can provide early warning of drought or flood conditions. They will evaluate how well state-of-the-art seasonal forecast methods for drought and flood are working in the study region, and how they can help anticipate impacts on crops, communities and other aspects of life. One of the forecast techniques the researchers will evaluate is the satellite and climate-based Vegetation Outlook, or VegOut, an effort led by Tadesse.

Tadesse, who also helped develop the drought center’s Vegetation Drought Response Index (VegDRI), is collaborating on this NASA project with researchers from Johns Hopkins University, NASA Goddard Space Flight Center, University of California-Santa Barbara’s Climate Hazard Group, the U.S. Geological Survey’s Earth Resources and Observation Science Center and Famine Early Warning Systems Network, the International Research Institute for Climate and Society at Columbia University, the University of Wisconsin-Madison, and the University of Nebraska–Lincoln, which is where the drought center is based.

Other UNL researchers included in the project are Guillermo Baigoria, assistant professor of natural resources; Shimelis Beyene, lecturer in ethnic studies and anthropology; Brian Wardlow, associate professor of agronomy and horticulture; and Michael Hayes, professor of natural resources.

Tadesse is also involved in related efforts at the drought center that include developing the Quick Drought Response Index (Quick-DRI), an integrated approach for rapid response agricultural drought monitoring in the United States funded by NASA, and developing the Vegetation Drought Response Index (VegDRI) model for Canada, funded by Agriculture and Agri-Food Canada.
so there always tends to be a long list of people in the water community that know of the project’s importance, but who have never had a chance to see the unique system of dams and reservoirs where much of our surface water resources come from.”

The water tour last traveled there four years ago.

“It is one of the most historic federal impoundment projects in the western U.S. and something anyone interested in or working with Nebraska water issues needs to see to fully appreciate, Ress said.

Nebraska, Wyoming and Colorado are all dependent on irrigation water and hydropower generated in the North Platte watershed and legally must share its waters.

Project construction began more than 100 years ago under then-President Theodore Roosevelt. Water impounded in its series of reservoirs irrigates a large swath of cropland in western Nebraska, above Lake McConaughy.

This summer’s tour begins in Kearney on Tuesday, July 15 and ends there on Friday, July 18.

Primary sponsors and co-organizers are NU’s Nebraska Water Center, part of the Robert B. Daugherty Water for Food Institute; Kearney Area Chamber of Commerce (KACC); Central Nebraska Public Power and Irrigation District; Nebraska Public Power District; Nebraska Rural Radio Association; Nebraska Water Leaders Academy; Osher Lifelong Learning Institute at UNL; and Platte River Recovery Implementation Program.

“We will of course be looking closely at North and South Platte River basin issues from the standpoint of how they effect us here in Nebraska from a number of perspectives,” Ress said.

Some of the planned tour stops and topics include the Platte River Recovery Implementation Program works near Kearney, wind tunnel pesticide research at UNL’s West Central Research and Extension Center in North Platte, Lake McConaughy, Northern Colorado Water Conservancy District in Berthoud, Colo., irrigation canals and diversion dams in western Nebraska and many others.

There will be discussions on water supply challenges in Colorado’s urbanized “Front range,” stream flow allocations among irrigators in Nebraska and Wyoming, water for wildlife habitat, effects on the rivers from invasive species, irrigation efficiency measures, and generation of hydroelectric power.

Nebraska tour stops will focus in part on issues facing local irrigation districts and Natural Resource Districts.

Overnight stops will be in Fort Collins, Colo., Casper, Wy. and Scottsbluff.

All-inclusive registration is $750 single occupancy or $650 double occupancy. Registration details are online at watercenter.unl.edu. Registration is first-come, first-served and will likely be capped at 55.
of Agriculture and Natural Resources (IANR) at the University of Nebraska–Lincoln (UNL).

Brozović is currently an associate professor in the Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign. His research focuses on using economic analysis to understand spatial, dynamic natural resource systems, with a special emphasis on water resources. He designs and evaluates management policies that can maintain or improve the condition of natural resources.

Much of his work is interdisciplinary and involves collaborations with engineers, urban planners and others. He is currently working to establish functioning resource markets, such as groundwater markets, that can be used as both research and teaching platforms and as models of sustainability for industry.

“I am delighted that we have been able to attract Dr. Brozović to the University of Nebraska,” said Roberto Lenton, founding executive director of the Daugherty Water for Food Institute.

“His experience in policy-relevant research in Nebraska and elsewhere around the world, together with his deep knowledge of groundwater management, will be enormously helpful in advancing the policy work of the Water for Food Institute and in ensuring that the results of scientific and policy research effectively inform policy and policymakers.”

