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“Daisy Well System” Promising Way For Small Communities to Fight Nitrates

by Steve Ress,
UNL Water Center

Stimulating natural microorganisms so they will eat potentially harmful groundwater nitrate-nitrogen contamination is helping small communities get formerly restricted water wells back in use.

“A sustainable technique small utilities can use to deliver a safe supply of drinking water is what we’re shooting for,” said University of Nebraska-Lincoln hydrochemist Roy Spalding. Spalding, who directs UNL’s Water Sciences Laboratory and agricultural engi-

neer Imtiyaz Khan, lead a team that is investigating ethanol and acetate injections into contaminated wells as an inexpensive and effective way to reduce potentially harmful nitrate concentrations that increasingly plague rural water systems in the upper midwest region.

The current U.S. Environmental Protection Agency safe drinking water standard for nitrate-nitrogen is 10 parts per million (ppm).

“There presently are over 100 public water suppliers in Nebraska sampling quarterly for nitrates because they have exceeded 8 ppm. This is the single most pervasive groundwater contamination problem in shallow aquifers in the upper midwest region,” Spalding said. “Kansas, Iowa, Nebraska and South Dakota have the dubious distinction of having the highest frequency of groundwater nitrate contamination exceeding the EPA’s maximum contaminant level (MCL) in the contiguous United States.”

Potential health risks associated with nitrate contamination includes Blue Baby Syndrome (methemoglobinemia), which lowers oxygen-carrying capacity of infants’ blood, bladder and ovarian cancer risks to middle-aged women and links to brain, stomach and prostate cancers.

The high occurrence of contamination in these and other regional states is directly linked to generally coarse soils and shallow groundwater aquifer formations that allow the infiltration of nitrogen-based agricultural chemicals and waste runoff from livestock feeding operations, he said.

“These hydrogeologies make many municipal wells vulnerable to nitrate contamination exceeding the MCL,” Spalding said.

To combat the problem in a simple and sustainable way, the UNL scientists have developed a process that feeds carbon-based ethanol or acetate to the water “capture zone” of contaminated wells. This is the part of the aquifer the well draws water from. The process

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Staff from the UNL Water Sciences Laboratory work on building a daisy well denitrification system in southeast Nebraska (photo: Steve Ress).

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Water and Natural Resource Seminar; Honing the Water Current; New Director's Appointment

from the DIRECTOR



Kyle D. Hoagland

We are very excited about the annual Water and Natural Resources Seminar series that will begin in January and run through the majority of UNL's spring semester. While the title of this year's series, "Current Water Issues in Nebraska," may strike you as one we could legitimately use each spring, given our mission, I can assure you that this spring's series of public lectures will be anything but typical.

At first glance, the topics to be addressed read a bit like the label for a very odd holiday fruitcake. Our ingredients include Tiger Beetles,

fresh fish, lake water, and CAFOs, TMDLs, and NET, probably to enhance flavor or act as preservatives. Definitely a fruitcake to pass along. Experts in their respective fields will present each of the Wednesday afternoon lectures and we have made extra effort to bring in speakers both from within the state, who are dealing directly with the issues being discussed, and from outside Nebraska who are experts on a critical topic.

For example, George Gibson, a senior scientist in the U.S. Environmental Protection Agency Laboratory at Fort Meade, MD, will describe efforts at the national level to develop nutrient criteria for wetlands, streams and lakes, a precursor to setting new water quality standards,

Ken Reckhow, director of the Water Resources Research Institute at the University of North Carolina, who served as chair of a national committee formed by the National Academy of Science to examine the scientific basis of Total Maximum Daily Loads (TMDLs) will present the committee's findings.

This is arguably the most important water quality issue facing agricultural states today.

Another topic of particular importance to Nebraskans, recharge of the Ogallala Aquifer, will be addressed by James Corbridge, professor emeritus, School of Law, University of Colorado.

For more details on the seminar, see the related article in this issue. We encourage you to attend them. All lectures are presented free of charge to the public, as well as university faculty and staff.

Since publication of the last few issues of the Water Current, we have received a fair amount of favorable comment regarding the increasing variety of water-related topics and authors we are giving coverage to, as well as our reaching out to professional colleagues to submit guest editorials. We want to hear more of what you have to say about the Water Current. If you have constructive comments to make, please feel free to email them to sress1@unl.edu or phone Steve Ress at (402)472-3305. In addition to our normal coverage of water-related research and cooperative extension programming here at NU, you will see an increasing variety of comment and opinion on water issues from colleagues, many of whom you will recognize, in upcoming issues.

It is with some trepidation that I tell you that my next column in this publication will likely appear six months to a year from now as I have recently agreed to step-in as Acting Director of UNL's School of Natural Resource Sciences on a temporary basis to help speed progress on a number of critical issues of importance to the SNRS, as well as to the Water Center and other affiliates.

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WATER CURRENT

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Meet the Faculty

Dr. Sherilyn C. Fritz

Associate Professor and Limnologist, Department of Geosciences & School of Biological Sciences, University of Nebraska-Lincoln since January 1999.

Education:

Ph.D. in Ecology, University of Minnesota, Minneapolis, MN, 1985
M.S. in Biology, Kent State University, Kent, OH, 1979
B.A. in Biology, Macalester College,



Sherilyn Fritz

St. Paul, MN (*Cum Laude*, with honors in Biology).

Current Research Programming:

- Climate in lake interactions, both in modern lakes and in the past. Much of my research deals with trying to reconstruct past climate variation, particularly drought variability, to assess whether or not 20th-century climate patterns differ from those in the recent geological past. I currently have paleoclimate projects in the Great Plains; northern Rocky Mountains; Lake Titicaca, Bolivia; and western Greenland. In addition to the analysis of lake sediments to reconstruct the environments of the past, these projects also involve modern process studies of how climate affects the biota and chemistry of lakes. I also use the fossil record to evaluate 20th-century human impact on lakes and determine whether modern lake chemistry, particularly nutrient concentrations, differ from the natural variability prior to human influences.

