Nebraska Water Resources Center
Annual Technical Report
FY 2006

Introduction

Dr. Kyle D. Hoagland served as director of the University of Nebraska Water Center again this year (since 2000), with Michael Jess as associate director and Dr. John Holz as the assistant director. Steven Ress and Tricia Liedle continued as communications specialist and office supervisor, respectively. The Water Center is currently housed in the newly renovated natural resources building, Hardin Hall (3310 Holdrege, Lincoln, NE 68583-0979).

The campus-wide Water Resources Research Initiative (WRRI) continued into its third year. To date, seven new faculty members have been hired in a variety of water-related fields including, water law, water chemistry, surface hydrology, climate modeling, water economics, and stream ecology. Faculty positions in water policy and hydrologic systems information are now being searched. The third annual Water Law, Policy and Science Conference was hosted by the University of Nebraska-Lincoln on May 4-5, with Adaptive Management for Resilient Water Resources as its theme. This ongoing conference series is aimed at better integrating water science and its societal dimensions, while focusing on themes of immediate relevance to this region, yet of international importance as well.

A color directory of all water faculty (>100) at the University of Nebraska was published in 2006, including descriptions of the major academic and research units that are involved in water research and education. The directory is distributed to state and federal water-related agencies, state and congressional delegations, NGOs and natural resources districts state-wide. Water resources briefing books containing 1-2 page summaries of key water topics (e.g., groundwater recharge) were produced for state and congressional legislators and their staff, as well as natural resource district board members (also elected) and other water resource managers and decision makers in Nebraska.

Research Program

In 2006, an external panel comprised of state and federal agency representatives reviewed six USGS 104(b) proposals and recommended three for full funding. In addition a 104(g) project was transferred to the UNL Water Center this year by a recent faculty hire. Areas under 104(b) funded this year included (a) quantification of river flow using a novel modeling approach, (b) use of remote sensing to quantify evapotranspiration, and (c) defining hydro-ecoregions in agriculturally dominated ecosystems for developing lake water quality standards. As of June 2007, a majority of these projects are now complete.

The efficacy of our Water Sciences Laboratory continued to increase this year. Core facility assistance to water science faculty increased again, both in breadth of analyses and the number of faculty utilizing this cutting-edge analytical facility. Analyses were again conducted for several other universities, six state and federal agencies, as well as private companies and individuals. Analyses included munitions (e.g., RDX), antibiotics and other pharmaceuticals, , pesticides (incl. herbicide metabolites), trace elements (metals), nutrients (esp. nitrogen species), and stable isotopes (e.g., 15N, 18O and 13C) for applications such as nutrient source determinations and groundwater dating.

The impact of rural water supply systems on property values

Basic Information

Title:	The impact of rural water supply systems on property values
Project Number:	2005NE83G
Start Date:	9/1/2005
End Date:	9/1/2007
Funding Source:	104G
Congressional District:	1
Research Category:	Social Sciences
Focus Category:	Economics, Water Supply, Water Use
Descriptors:	None
Principal Investigators:	Steven Shultz, Jay Andrew Leitch

Publication

2006 Annual Report Project 2005NE83G
WBS# 25-6254-0019-001
Period: March 1, 2006 through February 28, 2007
Title: The impact of rural water supply systems on property values
PI: Steve Shultz UNO

Completed Work Tasks:

1) Abandonment of the Agricultural Land Sale Aspects of the Study

2) Abandonment of the SW Study Areas in North Dakota

3) Expanding the number of rural residential sales in North Dakota

4) Expanding the Study to Nebraska (evaluating 145 sales in Washington County)

5) Characterizing the details of rural residential sales and rural water supply conditions in both study areas (ND & NE)

6) Measuring the impact of rural water supply systems on housing prices using hedonic regression modeling

7) Conclusions

Details on Completed Work Tasks:

1) Abandonment of the agricultural land sale component of the study

Preliminary hedonic regression modeling on 1040 agricultural land sales across 17 counties found no measurable relationships between rural water supply systems and agricultural land values. In fact only 22% of agricultural sales were within a mile of any rural water supply pipelines. While such relationships may occur in states with more urbanization pressure (residential development potential), it does not appear present in North Dakota. For these reasons the agricultural land value components of the study have been abandoned.