Ronnie Green, UNL vice president and Harlan vice chancellor of UNL’s Institute of Agriculture and Natural Resources, said: “We are enormously pleased that Dr. Brozović is coming on board in the Daugherty Water for Food Institute and as a UNL faculty member in agricultural economics and water policy.”

I have been impressed by his path-breaking work on groundwater trading in the Republican and Platte River basins in Nebraska, and I know that my colleagues on the IANR faculty are looking forward to working further with him on these and other issues when he joins the university soon.”

Brozović has a bachelor’s degree in geology from Oxford University, a master’s degree in geology from the University of Southern California, and a master’s degree and doctorate in agricultural and resource economics from the University of California-Berkeley.

From the Director continued from page 2

with the many means at our disposal for immediate communications with one another, these face-to-face retreats, away from offices and campus environs, are critical for research faculty and staff as a conduit to increased professional camaraderie and cooperation among the various water and environment-related disciplines, since multidisciplinary cooperation is absolutely critical to winning large research grants these days.

We are beginning to explore a March or April 2015 time frame for hosting a proposed three-day water conference and symposium. At least one day of this proposed conference will be devoted to water law and legal considerations, as has been done in recent years. We will be working with the UNL College of Law to develop that portion of the agenda as we move ahead. Another focus of this conference will be one-day symposium on the health of the highly debated Ogallala Aquifer.

Nearer in view is the annual Water and Natural Resources Tour that will be held July 15-18. The tour will begin and end in Kearney and will make stops in western Nebraska, Colorado and Wyoming, focusing on the U.S. Bureau of Reclamation’s Kendrick and North Platte Irrigation projects, which are the source of surface irrigation water to irrigated lands in western Nebraska, up to Lake McConaughy, near Ogallala.

We have had wonderful cooperation and cosponsorships for this year’s tour and many of the tour bus seats were pre-sold to current members and alumni of the Nebraska State Irrigation Association’s Water Leaders Academy. This will limit available tour seats somewhat, but will also expose a large group of young water professionals to the tour.

All-inclusive registration for the tour is will be $750 single occupancy or $650 double occupancy. Registration details are online at watercenter.unl.edu and on facebook.com/NebraskaWaterCenter.

I am very pleased to report that one of my lingering projects from the University of Hawaii will be published in July in book form as Low Cost Emergency Water Purification Technologies. This is a 224-page compilation of tips and techniques for supplying potable water at low cost under the most dire of circumstances. The book was co-written with Ravi Jain, my colleague at the University of the Pacific in Stockton, Calif. You can find the book online at elsevier.com.

Lastly, I noted with interest earlier this spring that UNL Extension’s Pesticide Safety Education Program has helped the state’s agriculture producers recycle more than 1,000 tons….that’s over 2,000,000 pounds….of plastic pesticide containers and chemical drums over the last 22 years. That is a lot of plastic pesticide bottles. The Nebraska Water Center has actively supported and helped promote this program since its inception, since improperly disposed of pesticide containers pose a significant potential danger to groundwater contamination.
The University of Nebraska’s Water Sciences Laboratory: A Cutting-Edge Analytical Tool for Water and Environmental Research

By Steve Ress

When Nebraska’s unicameral legislature created the Nebraska Research Initiative (NRI) in the late 1980’s to help fund basic research science and engineering as a means to boost Nebraska business, it would pave a path toward what has become one of the finest and most respected university analytical laboratories in the nation.

Because of NRI, the Nebraska Water Center (then, the UNL Water Center) was able to open what was then called the Water Science Research Facility (WSRF) under founding director Dr. Roy Spalding in 1990.

The WSRF (now Water Sciences Laboratory, or WSL) is in the former Wildlife Laboratory Building on the University of Nebraska–Lincoln's East Campus, where it provides state-of-the-art instrumentation and research methodology development and usage to measure organic and inorganic chemicals in the soil, streams and groundwater.

The WSL's guiding purpose is to provide analytical capabilities necessary to assess, resolve, and remediate groundwater and surface water contaminants. It's capabilities, in terms of staffing, equipment and methodologies have grown steadily and solidly over the past two dozen years, making it into a research facility that stands alone in both the expertise and technical facilities to provide solutions to a growing number and variety of water-related problems not only in Nebraska, but nationally and internationally.

Clients of the lab come from both within and outside the university and the wider academic community, as well as a variety of federal, state and local agencies, each needing high-level accuracy or sophisticated procedures.

The building the WSL occupies was fully renovated from a former veterinary sciences building in 1990, and upgraded 17 years later, and includes seven main laboratory spaces devoted to specific functions and procedures.