- Paleoclimatology and paleohydrology of the Great Plains and Northern Rocky Mountains.
- Quaternary climate history of tropical South America.
- Lake response to modern and Holocene climatic gradients adjacent to the Greenland Ice Sheet.
- Impact of non-point source pollution on lake ecosystems.

Selected Past Research:

- I have been involved in studies of lake acidification in the British Isles, pre-historic human impact on lakes in eastern England, and the impact of elk populations on the chemistry of lakes in Yellowstone National Park

Teaching:

- Advanced Limnology (with Kyle Hoagland).
- Quaternary Ecology & Climate.
- Biogeochemical Cycles.
- Ecosystem Ecology (with Jean Knops & Dave Wedin).

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Dr. Jose O. Payero

Water Resources Specialist/Irrigation Engineer and Assistant Professor, Department of Biological Systems Engineering, University of Nebraska-Lincoln, West Central Research and Extension Center, North Platte, NE.

Education:

Ph.D. in Irrigation Engineering, Utah State University, Logan, UT, 1997
M.S. in Agriculture-Plant Science, California State University-



Jose Payero

Fresno, Fresno, CA., 1987

B.S. in Agronomy, Universidad Catolica Madre y Maestra, Santiago, Dominican Republic, 1984.

Current Research/Extension Interests:

- Irrigation water management. Direct measurement of evapotranspiration and other energy-balance components over crop canopies. Water quality issues. Specifically:
- Direct measurement of energy balance components of corn using the eddy correlation method.
- Evaluating Time Domain Reflectometry (TDR) for estimating evapotranspiration and nitrate leaching.
- Developing irrigation and nitrogen best management practices for subsurface drip irrigation.
- Determining nitrate leaching from a multiple cropping system using percolation lysimeters.

Teaching:

- Has taught courses in irrigation, drainage and land surveying. Has coordinated student undergraduate research projects, etc.

Selected Publications:

- Yonts, C.D., B. Kranz, B.L. Benham, and J.O. Payero, 2001. Impact of wide drop spacing in corn. *Proceedings of the Central Plain Irrigation Short Course and Exposition*. Feb.5-6, Kearney, Nebraska. P126-135.
- Payero, J.O., 1997. Estimating evapotranspiration of reference crops using the remote sensing approach. Dissertation submitted in partial fulfillment for the degree of Doctor of Philosophy in Irrigation Engineering, Utah State University.
- Payero, J.O., 1996. Review of technologies used to improve water availability in the Dominican Republic. Report presented at the seminar about technologies to improve water availability in Latin America, organized by the Organization of American States (OAS) in Lima, Peru.
- Payero, J.O., E. Burroughs, M. García, and D. Carrasco, 1995.

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Water and the NRCS...All Encompassing Topics

by Steve Chick,
State Conservationist,
Natural Resources Conservation Service

Water, a huge topic in our state. Water levels in our streams. Water levels in our lakes. Groundwater. Water for crops. Water for lawns. Water for fish and wildlife. Water quality for people. Stories about water are everywhere. And here is another!

The Natural Resources Conservation Service (NRCS) plays a huge role with Nebraska's water. With the landowners and some partners, we slow its runoff, we store it in ponds and dams, we help the soil to have time to take more of it in, we help restore wetlands, we work with ranchers to get water into divided pastures, and we work with irrigation farmers who use the water.

Working with these water users, our irrigation farmers, is where I want to focus. NRCS has a handful of employees who carry the title of irrigation water management specialist. These specialists however work with both the individual farmer and the rest of our field office staff in providing free irrigation assistance.

The work varies like the Nebraska topography.

In the Panhandle, assistance is given to producers who are converting to low pressure center pivots. Installing the correct nozzles, pressure regulators, and other equipment matched to the soil intake and plant needs is critical. The contractor, producer and NRCS all work together. Improving these irrigation systems can increase their water use efficiency to about 95 percent. There are energy savings and water savings with an estimated 5 to 10 inches less water pumped. NRCS also partners with the Natural Resources Districts on the use of gypsum blocks and moisture meters to better manage the amount of water to be applied. Through the year, the producer learns how to take the readings and manage the moisture in the soil profile. The producers can then purchase the meter from the NRD and carry on by themselves.

Similar efforts in southwest Nebraska are underway with a surge valve loaner program. NRCS works with the producer for a year with a surge valve and then the producer can buy the surge valve from the irrigation

district or Bureau of Reclamation and receive some cost share dollars from the NRD. The benefits are: often the producer learns the wells are not pumping the amount of water the producer thought; there is a savings of 30-35 percent less water applied; and in irrigation canals when the water supply is short the valve helps with better management of a limited supply.

In eastern Nebraska, similar efforts continue on converting pivot systems to low pressure irrigation. Some work on installing water reuse pits and return lines and installation of surge valves follows the patterns across the state.

Economics, energy savings, and better water management are the driving forces for this technical assistance.

NRCS is constantly adopting/adapting new technology to address resource issues. Technology like sub-surface irrigation, turbulent fountains to operate a pivot from an open ditch, and variable tailwater flow recovery systems are just a few.

NRCS is in a unique partnership position with the University. Our daily work with land users helps us be added eyes and ears for University technology research needs. In turn, we use the latest University developed technology to help land users make improvements.

Humans have not yet figured out a way to create water. All we can do is manage what we have and try to be prepared if we get too little or too much.

In the last 45-50 years, NRCS, with the NRD and private landowners, have built nearly 900 floodwater reducing structures. Nationally, NRCS has helped store more water than any other federal agency. Some of these dams (about 100 in Nebraska) now are reaching their expected lifespan, having done their job, and are in need of rehabilitation.