2) Abandonment of the SW study area in North Dakota

We obtained 85 rural residential sales from Morton and Stark counties in the southwestern part of the State but all of these homes are on rural water supply systems in this part of the State without groundwater resources. Since there are no sales without rural water and hence it is not possible to use regression to model the impact of rural water supply systems on home values in this part of the State and this component of the original research plan has therefore been abandoned.

3) Expanding the number of rural residential sales in North Dakota

An additional 55 rural residential sales were obtained for the adjacent counties of Stutsman, and Barnes Counties based on visits to county tax assessor offices. These sales were digitized using previously described approaches, cross-matched with rural water service records, and buyers/sellers were surveyed to confirm transaction, housing characteristics, and water supply information.

4) Expanding the Study to Nebraska (evaluating 145 sales in Washington County)

Washington County Nebraska was chosen as a location to expand the original study focus. This area was chosen due to the fact that it contains two rural water systems for which pipeline data was available and with its proximity to Omaha (a major population center), a relatively large number of rural residential sales data was also available. A total of 155 rural residential sales sales were successfully geo-coded and intersected with rural water supply maps to determine their water supply status.

5) Characterizing the details of rural residential sales and rural water supply conditions in both study areas (ND & NE).

Among the sample of sold rural residences in North Dakota (n=188) slightly more than half are signed up for rural water (public). Homes using private wells are less expensive, smaller, and older than homes served by rural water supply systems. This is expected as many lenders of new home construction loans are requiring rural water hook-ups as a requirement for mortgages

Private well homes also have higher water quality (as measured by total dissolved solids) compared to the wells near homes on rural water which indicates that those homes with the worse water quality in their wells are more likely to sign up for rural water.

These and other characteristics of homes are summarized in Table 1. Statistical differences between homes having private versus public water systems were tested using paired t-tests at the 95% and 99% confidence levels. Characteristics that are statistically different across water supply types are denoted in bold.

Table 1. Characteristics of the Sample of Sold Rural Properties in North Dakota

Variable	Private (n=92)	Public (n=96)	All (n=188)
Sale Price ($)	59,206*	71,956	66,168
Total Dissolved Solids*	1,756*	2,479*	2,151
Lot Size (acres)	12.2	9.5	10.8
House Sq. Ft.	1,255**	1,483**	1,380
D Central Air	0.26**	0.47**	0.38
Bathrooms	1.32	1.73	1.55
Bedrooms	2.83	3.04	2.94
Age	37	32	34
D Oil Furnace	0.03	0.17	0.11
D Gable Roof	0.84	0.75	0.79
D Gas Fireplace	0.09	0.20	0.15
Outbuilding Sq. Ft.	680	863	780
Distance to Hospital [miles]	14.28	11.03	12.51
Dist to Large City [Miles]	9.29	9.38	9.34
D Block Basement	0.38	0.34	0.36
D 2001	0.14	0.12	0.13
D 2002	0.16	0.22	0.19
D 2003	0.23	0.18	0.20
D 2004	0.16	0.19	0.18
D 2005	0.14	0.14	0.14

Bold Variables Tested for Difference Using a paired t-test
* Different across Water Supply Types at the 5% level
**Different across Water Supply Types at the 1% level

Similarly, in Nebraska rural water homes are less expensive, smaller and older than homes on public water. However, private well homes do have slightly more updated heating and cooling systems. Again, statistically significant differences in home features across waters supply type are tested using paired-tests and the results are summarized in Table 2.