Main laboratories house instrumentation for stable isotope analysis, environmental contaminants, and associated sample preparation equipment. A faculty advisory committee, with input from other water-related faculty at NU, has assisted in selecting the type of instrumentation and methods offered at the lab.

Main laboratories:
- Stable Isotope and Noble Gas Mass Spectrometry
- Environmental Mass Spectrometry and Chromatography
- Wet Chemistry and Sample Preparation
- ICP-MS
- Corrosion Control
- Core and Sediment Processing

Having the WSL has been an important part of obtaining major research grants by NU and UNL faculty. An early example of this was the Management Systems Evaluation Area (MSEA) project, one of the largest research grants ever received up to that time by UNL's Institute of Agriculture and Natural Resources. A coalition of more than 20 UNL and U.S. Department of Agriculture - Agricultural Research Service scientists worked on the USDA-funded water quality study throughout the 1990s.

Thousands of groundwater samples analyzed by the WSL for pesticides and nitrate for this project, and others, help fund studies for pesticide fate and transport methodologies developed to analyze herbicides and their degradation products under differing cropping and irrigation practices. This has led to a better understanding of how groundwater becomes contaminated and what can be done to minimize or prevent it.

Instrumentation and methods for stable isotope analysis have been a part of the WSL since it was established. Nitrogen isotope analysis of nitrate and ammonia is always in demand as a “fingerprinting” method for tracing the sources of contaminants. In 1992, the facility acquired a high sensitivity dual inlet stable isotope mass spectrometer that ultimately replaced the outdated systems originally installed. The semi-automated stable isotope mass spectrometer has been used for
analyzing hundreds of samples for nitrogen isotopes, as well as for developing a high precision method for measuring what nitrogen gas enrichment does to bacteria denitrification in groundwater.

Two additional stable isotope mass spectrometers were added in 2002 to automate and improve precision of stable isotope analysis of water used as a trace for hydrologic studies. These automated systems can process and analyze samples much faster than using older off-line methods, thereby reducing costs and increasing the number of projects the methods can be used for.

In 1997, the lab got its first liquid chromatograph-mass spectrometer (LC/MS). This led to developing methods for a whole new group of contaminants including explosives such as RDX (found in groundwater at former ordnance manufacturing plants in eastern and central Nebraska) and pharmaceuticals like tetracyclines, found in livestock waste.

The impact of these and other water-soluble compounds on water quality could not be studied until methods were developed to measure them, as well as other “emerging contaminants” in groundwater and surface water. Research using these methods has been applied to determine how contaminants such as RDX groundwater can be “remediated” or cleaned up using advanced chemical treatment technologies.

The technical staff at the WSL now conducts analysis of samples for water research for a broad range of contaminants and stable isotopes. This unique facility offers an array of analytical services that rival even the most well equipped university or government research laboratory. The lab continues to develop and apply new methods using state-of-the-art technology to support water research in Nebraska and beyond.

Dr. Daniel D. Snow, who came to the WSL as a staff hydrochemist when the facility first opened, is now it’s director of services and a faculty member in UNL’s School of Natural Resources. He is responsible to the Nebraska Water Center director for operation of the lab. Both the lab and the NWC are part of the Robert B. Daugherty Water for Food Institute.
Stable Isotope and Noble Gas Mass Spectrometry

Stable isotope analysis can provide powerful tools for water science research. This equipment focuses on high precision measurements of naturally occurring isotopes of hydrogen, carbon, nitrogen, and oxygen. Natural variations of the abundance of these isotopes can help discover the origin and flow of these elements in the environment.

Stable isotope analysis often “fingerprint” sources of contaminants such as nitrate. Stable isotope analysis also is used in studying chemical reactions and metabolic processes.

The WSL offers methods for stable isotope analysis of gases, water, and solids. The lab is well known for its methods for determination of the isotopic composition of nitrate and ammonia nitrogen to support the investigation of nitrate contamination of groundwater and environmental fate and transportation.

Some of the lab’s most recent equipment includes automated sample preparation systems to reduce time and expense in preparing water samples for isotopic analysis.

Instrumentation used in the Stable Isotope Mass Spectrometry facility includes two dual inlet and two continuous flow mass spectrometers.