This past year we let nearly 53 contracts to create or restore wetlands. Another 400 contracts were written in the last year for the Environmental Quality Incentives Program across the state. These contracts are for conservation practices, most of which will impact water.

NRCS is multi-dimensional and a key player in this state and its water usage. We plan to continue that role. Our services are free and voluntary to the requester.

From the Director (continued from page 1)

These issues include planning and construction of a new natural resources building here on the UNL East Campus (which includes space for the Water Center), current budget reductions (which we all look forward to, of course), hiring of new faculty members in the natural resources disciplines and efforts to expand and elevate the SNRS's graduate programs.

The SNRS is now offering a Ph.D. in Natural Resource Sciences, so student recruitment is now a priority on both undergraduate and graduate levels.

This has been an extremely unsettling and difficult year for our nation, given all that has happened both on our own soil and abroad. I recently attended the Pearl Harbor memorial

at the Lied Center for Performing Arts and was struck by the similarities in the newspaper headlines, political speeches and public reaction to that attack and those of recent events. So this year especially, we at the Water Center want to wish you and your family a very happy, healthy and safe holiday season.

Variety and Current Issues Punctuate Spring Water and Natural Resources Seminar

by Steve Ress,
UNL Water Center

Get current on Nebraska water issues, for free, in a series of 13 hour-long lectures that begin in January at the University of Nebraska-Lincoln.

The UNL Water Center's annual spring semester Water and Natural Resources Seminar begins in January and is again offered as a free public lecture series, as well as a course for undergraduate and graduate student credit.

"There are so many water-related issues effecting our state that we want to present an overview of what we believe are some of the most pressing of those issues, as well as some ongoing topics and some interesting things that haven't received wide public attention," said seminar organizer Mike Jess, senior lecturer in UNL's Conservation and Survey Division and assistant director of the UNL Water Center.

Kicking-off the lectures is a look at endangered Tiger Beetles and the controversy surrounding possible development of their habitat in Lincoln's Salt Creek Watershed, by Glenn Johnson, general manager of the Lower Platte South Natural Resources District.

Subsequent lectures will delve into the activities and initiatives of the Nebraska Environmental Trust with its director, Mary Harding; details of the settlement in the recent Nebraska v. Wyoming lawsuit by Roger Patterson, director of the Nebraska Department of Natural Resources; and fish and wildlife diseases in Nebraska by Dean Rosenthal and Bruce Morrison of the Nebraska Game and Parks Commission.

Other weekly lectures look at sustaining the Ogallala Aquifer, an ongoing NU study of dissolved oxygen deficiencies in Lake Ogallala and quantifying stream flows needed for fish and wildlife as part of the federal Endangered Species Act.

The seminar closes with a panel discussion on uses for the Missouri River and revisions to the U.S. Army Corps of Engineer's Missouri River Master Manual on April 24.

The series of public lectures begin on Wednesday, Jan. 16 and continue each Wednesday through April 24 (except March 13 and 20). Lectures are from 3 to 3:50 p.m. each week.

This year, the seminar returns to its traditional venue in Room 116, L.W. Chase Hall on the UNL East Campus. Last year, the lectures were held at the George W. Beadle Center for Genetics and Bio Materials Research on UNL's City Campus.

The seminar is presented by the UNL Water Center, School of Natural Resource Sciences, Conservation and Survey Division, Institute of Agriculture and Natural Resources and UNL. Partial funding is provided by the Williams Trust.

For more information on the lectures or parking arrangements on the UNL East Campus, phone (402)472-3305 or email sress1@unl.edu.

Weekly Lectures

Jan. 16 — WILLIAMS LECTURE: "A Description of the National U.S. EPA Nutrient Criteria Program," George Gibson, senior scientist, U.S. Environmental Protection Agency Laboratory, Ft. Meade, MD

Jan. 23 — "Endangered Tiger Beetles in the Salt Creek Watershed," Glenn D. Johnson, General Manager, Lower Platte South Natural Resources District.

Jan. 30 — "Activities and Initiatives of the Nebraska Environmental Trust," Mary Harding, Executive Director, Nebraska Environmental Trust.

Feb. 13 — "Fish and Wildlife Diseases in Nebraska," Dean Rosenthal, Assistant Administrator, Fisheries Division; and Bruce Morrison, Assistant Administrator, Wildlife Division, Nebraska Game and Parks Commission.

Feb. 20 — "Provisions and Innovations of the Settlement in Nebraska v Wyoming," Roger Patterson, Director, Nebraska Department of Natural Resources.

Feb. 27 — WILLIAMS LECTURE: "Assessing the Total Maximum Daily Load (TMDL) Approach to Water Quality Management," Kenneth Reckhow, Director, Water Resources Research Institute, University of North Carolina.

Mar. 6 — KREMER LECTURE: "Sustaining the Ogallala Aquifer: Colorado's Regulatory Approach," James Corbridge, professor emeritus, School of Law, University of Colorado.

Mar. 13 — NO SEMINAR due to UNL spring break.

Mar. 20 — NO SEMINAR due to Nebraska Water Conference.

Mar. 27 — "Instream Flow Incremental Methodology: Quantifying Stream Flows for Fish & Wildlife," Edward Peters, professor, School of Natural Resources Sciences, UNL.

Apr. 3 — "Studying Lake Ogallala's Disappearing Oxygen," Kyle Hoagland, Director, UNL Water Center and David Admiraal, professor, Department of Civil Engineering, UNL.

Apr. 10 — "Status of the Litigation in Kansas v Nebraska," Don Blankenau, attorney, the firm of Fennemore Craig.

Apr. 17 — "Confined Animal Feeding Operations," Ralph Summers, CAFO Specialist, U.S. Environmental Protection Agency, Region 7, Kansas City, MO.