Table 2. Characteristics of the Sample of Sold Rural Properties in Nebraska

Variable	Private (n= 103)	Public (n= 84)	All (n=187)
Sale Price ($)	222,710*	228,116 *	225,137
D Rural Water	0.00	1.00	0.45
Age	29.48 **	24.12**	27.18
House Sq. Ft.	2,543**	2,649**	2591
Garage Spaces	2.21	2.17	2.19
D Metal Siding	0.09	0.06	0.07
Bedrooms	3.53	3.43	3.49
Bathrooms	2.70	2.74	2.72
D Updated HVAC	0.72	0.70	0.71
Basement Finished Sq. Ft.	572	572	572
D Vinyl Siding	0.29	0.13	0.22
D Brick	0.09	0.14	0.11
D 1997	0.03	0.04	0.03
D 1998	0.04	0.08	0.06
D 1999	0.11	0.08	0.10
D 2000	0.12	0.14	0.13
D 2001	0.11	0.17	0.13
D 2002	0.05	0.12	0.08
D 2003	0.12	0.10	0.11
D 2004	0.12	0.07	0.10
D 2005	0.20	0.13	0.17
D 2006	0.09	0.04	0.06

Bold Variables Tested for Difference Using a paired t-test
* Different across Water Supply Types at the 5% level
**Different across Water Supply Types at the 1% level

6) Measuring the impact of rural water supply systems on housing prices using hedonic regression modeling

A hedonic based multiple regression model was estimated for each sample (state) to quantify whether rural water supply systems have a statistically significant impact on the sale prices of rural homes while accounting for an array of other housing and location-based characteristics. The results are summarized in Tables 3 and 4. Due to heteroskedacity found in each model, both ordinary least square (OLS) and variance weighted least (VWLS) squares results are reported.

Regression results indicate that rural water supply connections ***do not*** have a statistically significant impact on housing prices in ***any*** of the study locations. This may be the result of relatively small sample sizes (few arms-length rural residential sales) and highly heterogeneous housing and drinking water supply conditions across the study areas. It is also likely due to the fact that most lending institutions require rural water connections for the financing of all new home construction.

Table 3. Multiple Regression Results (North Dakota)

	OLS		VWLS	
Variable	Coef.	P>t	Coef	P>z
D Rural Water	-702	0.904	878	0.862
LN Lot Size	5,922	0.003	5,287	0.001
LN House Size	10,607	0.162	9,663	0.153
D Central Air	26,361	0.000	25,807	0.000
Bathrooms	8,199	0.073	5,940	0.166
Bedrooms	1,622	0.576	3,201	0.210
Age	-283	0.014	-312	0.001
D Oil Furnace	-15,719	0.092	-14,909	0.041
D Gable Roof	-15,193	0.025	-12,440	0.037
D Gas Fireplace	7,366	0.240	9,661	0.132
Outbuilding Sq. Ft.	2.01	0.328	1.50	0.454
Distance to Hospital [miles]	-1,168	0.051	-1,032	0.023
Dist to Large City [Miles]	-1,817	0.018	-1,505	0.017
D Block Basement	8,523	0.137	4,966	0.335
D 2001	-8,657	0.379	-7,427	0.384
D 2002	-5,671	0.541	-2,600	0.742
D 2003	-5,443	0.545	-1,802	0.813
D 2004	9,667	0.291	10,720	0.162
D 2005	16,439	0.087	17,214	0.034
Latitude	0.26	0.025	0.25	0.011
Longitude	-6.58	0.004	-5.45	0.003
Longitude^2	0.00	0.003	0.00	0.002
Constant	450,857	0.621	137,172	0.858
Obs.	152			150
F-Value	9.86		Chi^2	259.92
Prob> F	0.000		Prob>Chi^2	0.000
R^2	0.627			
Adj. R^2	0.5634			
Root MSE	30036			

Table 4. Multiple Regression Results (Washington County, Nebraska)