An obsolete Nuclide 6-60-RMS mass spectrometer was replaced with a new dual inlet Isoprime in 2006. Current major instrumentation includes:

- **VG Optima** dual inlet isotope ratio mass spectrometer is the primary instrument available for nitrogen isotope work, but may also be used for hydrogen, carbon and oxygen analyses. Its dual inlet and cryo-focusing capability provide the high sensitivity required for small (micromole) samples.
- **AP2003** with Isoprep is a continuous flow isotope ratio mass spectrometer with a computer-controlled system enabling automated preparation and analysis of water and gas samples for carbon-13 and oxygen-18 analysis. A second automated sample preparation system, the Isoprep C, was added to expand this capability to rapid analysis of carbonate samples.
- **GV Isoprime** continuous flow mass spectrometer with a Eurovector PyrOH elemental analyzer using a chromium reduction furnace designed for automated high-precision determination of the deuterium content of water. A second Eurovector solids elemental analyzer was added to expand this capability to analysis of deuterium, carbon, nitrogen and oxygen isotopes in solids (plants, salts, sediments).
- **GV Isoprime** dual inlet isotope ratio mass spectrometer is state-of-the-art for small sample stable isotope analysis and will be used for both nitrogen and carbonate stable isotope analysis where high sensitivity is required.
- **Thermo Helix SFT** noble gas mass spectrometer for high sensitivity determination of helium and other inert gas isotopes. This instrument interfaces with an ultra-low temperature cryogenic gas extraction and purification system primarily for groundwater age-dating. The purification system includes a Hiden Analytical quadrupole mass spectrometer used to quantify dissolved gases for recharge temperature determination and evaluation of excess-air and denitrification effects in shallow groundwater. The purpose is to more accurately measure and access renewal aquifer recharge rates.

Other high vacuum preparation systems in the WSL are essential for conversion and purification of samples for isotope analysis.

While the automated preparation systems described above reduce dependence on off-line preparation methods, these systems will continue to be used where automated preparation cannot be used.

### Environmental Mass Spectrometry and Chromatography

The mass spectrometer is the most widely accepted detector for environmental analysis. Methods based on mass spectrometry are among the most powerful, sensitive, and reliable available for water science research.

Instrumentation in this lab is used for developing and applying methods to accurately measure very low concentrations of organic contaminants such as pesticides, munitions waste, both steroids and pharmaceuticals from concentrated animal feeding operations (CAFOs), toxins, gasoline additives, and degradation products in a wide variety of matrices.

Many new methods have been developed in this facility using state-of-the-art instrumentation for analysis of these and other emerging contaminants. An older Agilent 5970 GC/MS has been recently moved into the stable isotope facility and will be modified for the development of new methods (compound specific isotope analysis).
Major instrumentation in this area includes:

- **Hewlett Packard 5972 Gas chromatograph/mass spectrometer** is the primary instrument used for trace level pesticide analysis.
- **ThermoFinnigan LCQ Ion trap Liquid chromatograph/mass spectrometer** system allows for trace level detection of explosives residues, pesticides, antibiotics and compounds formed during their degradation. The ion trap permits tandem mass spectrometry (MS/MS) for improved selectivity and multiple fragmentation capability (MSn) to characterize compound structures and has proven quite useful for identification of unknowns in contaminant remediation experiments. An INUS BetaRam radioactivity detector was added to permit unequivocal detection and mass spectrometer characterization of radioactively labeled compounds used in remediation experiments.
- **Micromass Quattro Micro Triple quadrupole liquid chromatograph/mass spectrometer** is a state-of-the-art instrument capable of highly sensitive and selective analysis of polar (water soluble) organics such as explosives, pharmaceuticals, hormones, surfactants and other emerging contaminants. A Spark Holland Symbiosys Environ online extraction system was later added to allow more rapid extraction and analysis of samples for this instrument. This capability has also lead to even more sensitivity in methods developed through this technology because of the ability to easily concentrate and immediately analyze contaminants.
- **Agilent 5973 Gas chromatograph/mass spectrometer** has both electron and chemical ionization sources and a newly designed inert source that improves sensitivity by an order of magnitude. This GC/MS was installed with a Leap CombiPAL autosampler that permits automated headspace and solid phase microextraction in addition to the traditional liquid solvent injection of samples. This instrument is used for gasoline oxygenate analysis, along with methods for volatile organics and pesticides. An OI purge and trap autosampler, was installed on this instrument for analysis of volatile organics.

**Other Chromatography equipment**

- **Hewlett Packard 5890 GC** with flame ionization and electron capture detectors is used for headspace analysis of solvents and gases.
- **Gow Mac 550P GC** with thermal conductivity detector used for analysis of gases.
- **Trace Analytical RGA3 GC** is a specially designed gas chromatograph for analysis of dissolved hydrogen gas in water.
- **Agilent 6890 GC** with a high sensitivity micro-electron detector has been modified with a custom-built vacuum extraction system for ultra-trace level analysis of Freon for groundwater age dating. It is also used for analysis of halogenated compounds such as SF6 used as environmental tracers.
- **Waters 2695 HPLC** with photodiode array detector is used for analysis of compounds that do not require MS detection and includes a Spectrum fraction collector for purification of organic compounds. Each of the LC/MS systems are also equipped with a Waters 2695 HPLC as the separations unit and facilitates operation and maintenance issues.
- **Varian 3600CX**, with 8200 autosampler and multiple detectors (ECD, FID, TCD, and NPD) can be used where mass spectrometric detection is not required for volatile organics and gases.