Apr. 24 — "Revision of the Missouri River Master Manual," a panel discussion:

Chad Smith, American Rivers
Rob Roberson, Nebraska Farm Bureau Federation

Moderator: Michael Jess,
Conservation & Survey Division
and School of Natural Resource
Sciences, UNL

Integrated Water Management Options in the Nebraska Ground Water Management & Protection Act

by J. David Aiken
UNL Water & Agricultural Law Specialist

Nebraska statutes authorize natural resources districts (NRDs) and the Nebraska Department of Natural Resources (DNR) to regulate ground water and surface water uses respectively when there is insufficient water for all uses. These 1996 “integrated water management” authorities have yet to be implemented.

This handout describes (1) the general framework of the Nebraska Ground Water Management & Protection Act (GMPA), (2) the special GMPA integrated water management options, (3) an overview of how conflicts between surface and ground water users are resolved in the West generally, with special reference to Colorado law, (4) how such water conflicts might be resolved within a correlative rights framework, and (5) what additional water management tools are needed to effectively deal with surface-ground water disputes in Nebraska.

Ground Water Management & Protection Act

In Nebraska ground water management is largely a local (NRD) rather than a state responsibility. Under the GMPA all NRDs must prepare ground water management plans (GMPs). The GMP is the framework within which NRDs may regulate ground water development (well spacing regulations, well drilling prohibitions) and ground water use (well metering, pumping restrictions) in ground water management areas (GMAs).

The GMP must address a variety of issues, including ground water depletion and ground water protection from agricultural chemical use. The GMP must be reviewed by the DNR before it can be implemented by the NRD. The GMP must also identify the regulations the NRD intends to implement to deal with specified ground water management issues. NRD approval of the GMP and establishing GMA regulations both are subject to public notice and hearing requirements.

Authorized GMA regulations include: (1) ground water allocation (i.e. pumping quotas), (2) rotation of use, (3) well spacing, (4) well metering, (5) irrigated acreage reduction, (6) mandatory ag chemical best management practices, (7) soil testing, (8) voluntary or mandatory educational programs, (9) water quality monitoring and reporting, (10) limit or prevent the expansion of irrigated acres, and (11) other reasonable rules and regulations.

Regulations may be varied within an GMA based upon different GMA conditions, including different irrigation systems and differing hydrologic relationships between ground water and surface water. When ground water problems are so severe that they cannot be addressed solely by implementing the above GMA

regulations, well drilling may be halted or conditioned. NRD permits are required before new wells pumping more than 50 gallons per minute may be constructed. The permit fee is \$17.50 (\$250 for late permits.)

Most if not all NRDs have established water quality GMAs to deal with nitrate contamination from fertilizer use. Some water quality GMAs also deal with pesticide contamination of ground water.

The Nebraska Department of Environmental Quality (DEQ) may in some circumstances establish ground water regulations to protect ground water quality from ag chemical use if the local NRD does not regulate or if its water quality GMA regulations are ineffective. A few NRDs have established GMAs to manage ground water depletion. No NRDs have yet established a GMP to deal with surface-ground water conflicts

Integrated Water Management Options

NRDs have the option to deal with current or future surface-ground water conflicts in integrated management GMAs (IM-GMAs). IM-GMA regulations may treat new wells differently from existing wells when a the IM-GMA is established.

Joint action plan (JAP): If the NRD deals with surface-ground water conflicts on its own, only ground water uses will be subject to IM-GMA regulation. If the NRD wishes to bring surface water uses into the IM-GMA program, the NRD may request the DNR to study the surface-ground water conflicts. When the DNR study is completed and if DNR concludes that surface-ground water problems exist, the DNR holds a public hearing. Within 90 days of the hearing the NRD determines whether it will pursue an IM-GMA to deal with surface-ground water conflicts. If so, and the DNR concurs, the NRD develops an IM-GMA joint action plan (JAP) with the DNR.

The NRD and DNR JAP is adopted within one year of the determination to proceed. The NRD portion deals with ground water regulations and the DNR portion deals with surface water regulations. Possible DNR JAP surface water regulations include (1) increased monitoring and enforcement of surface water appropriator diversion rates and quantities, (2) prohibiting or limiting new appropriations, (3) requiring surface appropriators to implement reasonable conservation measures or best management practices, and (4) other reasonable regulations. The GMPA acknowledges that hydrologically connected surface and ground water may need to be managed differently than other surface or ground water.

If the JAP establishes surface water conservation measures or best management practices, appropriators are given up to 180 days to identify such measures or practices and develop an implementation schedule. Neither well registration dates nor appropriation priority

dates can be a factor in determining whether an IM-GMA is established or a JAP prepared.

When the NRD and DNR have each completed their portion of the JAP, a public hearing must be held within 60 days. The notice must include a general description of the area to be included in the IM-GMA, and the complete text of proposed regulations. The NRD determines within 90 days whether the JAP should be implemented in an integrated management GMA. If the JAP is implemented, a monitoring program must be established. The NRD may also establish a temporary 3-year ban on well drilling while the JAP is being prepared (authority expires 12/31/02).

Interstate surface-ground water disputes. The DNR may initiate the IM-GMA JAP process on its own motion where interstate surface-ground water disputes are at issue. If the affected NRD does not participate in the JAP process, the DNR assumes the NRD responsibilities for developing IM-GMA regulations, but only with the approval of the Integrated Water Review Committee (IWRC). The IWRC is composed of the Governor and two disinterested members of the Natural Resources Commission.

The IM-GMA study that is conducted prior to preparing the JAP would be invaluable for identifying surface and ground water management options for dealing with the surface-ground water conflicts.

Colorado Approach

In Colorado (as well as in the West generally) the priority doctrine of “first in time is first in right” applies to surface water and to ground water tributary to a surface stream. Colorado has the most advanced administrative system for dealing with surface-ground water conflicts and is a good model to consider.