	OLS		VWLS	
Variable	Coef.	P>t	Coef.	P>z
D Rural Water	-1,770	0.855	-8,309	0.253
Age	-157	0.393	-27.77	0.813
House Sq. Ft.	79.10	0.000	82.44	0.000
Garage Spaces	16,686	0.000	18,780	0.000
D Metal Siding	-25,592	0.159	-29,558	0.017
Bedrooms	-26,163	0.000	-31,604	0.000
Bathrooms	21,609	0.006	14,360	0.022
D Updated HVAC	-14,603	0.191	-21,461	0.015
Basement Finished Sq. Ft.	-7.86	0.455	-8.18	0.441
D Vinyl Siding	11,297	0.370	7,121	0.462
D Brick	34,440	0.034	41,186	0.006
D 1997	21,559	0.556	19,596	0.413
D 1998	-6,251	0.841	15,226	0.457
D 1999	49,320	0.102	31,732	0.146
D 2000	21,871	0.447	18,693	0.370
D 2001	22,175	0.444	28,522	0.186
D 2002	13,014	0.674	5,503	0.810
D 2003	57,628	0.050	41,074	0.060
D 2004	78,906	0.010	58,988	0.012
D 2005	50,880	0.069	41,811	0.039
D 2006	79,370	0.013	76,314	0.002
Constant	-11,585	0.752	24,284	0.316
Obs.	176			175
F-Value	31.02		Chi^2	1163.01
Prob> F	0.000		$Prob>Chi^2$	0.000
R^2	0.8001			
Adj. R^2	0.7743			

7) Conclusions:

This research has demonstrated that the water quality of private wells is higher among non-connected versus connected homes (In North Dakota) which implies that property owners decisions to sign up for rural water services is likely to be influenced by property specific rather than regional water quality measures. Such factors should be quantified and evaluated prior to the funding and implementation of rural water supply projects to avoid lower than expected customer sign-ups.

However, difficulties associated with hedonic price modeling of rural water supply systems are not as statistically robust and informative for water policy decision-making as with other recent applications. For example, the authors have recently used hedonic multiple regression modeling to successfully quantify the impact of reservoir views on housing values, and the impact of low impact housing developments (from a storm water runoff perspective) on property values. Both studies were conducted in the metropolitan

area of Omaha, NE and were hence able to take advantage of much larger sample sizes and more heterogeneous housing characteristics.

Work Tasks Planned for 2007:

The inclusion of additional analyses in another part of Nebraska.

Present research results at the UCOWR/NIWR meetings in Boise Idaho

Alternative multiple regression modeling including running a fixed effect model.

Publications

None

Use of Remotely Sensed Data for Improved Quantification of Evapotranspiration for Water Management in Nebraska

Basic Information

Title:	Use of Remotely Sensed Data for Improved Quantification of Evapotranspiration for Water Management in Nebraska
Project Number:	2006NE117B
Start Date:	3/6/2006
End Date:	2/28/2007
Funding Source:	104B
Congressional District:	First
Research Category:	Climate and Hydrologic Processes
Focus Category:	Water Use, Water Quantity, Hydrology
Descriptors:	None
Principal Investigators:	Ayse Irmak, Qi Steven Hu, Suat Irmak, Derrel L Martin, George E. Meyer, Donald C. Rundquist, Shashi Verma

Publication

1. Sing, R., A. Irmak, S. Irmak, and D.L. Martin. Satellite remote sensing based estimation of land surface evapotranspiration in Great Plains. 2007 World Environmental and Water Resources Congress. Tampa, Florida. May 07-May 15. The power point of this presentation is attached
2. Sing, R., A. Irmak, S. Irmak, and D.L. Martin. 2007. Application of SEBAL for mapping evapotranspiration and estimating surface energy fluxes in south central Nebraska. Journal of Irrigation and Drainage Engineering, ASCE (in review).
3. A. Irmak, Sing, R., S. Irmak, and D.L. Martin. 2007. Operational aspects of remote sensing-based energy balance models for estimating surface energy fluxes. 2007 ASABE Annual International Meeting, Minneapolis, Minnesota, 17-20 June 2007.

Progress Report for USGS, Section 104b Program Funding

Project #: 2006NE117B
WBS #: 25-6254-0020-004
Funding Period: March 1, 2006 through February 28, 2007
Title: Use of Remotely Sensed Data for Improved Quantification of Evapotranspiration for Water Management in Nebraska

PI(s): Ayse Irmak, Suat Irmak, Steve Hu, Derrel Martin and Don Rundquist

Problem and Objectives

In the Central Plains of the United States, at least 90%, or more, of the precipitation is returned back to the atmosphere by evapotranspiration (ET) (USGS, 1997). Thus, accurate estimation of ET is one of the key elements for better managing water resources management. Particularly, in the context of crop production in irrigated agriculture such as a) scheduling of irrigation, b) evaluation of the effects of changing land use on water yields, c) environmental assessment by developing best management practices for surface and groundwater quality protection, d) predicting the status of the soil water supplies and their allocation and efficient use and e) quantifying water use by different vegetation surfaces over large areas. Better allocation and management of the region's water resources will ultimately affect the economics of the region and will in meeting stream requirements for water compacts and endangered species.