**Wet Chemistry Lab**

Used for preparation of water samples for trace organics analysis, and for analysis of water using ion chromatography, spectrophotometry, and automated analyzers. Equipment operated in this lab includes:

- **Dionex ICS-90 Ion Chromatograph** with PeakNet data system is the primary instrument for analysis of major anions.
- **Seal AQ2 Autoanalyzer** is a new generation of autoanalyzer used for rapid and precise colorimetric analysis of hundreds of water samples for ammonia, nitrate, phosphorus and other water quality parameters.
- **Lachat 8500 Quikchem Flow Injection Autoanalyzer (FIA)** is used for high throughput and low cost nutrient (nitrate, phosphate, ammonian, TN) analysis in water and soil extracts.
- **Ol Model 1010 Carbon Analyzer** with autosampler is used for automated analysis of organic carbon in water.
- **Perkin Elmer AAnalyst 400 Spectrophotometer** is primarily used for determination of cations and dissolved elements.
- **Labconco RapidVap Concentrator** is used for evaporating solvents

**Inductively Coupled Plasma-Mass Spectrometry Lab**

A GVI Platform XS collision cell ICP-MS is state of the art for highly sensitive trace element analysis and is used for analysis heavy metals and toxic contaminants such as arsenic.

The collision cell technology removes many of the isobaric interferences common in earlier ICP-MS systems and expands the range of elements that may be quantified. The Platform XS is interfaced with CETAC ultrasonic nebulizers, a CETAC cold vapor and hydrid generation system, and can be used with a SSI liquid chromatography system for development of speciation methods based on ion exchange and metal chelation chromatography.
Water Sciences Laboratory Clients Stretch Across Campus and Across the Globe

By Steve Ress

An enormous number of water samples make their way through the University of Nebraska Water Sciences Laboratory (WSL) each year, contributing to water projects and advancing water research programs worldwide.

“We have received an average of 3,500 samples per year for more than the past 10 years,” said WSL director of services Dan Snow.

Of those, the number coming from clients within the NU system averages between 1,500 and 2,000 per year, with about 65 percent of those NU clients representing faculty researchers from 25 separate departments.

“Departments who have multiple faculty members using the lab include Biological Systems Engineering, Civil Engineering, School of Natural Resources, Agronomy and Horticulture, Animal Sciences, Chemistry and Geosciences,” Snow said.

About 20 percent of lab users represent other universities such as Illinois, Maryland, Indiana, Wisconsin, New York, Minnesota, Michigan, Wyoming, West Virginia, and Iowa. A fair number of these are fellow Big-10 conference member schools.

Local, state and federal agencies are the largest grouping of external clients for the WSL. They include more than two-thirds of Nebraska’s 23 Natural Resource Districts (or NRDs), state agencies such as the Departments of Environmental Quality and Health and Human Services, plus county and city health departments across the state.

Other state agencies using the WSL are in Idaho, New Mexico and South Dakota.

Federal clients and collaborators include researchers and investigators from the U.S. Environmental Protection Agency and U.S. Geological Survey.

Private sector usage of the WSL, Snow said, typically accounts for a relatively small percentage of samples received, “Although about 25 percent of the list includes this type of client and environmental consulting firms, engineers, other laboratories, and even private individuals may bring samples to us for specific analyses,” he said.
**Faculty and Staff at the NU Water Sciences Laboratory**

**Dr. Daniel D. Snow, Director of Services:** Snow oversees all aspects of Water Sciences Laboratory (WSL) operation and conducts research in environmental and isotopic methods development. He collaborates with faculty on proposal development and present research results at conferences and publishes papers in peer-reviewed journals. Snow also advises and mentors a growing number of undergraduate and graduate students at the WSL.

**David Cassada, Separations Chemist and Network Administrator:** Cassada provides expertise and oversight for trace organic contaminant analysis using environmental mass spectrometry and is responsible for method development using gas and liquid chromatography-mass spectrometry. He provides validation of all instrumental results, performs maintenance and troubleshooting of laboratory instrumentation, computer equipment, and software, including LIMS database.