In Colorado, ground water users who are “junior” (i.e. later in time) to “senior” surface appropriators, are prohibited from pumping their junior wells unless sufficient replacement water is provided to meet the priority



The Nebraska State Government Chapter of the National Management Association recently recognized the UNL/Nebraska Department of Environmental Quality “CLEAR” lake restoration team as a “Team of the Year” awardee. Governor Mike Johanns (left) presented the award to NDEQ’s Elbert Traylor, UNL’s Tadd Barrow, and NDEQ’s Paul Brakhage and Rick Eades. David Svik, president of the NSGC/NMA is at right (NSGC/NMA photo).

calls of senior surface appropriators. This may be accomplished (1) by purchasing and retiring surface water appropriations, (2) purchasing stored surface water which can be released as needed to meet senior priority calls, (3) providing ground water directly to a senior surface appropriator, and (4) pumping ground water directly into a stream.

Replacement water programs in Colorado are implemented through state-approved water “augmentation plans.” Ground water users join user associations and pay a fee (usually based on acres irrigated) to fund the augmentation plan. Water augmentation plans are approved by the Colorado State Engineer if the plan provides sufficient replacement water to cover the association members’ well pumping.

Correlative Rights

Colorado’s surface-ground water conflicts are based on the theory of priority, first in time is first in right. This favors surface water appropriators, whose priority dates may be decades older than most irrigation well priority dates.

In contrast, Nebraska ground water law has historically been based on correlative rights: those using water for the same purpose have equal rights to the water, regardless of well priority date.

One approach to resolving surface-ground water conflicts in Nebraska other than priority is correlative rights. Under this approach, if a water management study determined that there were sufficient water to supply all irrigators (surface and ground water) with e.g. 60 percent of their normal irrigation water supply, that is what each user would be entitled to. All users (not just junior ground water users) would pay a fee to fund water management activities to (1) see that as many irrigators as possible received their 60 percent allocation, and (2) purchased the water rights of those irrigators whose uses could not be supplied.

This approach would guarantee senior surface appropriators only a partial irrigation water supply, not the full water supply they would receive under the priority rule. It would also lessen the financial burden on ground water irrigators by having all irrigators pay for supply augmentation, not just the junior ground water irrigators.

Needed Water Management Tools

The correlative rights approach could be implemented (1) by mutual agreement of surface and ground water irrigators, (2) possibly within a JAP, or (3) pursuant to new legislation authorizing water marketing and supply augmentation activities. This approach would not likely be implemented through litigation unless it were by mutual agreement. This approach also represents the most favorable outcome ground water irrigators would likely be able to legally achieve where wells are depleting streamflow appropriated by senior surface appropriators.

Arkansas Researchers Study Water Quality on Nebraska Tribal Lands

by Ralph Davis, Department of Geosciences and Shelley McGinnis, Ph.D. candidate in Environmental Dynamics Program, University of Arkansas, Fayetteville

Recent surveys of Native Americans suggest that individuals living on reservations may be at greater environmental/health risk than the population at large, due to water-quality problems.

Despite the fact that water quality is a major concern within tribal lands, few published studies documenting specific problems within reservations exist.

The authors, Davis, an associate professor of Geosciences; and McGinnis, a graduate student in Environmental Dynamics Program; recently conducted research examining water-quality data from two reservations in northeast Nebraska, the Omaha and Santee Sioux reservations.

An area of concern on both reservations is the high percentage of domestic wells containing coliform bacteria and exceeding the U.S. EPA's maximum contaminant level (MCL) for nitrate-nitrogen.

Within the Omaha reservation, 38 percent of domestic wells sampled had at least one colony forming unit (cfu) of coliform bacteria per 100/mL of water and 24 percent exceeded the

EPA MCL for nitrate-nitrogen.

Within the Santee Sioux Reservation, approximately 27 percent of the wells had concentrations of nitrate-nitrogen in excess of the MCL, while 44 percent contained coliform bacteria.

Wells containing coliform bacteria and exceeding the MCL for nitrate-nitrogen are health concerns for those who rely on them as a primary source of drinking water.

Nitrate contamination has been linked to health risks such as Blue Baby Syndrome, which lowers the oxygen-carrying capacity of infants' blood, and bladder cancer in middle-aged women (according to a recent study in Iowa).

Coliform bacteria can indicate that other potentially harmful bacteria may be present in the water, as well.

Potential well contaminants such as nitrate-nitrogen and coliform bacteria are of special concern within tribal lands since 23 percent of Native American households on reservations obtain their water from domestic wells, compared to 14 percent of all households, nationally.

It appears that the presence of these contaminants with the Omaha and Santee Sioux Reservations wells may be linked to factors such as well construction, maintenance and land use patterns in the immediate vicinity of the wells rather than agricul-

tural nonpoint source contamination.

Within others areas of eastern Nebraska, many communities have turned to the formation of rural water districts as an alternative to private wells. This is, perhaps, the best long-term solution for providing the reservations with a reliable source of drinking water.

In the meantime, educational outreach programs may be one way to increase community awareness and lead to prevention of contamination in domestic wells.

Both tribes are currently receiving funding from the EPA and other sources to develop comprehensive environmental programs on their lands which will play a crucial role in this educational process.

Other short-term alternatives for improving water quality include on-site treatment, upgrading well construction and increased maintenance intervals for domestic wells.

(Editor's Note: This article was taken, in part, from the Summer 2001 issue of Arkansas Waterdrop, a publication of the Arkansas Water Resources Center at the University of Arkansas, Fayetteville. Research findings are slated to appear in an upcoming issue of Environmental Geology).