Practical, reliable and cost-efficient techniques are needed for quantification of ET to enhance efficient use of water resources and protect water quality in the region. Most field measurements are indirect and based on equations and assumptions. Bowen ratio energy balance systems (BREBS), eddy correlation systems (ECS), weighing lysimeters, and water balance techniques offer alternatives for measuring ET and surface energy fluxes. However, in spite of the elegance and theoretical attractions of these techniques for measuring ET, their practical use over large vegetation surfaces is limited. These techniques provide point measurements and may not be practical when quantifying water use over large areas (i.e., watershed or basin scale or regional scale). Despite the high accuracy of techniques, they can be very expensive for practical applications in regional scales under heterogeneous terrains composed of different agro-ecosystems. What is also lacking is a more quantitative and systematic understanding of what modeling approach is most suitable for predicting ET at scales that range from plot to region. What are suitable data sources that can help improving ET predictions? What role can remote sensing play in this process? What are the uncertainties involved and how can they can be minimized? How reliable is ET across the region?

Spatio-temporal information on actual ET helps users to better understand evaporative depletion and to establish links between land use, water allocation, and water use. Satellite-based measurements, used in conjunction with energy balance models, can provide spatial distribution of ET for these linkages. Remote sensing is becoming increasingly sophisticated and potential exists for indirect ET measurement. It involves using a set of equations in a strict hierarchical sequence to convert the spectral radiances measured by satellites or airplanes into estimates of actual ET. The demand of using remote sensing and satellite imagery for quantification of ET over large areas is growing. Application of ET mapping from satellite measurements can actually be an expansion of field measurements using aforementioned techniques when applied properly. Surface Energy Balance Algorithm for Land (SEBAL) has been offered as an alternative technique to quantify ET over large areas using satellite surface energy fluxes measurements. Since its' development, this technique has been successfully used for ET estimations for different surface and in different environments.

The principal thrust of our proposal is to conduct applied scientific research for satellite-derived estimates of evapotranspiration in conjunction with the surface energy balance algorithm for land at different scales with emphasis on the major agroecosystems of the U.S. Corn Belt in Nebraska. The specific objectives were:

1) Estimate actual evapotranspiration and the biomass production under different agroecosystems in Nebraska using energy balance models with remote sensing data

2) Assess the performance of the model results against several reference ground-truth ET techniques for testing its accuracy

3) Quantify ET over large areas at field and watershed scale in Nebraska.

Principal Findings and Significance

Our primary goal is spatiotemporal estimation of ET using satellite-derived spectral radiances in real time in conjunction with SEBAL model to enhance efficient use of our water resources and protect water quality in the Great Plains. A total of seven cloud free Landsat TM/ETM satellite images (May 19, June 20, July 22, August 7, September 8 and 16, and October 18, 2005) were processed to generate crop evapotranspiration (ET_c) maps and estimate surface energy fluxes in Nebraska. The predictions from SEBAL model were compared with the Bowen Ratio Energy Balance System (BREBS)-measured fluxes on an instantaneous and daily basis.

The ET_c maps generated by model for seven Landsat overpass days showed a very good progression of ET_c with time during the growing season in 2005 as the surface conditions continuously changed. Overall, a very good correlation was found between the BREBS-measured and SEBAL-estimated ET_c for all images analyzed with a good r^2 of 0.73 and a low RMSD of 1 mm d^{-1}. The estimated ET_c was within 5% of the measured ET_c. The model was able to predict growing season (from emergence to physiological maturity) cumulative daily corn ET reasonable well within 5% of the BREBS-measured values.