**Aaron Shultis, Isotope Scientist:** Shultis provides expertise and oversight for high precision stable isotope analyses, leading development and application of methods for analyses of the isotopes of nitrogen, hydrogen, oxygen, and carbon of samples at natural abundance levels; operate, maintain, and repairs four computer controlled isotope ratio mass spectrometers and associated sample preparation systems.

**Dr. Sathaporn (Tong) Onanong, Research Technologist II - LC/MS:** Onanong runs the WSL’s triple quadrupole mass spectrometer and other trace level equipment. He performs analysis of water, soil, and sediment samples for pharmaceuticals, algal toxins, munitions, antibiotics and degradation products using gas chromatography/mass spectrometry, high performance liquid chromatography, liquid chromatography/mass spectrometry, and liquid chromatography/tandem mass spectrometry.

**Autumn Longo, Research Technologist:** Longo performs analysis of water, soil, and sediment samples using inductively coupled plasma-mass spectrometry (ICP-MS), automated analyzers, and other standard analytical instrumentation. Receive and logs samples, and works closely with the laboratory director for scheduling and preparing and analyzing samples. She trains students, interns, and new technicians at the facility, and supervises all work conducted with the ICP-MS and in the wet chemistry laboratory.

**Undergraduate and Graduate Student Interns:** Receive and log samples and work with the laboratory director for scheduling, preparation and analysis of samples. They help train other students, interns, and new technicians at the lab and supervise work conducted in the wet chemistry laboratory. They also help prepare and update standard operating procedures and maintain chemical inventories.
Teaching:

Li has taught the following courses in the UNL Department of Civil Engineering:

- CIVE 326 Introduction to Environmental Engineering
- CIVE 326 Environmental Engineering Laboratory
- CIVE 425 Process Design in Water Supply & Wastewater Treatment
- CIVE 828 Environmental Engineering Chemistry
- CIVE 498/898 Environmental Engineering Microbiology

Selected Publications:


Email/web addresses:

xuli@unl.edu
http://www.engineering.unl.edu/civil/faculty/XuLi.shtml

correlating the resulting bacterial resistance with changes in proteins, the team can determine which proteins are involved in resistance and begin to understand their role under different nutritional conditions.

Preliminary results suggest that bacteria starved of nutrients respond similarly to the stress of antibiotic exposure. Those bacteria already responding to nutritional stress may therefore be better able to defend against antibiotics. Understanding this relationship may lead to waste management practices or technologies to reduce bacterial resistance.

In contrast, some bacteria can break down complex environmental molecules for nourishment, and therefore may also be able to degrade complex antibiotic molecules. Identifying those bacteria and a better understanding of their capabilities could lead to harnessing bacteria to degrade antibiotic compounds, in a waste treatment facility for example.

Decreasing antibiotic use also is critical to reducing public health and environmental threats. Li’s award allows him to pursue several outreach and educational programs aimed at Nebraska livestock producers and rural students.

"Antibiotics are used extensively in the livestock industry, but a lot of the antibiotics are not absorbed by the animal, so it ends up in the waste," he said. “Without proper waste management, it’s directly introduced to the environment. If we can raise awareness among livestock producers and help them develop waste management practices, maybe we can reduce the total load of antibiotics in the environment.”

Li will work with UNL Extension educators to give presentations and provide educational material to livestock producers. He will also develop related educational materials for rural high school students and their teachers. He hopes to encourage rural students to pursue environmental engineering degrees because their backgrounds could help them both develop appropriate technologies and aid in promoting new approaches in rural communities.

NSF award Xu Li

continued from page 4

outreach and educational programs aimed at Nebraska livestock producers and rural students.

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Pastoralism in Transition: Linking Localized Interactions and System Behaviors to Evaluate Social-Ecological Vulnerability. Drylands cover 40 percent of the African continent and are the basis for traditional pastoralist social ecological systems, in which societies have adapted to rely heavily or entirely on livestock production for their livelihoods in harsh and variable environments. Modernity has brought drastic political, social and land use changes, as well as unprecedented population growth, land degradation and more frequent droughts that decimate herds. Here the project team will employ complex adaptive system approaches to evaluate emerging patterns of vulnerability in two pastoralist communities in Kenya which have begun to diversify into maize agriculture alongside their struggling livestock-based livelihood system. We will adopt approaches to investigate how mixed land use affects the sensitivity of range productivity to drought and shifting grazing pressures; how composition and inequities in household livestock assets create differential patterns of risk exposure associated with entry into agriculture; and how evolving landuse institutions affect the coping capacity and resilience at individual and collective scales.