"Daisy Well System" Promising Way For Small Communities to Fight Nitrates

(continued from page 1)

arranges a series of injection and extraction wells (where the resulting clean water comes out) in a circular, or daisy pattern around the contaminated well. Other wells that have sampling and monitoring devices placed at various levels in the contaminated capture zone are included in the daisy arrangement so researchers can monitor the nitrate clean-up.

The daisy pattern of injection and extraction wells can be customized to fit individual characteristics and groundwater flow patterns of contaminated wells.

The daisy well system has been extensively tried, analyzed and modified over the past several years by Spalding and Kahn at several locations in Nebraska, including near

Central City, in Merrick County.

Continuing experimentation has led the two to determine that one of the best ways to use the daisy system is by computer-timed injections of ethanol or acetate, what they term pulsed injections. Pulsed injections reduce fouling of the injection wells, which must be cleaned, and have

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Platte River Policy Preferences

by Raymond J. Supalla,
Professor, UNL Department of Agricultural Economics

The Platte River system consists of the North Platte and South Platte Rivers. The North Platte begins in North Central Colorado, passes through South Central Wyoming, crosses all of Nebraska and joins the Missouri River at Omaha, Nebraska. The South Platte begins in East Central Colorado and joins the North Platte River at North Platte, Nebraska.

The Platte system provides irrigation water to over one million acres, supplies 300 MW of hydroelectric power, supports in excess of two million visitor days of recreation each year and provides critical habitat for fish and wildlife.

The reach of the Platte River between Lexington and Grand Island, which is often called the Middle Platte or the Big Bend Reach, is especially critical ecologically. It provides critical habitat for several protected species, including the Interior Least Tern, Piping Plover and Whooping Crane. The Middle Platte also serves as a migration staging area for thousands of Sandhill Cranes, and each year is the site of an internationally acclaimed bird watching spectacle.

The central resource management problem is that there is insufficient water available in the Platte system to meet all competing demands. Environmental interests in all political jurisdictions (Colorado, Wyoming, Nebraska and the U.S. Fish and Wildlife Service) want increased stream flow and management of riparian lands for endangered species protection.

Upstream surface water irrigators want the right to continue irrigating and, in some instances, the right to develop additional acreage. Downstream surface water irrigators want their water supply protected against additional depletion from upstream irrigation or from environmental demands. Most groundwater irrigators want the right to pump at will, irrespective of stream flow considerations.

Hydropower interests want high reservoirs to maximize feet of head and would like to make reservoir releases during the summer months when electricity is worth the most. Coal fired electric utilities want assured cooling water supplies and expansion opportunities. Finally, recreation interests have mixed demands, including moderate reservoir storage levels, stream flows which sustain fishing and waterfowl hunting and easy access to the river and to bird watching opportunities.

Plans for management of the Middle Platte ecosystem have been mired in controversy for over two decades. The controversy has been intractable because of competing interests, because of scientific disagreements and because the parties have been reluctant to potentially undercut their respective negotiating positions by revealing their true preferences.

Significant progress was made in 1997 with the signing of the Cooperative Agreement (CA). This agreement established an interim endangered species water supply target of 140,000 acre-feet in contrast to the USFWS request for 420,000 acre-feet, but it did not establish a

long-term water requirement, or where all the water was to come from and at what cost. A recent study funded by USEPA and the Agricultural Research Division, IANR explored the use of game theory as a resource management tool for addressing these policy issues.

This study defined the Middle Platte management problem in terms of two game models: Model I, which addressed who should provide and pay for environmental water; and Model II, which addressed how much water should be allocated to environmental use. Data for both models was collected in a survey of households in Colorado, Nebraska and Wyoming. Just a few of the results from this study are discussed in this article.

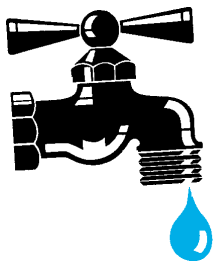
The study found that the most important differences of opinion regarding Middle Platte management policies existed between agricultural and environmental interest groups within each state, rather than between states. At the aggregate level, all three states preferred an adaptive management policy which minimized the reallocation of water from agriculture to environmental uses and involved a mid-range level of investment, with the costs shared equally between the federal government, the states and private environmental interests. Agricultural interests within each state, however, favored minimal investments in endangered species protection, with little if any water reallocated from agricultural to environmental uses.

Environmental interests preferred a policy of meeting all endangered species needs at whatever the necessary cost, using methods which minimized the reallocation of water. Surprisingly, all interest groups preferred that a significant part of the cost be paid by private environmental interests, a policy option which is not a part of any current proposal. All interest groups were also quite receptive to the concept of adaptive management that is incorporated in the Cooperative Agreement. Adaptive management calls for making smaller, short-term changes and observing the consequences, an approach to policy which is especially appropriate when needs and consequences cannot be determined with a reasonable degree of scientific certainty.

An analysis of policy preferences using three different sets of bargaining rules found that a negotiated solution is most likely to consist of an adaptive management approach that minimizes the reallocation of water, requires a modest level of investment and involves an equal sharing of the costs between federal, state and private entities.

An analysis of the impact of technical knowledge on policy preferences found that much of the disagreement between agricultural and environmental interest groups would cease to exist if both groups had technical beliefs that were similar to those held by well informed individuals. This suggests that management disputes can be significantly reduced with technical education programs.

(continued on page 12)



Water News Briefs

Free Tabloids

Copies of *Wetlands-Understanding a Resource (1997)* and *Drinking Water-Understanding a Resource (1999)* are available free from the UNL Water Center.

Organizations wanting copies for educational use or general distribution can have up to several hundred copies of either or both publications at no cost, providing they make arrangements to pick them up from our UNL East Campus offices. If you need copies shipped to you, we will only ask that you pay the actual costs of shipping/ mailing.