The results from this seed project provided insights into to improve our understanding of biophysical processes governing evapotranspiration. While our results showed that SEBAL can be a viable tool for generating ET_c maps to assess and quantify spatiotemporal distribution of ET on large scales as well as estimating surface energy fluxes, its operational assessment for estimating sensible heat flux and ET_c, especially during the drier periods for different surfaces needs further investigation.

Notable Achievements

1. A proposal is submitted to Nebraska Department of Natural Resources entitled "Estimation of Evapotranspiration from Riparian and Invasive Species Using Remote Sensing and in Situ Measurements in the Republican River Basin". A funding in the amount of $946,549 has been secured for the next five year. Project PIs: Derrel Martin, Ayse Irmak and Suat Irmak, and Shashi Verma.

2. Measurement of growing season actual crop evapotranspiration and crop coefficients, and dormant season evaporative losses for key vegetation surfaces in the Central Platte Natural Resources District. A funding in the amount of $475,000 has been secured for the next four year. Project PIs: Suat Irmak, Ayse Irmak, Derrel Martin, Shashi Verma, and Simon vanDonk.

Acknowledgement

We would like to express our sincere appreciation for the financial support for this research project. The research was made possible from funding through the USGS, Section 104b program administered by the University of Nebraska-Lincoln, Water Center and Biological Systems Engineering department. We would like to thank Milda Vaitkus of Center for Advanced Land Management Information Technologies (CALMIT) at the University of Nebraska-Lincoln for providing some of the Landsat images used in this research.

Water quantity and quality within the Great Plains: Model development within a Nebraska Basin

Basic Information

Title:	Water quantity and quality within the Great Plains: Model development within a Nebraska Basin
Project Number:	2006NE126B
Start Date:	3/1/2006
End Date:	8/28/2007
Funding Source:	104B
Congressional District:	lancaster
Research Category:	Water Quality
Focus Category:	Water Quality, Hydrology, Solute Transport
Descriptors:	
Principal Investigators:	Erkan Istanbulluoglu, Durelle T. Scott

Publication

Water Quantity and Quality within the Great Plains: Model Development within a Nebraska Basin

PI(s): Erkan Istanbulluoglu and Durelle Scott

Water is the lifeblood of the Great Plains. However, both water quantity and quality within the Great Plains is expected to alter in response to climate change. During the 20th century, temperatures in the Northeastern and Central Great Plains have risen more than 2°F on average, and up to 3°F in various regions [e.g., Groisman et al., 2004]. Such a trend is expected to continue in the coming years, as predicted by the Global Climate Models [Easterling et al., 2000]. Some of the most profound impacts of global warming in the Great Plains can be summarized as: (1) longer growing seasons due to early onset of spring temperatures; (2) increase in climate extremes- including air temperatures, rainfall rates, and floods; (3) alteration in the timing of growing season precipitation- less frequent storms with increased magnitudes; (4) reduction in soil moisture, as the rate of increase in potential evaporation, with rising temperatures, is expected to surpass precipitation.

During the last year, we have engaged in 4 activities to increase our understanding of how climate will alter water and material fate and transport through Nebraksa watersheds. The first activity involved a characterization of the Elkhorn Watershed using spatial topographic analysis. The analysis is the first step in building our understanding of hydrologic flowpaths across the landscape. This component of the work is ongoing.

The next activity involved conducting an in-stream tracer experiment to characterize hydrologic exchange through Maple Creek, a 3rd order stream within the basin. Prior to the experiment, 48-hours of sampling occurred within the stream over an entire flood pulse. Following the flood pulse, measurements were made at 4 stations within the stream both during the tracer injection and following for 24-hours. Analysis of these samples is almost complete, and includes dissolved organic carbon characterization, anions, and dissolved nitrogen species. Analysis of these results in conjunction with stream respiration measurements is now underway, and we expect the analysis to result in a peer-review publication.

The 3rd activity involves basin wide characterization of organic matter dynamics through time. We developed an approach to measure bioavailability of organic matter and organic matter characterization within the aquatic system. Five stream sampling stations ranging from 2nd – 7th order streams are now being measured on a monthly basis to both build on our understanding of in-stream cycling, with both an expectation of a peer-reviewed paper and submission of proposal for continuation of the work.