Investigators: Elizabeth King (UGA), Laura German (UGA), and Trenton Franz (UNL)

Examples of Outreach Programs:
Franz is currently developing an extension program related to the use of hydrogeophysical sensors in agricultural settings. The goal of this program is to show the utility of hydrogeophysical sensors towards effective and efficient management of water resources in Nebraska and beyond.

Teaching:
Hydrology (NRES 498/853) and developing a future hydrogeophysics course.

Selected Publications:


Email/web addresses:
tfranz2@unl.edu
http://tfranz2.wix.com/trenton-franz
http://waterforfood.nebraska.edu/
Zellmer Co-Authors

Sandra Zellmer is co-author of “Mississippi River Tragedies: A Century of Unnatural Disaster,” a new book that uses a series of stories to show that it is misleading to call floods and other environmental catastrophes “natural.” The book was published by New York University Press.

Zellmer, a professor of law at the University of Nebraska–Lincoln’s College of Law, and co-author Christine Klein, strive to uncover the larger story of how the law reflects and even amplifies ambivalent attitudes toward nature — simultaneously revering wild rivers and places for what they are, while working feverishly to change them into something else.

In this book, the authors conclude that, although the acknowledgement of human responsibility for unnatural disasters can lead to blame, guilt, and liability, it can also prod individuals to confront the consequences of society’s actions, hopefully leading to a liberating sense of possibility and to the knowledge necessary to avoid future disasters.

Water Matters

The eighth and ninth editions of Water Matters are now available on the Nebraska Department of Natural Resources’ website. Water Matters is the Integrated Water Management Division’s publication in which topics related to integrated water management in Nebraska are explained and explored.

The eighth edition (“Balancing Water Supplies Through Groundwater Recharge. Part One: A Component of the Conjunctive Management Toolbox”) describes how purposeful groundwater recharge projects can be used as conjunctive management strategies to increase available storage capacity in order to mitigate flooding, protect rivers, and provide long-term benefits to future water supplies.

The ninth edition (“Balancing Water Supplies Through Groundwater Recharge. Part Two: A Conjunctive Management Demonstration Project”) illustrates a conjunctive management demonstration project that the Department of Natural Resources, five Natural Resources Districts, and 21 irrigation districts participated in along the North Platte River in 2011.

These and past Water Matters are online at http://dnr.nebraska.gov/iwm/water-matters.

DNR Assistantships

The Nebraska Department of Natural Resources (DNR) is offering an opportunity for graduate students to work on applied water resource analysis or research addressing a variety of agency needs.

The University of Nebraska Water Center, part of the Robert B. Daugherty Water for Food Institute, is coordinating the program. The assistantship is anticipated to support one graduate student for up to 24 months and potentially provide the intellectual content for a thesis/dissertation.

The student is expected to supply a project proposal for consideration by DNR as part of the application process. The assistantship is primarily aimed at MS students, but Ph.D. students will be considered. The assistantship will have the same general pay rate and benefits as other graduate assistantships in the student’s program of study. Admission to the program is competitive. Deadline for consideration for a summer or fall 2014 start is May 31, 2014.

The issues of interest for a graduate student to work on at DNR include one or more of the following:

1. Hydraulic and Hydrologic analyses focusing on the relationship between surface water and groundwater.
2. Streamflow data analysis, including excess flows, environmental flows, and water supply and use.
4. Development and analysis of land use data. Use of remote sensing or other means in analysis of basin consumptive water use.
5. Analysis of precipitation and climate data for use in water modeling and other analysis.
6. Generalized development of water analysis tools. May include work on aspects of a decision support system to help optimize surface water operations and integrate groundwater utilization strategies.
8. Technical tools for economic analysis of water options.

For more information and complete details of the application process, contact Jennifer Schellpeper (DNR) at (402) 471-2899 or Tricia Liedle (Nebraska Water Center) at (402) 472-3305.
images for his research, especially since he didn't have any formal funding to offer as compensation.

Still, meeting with Cornerstone Mapping's owner, Aaron Schepers, was worth a shot.

“He’s a UNL alumnus who turned out to be a wonderful person,” Szilagyi said. “He immediately agreed to cooperate with me and for free.”

Schepers said that his airborne thermal imagery was a perfect fit for Szilagyi's application.

“I thought if Joe can help improve crop modeling by using my thermal imagery, I was contributing to the future success of research for optimizing crop production,” Schepers said.

From the thousands of images collected across Nebraska by Cornerstone Mapping, Szilagyi selected 90 that were obtained with the company's highly sensitive thermal-infrared camera.

“If I could show — with the high-accuracy surface temperature values of these images — that the irrigated land's surface temperature did not change with distance from the edge under strong heat-advection conditions, then I would have strong direct proof for the first part of the hypothesis,” Szilagyi said.