If you want copies of either or both tabloids, call the Water Center at (402)472-3305 or email sress1@unl.edu. For a list of other free publications available through the Water Center, access us online at <http://watercenter.unl.edu>.

New Sites and Information

The U.S. Geological Survey has launched a new web site at <http://water.usgs.gov/nwis>.

The site accesses several hundred million pieces of archival and real-time data from a national network of more than 1.5 million USGS water data collection stations. The site is called the "National Water Information System (or NWISWeb)."

The Conservation Technology Information Center and the American Farm Bureau Federation have developed virtual tours of new nature management technologies at <http://www.agtours.org>.

The United Nations have a number of new publications dealing with dispute resolution, eutrophication, hydrogeology, pollution, water crisis, water and development and water management available for order online at <http://www.un.org/Pubs/update/envirupd.htm>.

The American Water Works Association has published *Handbook of Water Use and Conservation* by Amy Vickers. The volume contains water-efficiency technologies and practices for all consumer groups. The book can be accessed online at http://www.awwa.org/bookstore/timssnet/products/tnt_products.cfm.

The U.S. Environmental Protection Agency's "Watershed Assessment, Tracking and Environmental Results (WATERS)" integration web

site unites geographically specific water quality data from state web sites and various EPA sites, including its new National Water Quality Standards Database and TMDL database with the USGS' National Hydrographic Dataset. The site is located at <http://www.epa.gov/waters/> and can be used to generate summary reports on all waters of a given state.

Chemistry Department Appointees

Pat Dusssault, Chair of the UNL Chemistry Department announced the appointment of Dipanjan Nag as the Director of Chemistry's Research Instrumentation Facility (RIF) and Ron mCerny as the Director of Services for the Nebraska Center of Mass Spectrometry (NCMS). Cerny is also co-director of the Biotechnology Proteomics Core Facility.

The RIF contains instrumentation including high-field NMR (solid and liquid state, including capability to work on biomolecules in aqueous media), IR, GC/MS and UV/visible spectrometers. Dr. Nag can be reached at (402)472-6255 or dnag@unlserve.unl.edu.

The NCMS offers low and high-resolution data in conjunction with electron ionization, chemical ionization and fast atom bombardment, in other addition to other capabilities. Professor Cerny can be reached at (402)472-3507 or rcerny1@unl.edu.

"Daisy Well System" Promising Way For Small Communities to Fight Nitrates

(continued from page 8)

proven highly effective in reducing nitrate contamination to acceptable levels in a very short period of time.

Adding a biodegradable organic carbon (such as ethanol or acetate) stimulates the natural microbes in the soil to convert potentially harmful nitrates into innocuous nitrogen gas, while the organic carbon oxidizes to carbon dioxide. Though not considered harmful, these microbes are also removed from the water before it is delivered to customers.

"The result is often that contaminated wells can be restored to pumping water below the MCL, or at the very least, a level low enough that mixing water from the contaminated well with water from other, noncontaminated wells in a city's system will result in a safe supply of water," Spalding said.



Monitoring wells are included in the daisy well denitrification systems being perfected at the UNL Water Sciences Laboratory (photo: Steve Ress).

16: UNL Water Center Water and Natural Resources Seminar (Williams Lecture): "Lake Classification Methodology, George Gibson, senior scientist, U.S. EPA Laboratory, Fort Meade, MD, 3 p.m., Room 116, L.W. Chase Hall, UNL East Campus.

23: UNL Water Center Water and Natural Resources Seminar: "Endangered Tiger Beetles in the Salt Creek Watershed," Glenn Johnson, Lower Platte South Natural Resources District, 3 p.m., Room 116, L.W. Chase Hall, UNL East Campus.

27-30: Conference on Tailings and Mine Waste '02: Colorado State University, Fort Collins, CO. Contact Linda Hinshaw at (970)491-6081, email jhinshaw@engr.colostate.edu or go to <http://www.tailings.org>.

30: UNL Water Center Water and Natural Resources Seminar: "Activities and Initiatives of the Nebraska Environmental Trust," Mary Harding, Nebraska Environmental Trust, 3 p.m., Room 116, L.W. Chase Hall, UNL East Campus.

FEBRUARY

13: UNL Water Center Water and Natural Resources Seminar: "Tracking Fish and Wildlife Diseases, Rosenthal/Morrison, Nebraska Game and Parks Commission, 3 p.m., Room 116, L.W. Chase Hall, UNL East Campus.

17-20: "Disinfection 2002," sponsored by the Water Environment Federation, St. Petersburg, FL. For registration and

program information, go to <http://www.wef.org/conferences/index.html>, email confinfo@wef.org or call (800)666-0206.

20: UNL Water Center Water and Natural Resources Seminar: "Provisions and Innovations of the Settlement in Nebraska v Wyoming," Roger patterson, Nebraska Department of Natural Resources, 3 p.m., Room 116, L.W. Chase Hall, UNL East Campus.

22-23: Eighth Xeriscape Conference, Albuquerque, NM. Contact Scott Varner, at (505)294-7791 or go to <http://www.xeriscape.nm.com>.

25-March 1: "Adventures in Erosion Control," International Erosion Control Association, 33rd Annual Conference and Expo, Orlando, FL. Contact IECA at (970)879-3010 or email ecinfo@ieca.org.

27: UNL Water Center Water and Natural Resources Seminar (Williams Lecture): TMDLs," Kenneth Reckhow, North Carolina State University, 3 p.m., Room 116, L.W. Chase Hall, UNL East Campus.

27-March 1: Fifth National Mitigation Banking Conference, Washington, D.C. Contact: Carlene Bahler, Terrene Institute, 4 Herbert Street, Alexandria, VA, 22305; (703) 548-5473, cbahler@erols.com or online at <http://www.terrene.org> (click on National Mitigation Banking Conferences).