The last activity involved the PI Scott in learning a modeling code SPARROW (Spatial regression on watershed attributes), a U.S.G.S. code. Scott attended a 4-day training workshop at the E.P.A.. Although the model has not yet been applied by the PI within the Great Plains, we expect that this spatial regression model will be used within our group to compliment other hydrologic modeling to quantify relationships between sources, landscape delivery, and in-stream retention of

nutrients / contaminants.

Determination of Appropriate Lake Water Quality Expectations in Agriculturally Dominated Ecosystems. Phase 1: Defining Nebraska's Hydroecoregions

Basic Information

Title:	Determination of Appropriate Lake Water Quality Expectations in Agriculturally Dominated Ecosystems. Phase 1: Defining Nebraska's Hydroecoregions
Project Number:	2006NE128B
Start Date:	3/1/2006
End Date:	5/1/2007
Funding Source:	104B
Congressional District:	NE-1
Research Category:	Water Quality
Focus Category:	Surface Water, Nutrients, Agriculture
Descriptors:	
Principal Investigators:	Aris Alizbeth Holz, John Carl Holz, James W. Merchant

Publication

Project Title: Determination of Appropriate Lake Water Quality Expectations in Agriculturally Dominated Ecosystems. Phase 1: Defining Nebraska's Hydroecoregions

Investigators: Aris Holz (aholz2@unl.edu), John Holz (jholz@unl.edu) and James Merchant (jmerchant1@unl.edu)

Progress Summary: The overall goal of this research is to develop a dynamic strategy for determining appropriate water quality standards for agricultural ecosystems by grouping geographic regions with similar natural landscape characteristics into management groups (termed "hydroecoregions"), using Nebraska as a model. Specifically, we proposed to (a) extract watershed characteristic data from existing HUC's (i.e. hydrologic cataloging units) using the zonal summary in ARCMAP GIS, (b) convert the data file to MS Excel, (c) statistically group (classify) HUC's with similar landscape characteristics into hydroecoregions, and (d) compare these regions to the 65 watersheds that were delineated in our previous lake and reservoir classification project to ensure that they HUC-derived hydroecoregions adequately represent watersheds. The classification results from either of these hydrologic units can be used to create a hydroecoregion map for Nebraska which will facilitate the subsequent modeling efforts to predict nutrient and sediment runoff.

Research progress on this project has exceeded our expectations. Tasks (a) – (c) are completed and task (d) is underway. In addition, one Co-PI (A. Holz) and one M.S. graduate student (A. Zoller) attended an intensive watershed modeling workshop and an appropriate watershed model has been selected for the project. Actual modeling is scheduled to begin in July, 2007. Our successful approach to deriving the hydroecoregions and subsequent modeling will contribute greatly to field of watershed/surface water management and will form the backbone of future research and proposals. We also anticipate at least two manuscripts will be submitted for publication based on our current work alone.

Background. Large inputs of nutrients such as nitrogen and phosphorus to lakes and reservoirs are well known to cause a variety of water quality problems such as excessive vegetation growth, noxious odors, poor water transparency, oxygen depletion, fish kills, reduced recreational value, and reduced property value. In recent decades, substantial progress has been made in improving the quality of U.S. surface waters. Nevertheless, much work remains to be done. It is estimated, for example, that the water quality of more than 75% of Midwestern lakes (both natural and man-made) are still "impaired" by nonpoint sources of silt, organic matter, and nutrients (Duda, 1985). Impairment implies that the existing lake water quality, as measured by some selected criteria (e.g., nitrogen, phosphorus), is lower than a set of target standards that presumably reflect optimal attainable water conditions. The U.S. Environmental Protection Agency (EPA) is charged with establishing national standards and criteria for assessing lake water quality. It is, however, increasingly evident that a single set of national water quality standards that do not take into account regional hydrogeologic and ecological differences will not be viable, since lakes clearly have different inherent capacities to meet such standards (e.g., lakes occurring in the nutrient-rich soils of the Midwest will not have the same characteristics of lakes occurring in nutrient-poor soils of the Northeast).