And indeed, on average the wet surface temperature changed less than 0.2 degrees between the edge and the center of the irrigated crop circles.

As for the second part of the hypothesis, Szilagyi had to prove that these wet surface temperatures would stay the same during the progression of a drought, provided solar radiation and wind would not change much.

Although mean wet surface temperatures are hard to obtain, they can be replaced by wet-bulb temperatures, since one is constant as long as the other is under unchanging solar radiation and wind conditions.

“Basically, I had to show that these wet-bulb temperatures stayed constant when solar radiation equaled a predefined value under different surface moisture conditions to be found by roving central Nebraska from the Sandhills to the neighboring irrigated lands,” Szilagyi said.

The experiment worked. Wet-bulb temperatures — and therefore wet surface temperatures — stay constant as the environment dries out under largely constant solar radiation and wind conditions.

“So in the end I felt doubly satisfied with the outcome,” Szilagyi said. “The only question remaining was if other researchers would be similarly convinced and recommend publication of the results.”

In early January, Szilagyi was notified that this research — co-authored by Schepers — is set to be published in Geophysical Research Letters, the preeminent journal within the geophysics field.

“It is definitely an honor to have a study accepted for publication in GRL,” Szilagyi said. “I feel really blessed to have been able to work at UNL for more than 15 years, where I have been provided the conditions necessary for undisturbed research.”

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**Rising Pressures continued from page 20**

Agricultural areas are well known, but there are possibly more subtle effects that are less well understood and yet potentially more serious. For example, there is evidence that increasing levels of nitrates can lead to a change in chemical conditions in which naturally occurring contaminants such as uranium and selenium can be mobilized and as a result find access to the drinking-water supply. Combinations of nitrate and other difficult-to-treat and potentially toxic chemicals increasingly have been identified in both public and private drinking-water supplies.

Add to this the expected increase in the variability of precipitation events — from drought to flood in a short space of time — and there is the possibility of episodic events that overwhelm the drinking-water system. Some states, such as Iowa, have already experienced surges of nitrates from fertilizers that accumulate in dry soils during drought and then are washed out when rains return. These kinds of changes in source water quality have only recently come under study.

Finally, an aging treatment and distribution infrastructure is unlikely to meet the technological demands of more challenging clean-up requirements and may also contribute to contamination, especially from bacteria, through leakage and cross-connections. Water-supply and sewage systems are closely linked in many communities, both above and below ground.

If we expect to solve these problems by cleaning up contaminated waters at the point of release, then the costs are likely to be considerable. If treatment alone is viewed as the only solution, then costs are unfairly passed on to communities not responsible for the contamination. These costs can be particularly serious for small rural communities, where the technology required to remove both uranium and nitrate could cost as much as $5 million and require substantially increased operational costs.

Potable drinking water supplies are especially vulnerable and increasingly expensive to maintain in an agricultural landscape. There must be a balance between the costs and benefits of using chemicals that can impact water quality at different points of the water system. For example, how do the costs of managing fertilizer applications at the farm stack up against lost agricultural yield? And how do these compare with the costs of treating for nitrates and related contaminants at the water-treatment plant?

Studies of questions like these are few and far between. Yet if we are going to respond efficiently and equitably to the complex and intensifying pressures on our water supplies, we will need to do it through dialogue that uses this kind of evidence as a basis for developing sound policy.
The Rising Pressures on the Water We Drink

We need to know more about how agricultural practices, extreme weather and aging infrastructure affect our water systems.

By Daniel Snow and Peter Calow

With large areas of the United States suffering through severe drought, it is understandable that policymakers should be focused so intensively on the availability of water for agricultural, industrial and drinking uses. Yet, as our recent study of Nebraska water resources suggests, there are equally challenging and closely related issues for managing the quality of the water supply.

The costs of managing drinking-water quality are substantial and rising. The federal Environmental Protection Agency estimated last year that the nation may need to spend upwards of $380 billion in capital costs alone to upgrade its drinking water systems. Investing in our water infrastructure is certainly important. But what is equally important is a more integrated and balanced approach to managing the water supply that recognizes the interconnection of land-use and agricultural practices with surface- and ground-water quality.

For Nebraska, there are three main pressures on water quality that are likely to resonate across the United States, especially in farm states: the ever-increasing intensification of agriculture in response to increasing demands for food; the increasing frequency of extreme weather events as climate changes; and an aging infrastructure of drinking-water and sewage-treatment systems.

Without improved management practices at the source, intensification of agriculture will inevitably lead to increased contamination from runoff into surface waters and leaching into ground waters. The adverse human-health effects of nitrates and traces of pesticides in drinking water in...