Meet the Faculty

Sherilyn C. Fritz (continued from page 3)

Selected Publications:

- Baker, P.A., G.O. Seltzer, S.C.Fritz, R.B. Dunbar, M. Grove, P. Tapia, S. Cross, H. Rowe, and J. Broda, 2001. The history of South American tropical climate for the past 25,000 years. *Science* 291: 640-643.
- Engstrom, D.R., S.C. Fritz, J.E. Almendinger, and S. Juggins, 2000. Chemical and biological trends during lake evolution in recently deglaciated terrain. *Nature* 408:161-166.

- Fritz, S.C., E. Ito, Z. Yu, K.R. Laird, and D.R. Engstrom, 2000. Hydrologic variation in the northern Great Plains over the last two millennia. *Quaternary Research* 53: 175-184.
- Saros, J.E. and S.C. Fritz, 2000. Changes in the growth rate of saline-lake diatoms in response to variation in salinity, brine type, and nitrogen form. *Journal of Plankton Research* 22: 1071-1083.
- Fritz, S.C., B.F. Cumming, F. Gasse, and K.R. Laird, 1999. Diatoms as

indicators of hydrologic and climatic change in saline lakes. In E.F. Stoermer & J.P. Smol, eds. *The Diatoms: Applications for Environmental and Earth Sciences*. London, Cambridge University Press. pp 41-72.

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Jose D. Payero (continued from page 3)

- Evaluation of the capacity of the users of the CUFE Canal for managing the irrigation system in a sustainable manner. Instituto Superior de Agricultura, Dominican Republic. Report written for *Winrock International*.
- Carrasco, D.A., J. Payero, V. Vasquez, and K. Murphy, 1992. The Yaque del Norte River: Causes and consequences of its pollution. Case Study, Instituto Superior de Agricultura, Dominican Republic.

- Payero, J.O., M.S. Bhangoo, and J.J. Steiner, 1990. Nitrogen fertilizer management practices to enhance seed production by Anaheim Chili peppers. *Journal of the American Society for Horticultural Science* 115(March):245-251.
- Payero, J.O., 1987. Petiole NO₃-N Analysis as a Guide for Nitrogen Fertilizer Management of Anaheim Chili Pepper. Thesis submitted in partial fulfillment for the Master of Science degree in Agriculture-Plant Science,

- California State University-Fresno.
- Payero, J.O., and E. Pujols, 1984. Evaluation of irrigation depths and frequencies for dry beans. Thesis submitted in partial fulfillment for the Bachelor degree in Agronomy. Universidad Catolica Madre y Maestra, Dominican Republic.

Web/email addresses:

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jpayero2@unl.edu

Recent Journal Articles

Chen, X. H., 2001. Migration of induced-infiltrated stream water into nearby aquifers due to seasonal ground water withdrawal, *Ground Water*, v. 39, no. 5, p. 721-728.

Chen, X. H., and Y. Yin, 2001. Streamflow depletion: modeling of reduced baseflow and induced stream infiltration from seasonally pumped wells. *Journal of American Water Resources Association*, v. 37, no. 1, p. 185-195.

Dvorak, B. and Schauble, J., 2001. Uncertainty in Air Stripping Tower design: Implications of Air-to-water Ratio. *Water Science and Technology*, October.

Behrens, M., Dvorak, B., and Woldt, W. 2000. Implications of Hidden Costs: Comparison of Bitumen Testing Procedures. *Environmental Technology*, 21, 243-255.

Baker, P.A., G.O. Seltzer, S.C.Fritz, R.B. Dunbar, M. Grove, P.

Tapia, S. Cross, H. Rowe, & J. Broda. 2001. The history of South American tropical climate for the past 25,000 years. *Science* 291: 640-643.

Schalles, J.F., J.A. Maeder, D.C. Rundquist, S. Narumalani, and J. Keck. Close range hyperspectral reflectance measurements of corals and other reef substrates. *Proceedings of the 9th International Coral Reef Symposium*, International Society of Reef Studies (Accepted).

Schalles, J.F., D.C. Rundquist, and F.R. Schiebe. 2001. The influence of suspended clays on phytoplankton reflectance signatures and the remote estimation of chlorophyll. *Vehrein Internationale Verein Limnologie* (In Press).

Szilagyi, J., 2001. Modeled areal evaporation trends over the conterminous United States, *Journal of Irrigation and Drainage Engineering*, 127(4): 213-218.

Szilagyi, J., 2001. On Bouchet's complementary hypothesis, *Journal of Hydrology*, 146: 155-158.

Zlotnik, V.A., B.R. Zurbuchen, and T. Ptak, 2001, Steady-state dipole-flow test for characterization of hydraulic conductivity statistics in a highly permeable aquifer: Horkheimer Insel Site, Germany, *Ground Water*, 39, in press.

Butler, J.J., Jr., V.A. Zlotnik, M.-S. Tsou, 2001, Drawdown and stream depletion produced by pumping in the vicinity of a partially penetrating stream, *Ground Water*, 39, in press.

(Editor's Note: Recently published journal articles may be submitted for listing in upcoming issues of the *Water Current* by emailing the information to sress1@unl.edu or phoning 402-472-3305).

Platte River Policy Preferences (continued from page 11)

In total, the people in all three states who have been patiently searching for ways to equitably and agreeably allocate a very limited Platte River water supply among competing uses can find some encouragement in the results of this analysis. Game model results suggest that there are solutions which all

sides are likely to find acceptable. The finding that differences in interest group views may be due primarily to differences in technical beliefs rather than values is especially encouraging. Education and science can address differences in technical beliefs in a search for mutually acceptable outcomes, but value

difference can only be addressed in a political or legal fight where there are inevitably losers as well as winners.

(Editor's Note: Additional contributors to this study were Bettina Klaus, John Allen and Osei Yeboah, all current or former members of the UNL Department of Agricultural Economics).

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