A more tenable approach is to define different standards (targets) for groups ("classes") of lakes determined to be similar to one another in terms of their potential to attain a certain level of water quality. Standards would then be established independently for lakes in different classes according to a set of "reference" target conditions unique for each class. This approach was used in Nebraska to form lake and reservoir classes using the Ecological Continuum Approach (ECA) that groups lakes by ecological function along a linear continuum (Holz, 2005). All of the parameters that contribute significantly to lake water quality interact similarly within classes defined by the ECA, giving a better indication of potential water quality. However, some lakes may require more action than others to meet water quality benchmarks depending upon their location along the ecological continuum. Lakes within a group may have very different parameter values (e.g., TP, chlorophyll *a*, Secchi depth), but have the same potential to achieve water quality expectations. Once lake classes were identified using the ECA, the USEPA 25th percentile approach was used to identify the best 25% of lakes, which were used to establish nutrient benchmarks (reference conditions) for members of a lake class. This approach is recommended for regions where some lakes are impacted by anthropogenic disturbances (USEPA, 1998). However, the approach may not be optimal in agricultural regions where nearly all lakes are heavily impacted by land-use (Holz, 2005) as the relative contributions of land-use (e.g., agriculture) and natural processes to the lake nutrient concentrations have not been determined and thus make the values highly artificial.

Holz (2005) also tested the effectiveness of watersheds to identify the ECA reservoir classes. Sixty-five watersheds were delineated from the dam of each reservoir using DEM based EDNA datasets (Bulley, in review), and then classified. Reservoir classes were very similar to watershed classes when land-use data was incorporated in the classification (94.4% agreement), however, similarities were not as strong when land-use parameters were left out of the classification (81.4% agreement). The watershed classification alone primarily explained large reservoir classes, but did not do a good job of predicting outlier reservoirs (i.e. those with exceptionally unusual or poor water quality). However, the addition of land-use to the watershed classification explained most of these outlier classes. This indicates watersheds are strongly correlated with reservoir water quality in Nebraska and that land-use clearly impacts water quality in a significant number of reservoirs. Thus, reservoirs appear to be highly impacted by land-use, and ***it is not possible to determine if the benchmark values are appropriate without understanding the natural background reservoir nutrient levels.*** For example, if the high nutrient conditions in Nebraska reservoirs are due mainly to Nebraska's naturally nutrient-rich prairie soils, then the benchmarks are realistic. Conversely, if the high nutrient conditions result from crop production practices, then the values may be too low. The potential regulation of nitrogen and phosphorus containing crop fertilizers and associated impacts on production practices clearly establishes the need for appropriate nutrient criteria as one of the most critical and pervasive issues currently facing the agricultural Midwest.

Research Goal and Objectives. The overall goal of this proposal is to develop a dynamic strategy for grouping geographic regions with similar natural landscape

characteristics into management groups (termed "hydroecoregions") by using Nebraska as a model for agricultural ecosystems. Agricultural land-use data will not be used to define the hydroecoregions, resulting in a representation of geographic regions unaltered by anthropogenic disturbances. This strategy will facilitate subsequent research that will build and calibrate integrated models of agricultural watersheds and lake water quality for each hydroecoregion. These models will allow the determination of appropriate water quality expectations under (1) low and no agricultural land-use scenarios (i.e. natural conditions), (2) multiple best management scenarios (i.e. best-attainable conditions), and (3) various economic scenarios (i.e. cost-effective conditions). Here we propose to address the critical first step in determining appropriate water quality expectations: defining hydroecoregions. The specific objectives for this goal are: (1) Extract landscape characteristic data for each appropriate aggregate level (i.e. hydrologic unit). (2) Statistically group aggregate levels with similar landscape characteristics into hydroecoregions. (3) Identify the appropriate aggregate levels for hydroecoregion development.

Approach. We have at UNL a unique contingent of scientists, spanning several disciplines (e.g., limnology, aquatic ecology, geographic information systems, statistical ecology), who are unusually well-prepared to make significant progress towards resolving such problems. The project we propose here will provide the catalyst, critical mass, and resources required to further integrate our ongoing research and, thereby, develop focus and synergism that will result in new and improved approaches to water quality assessment and management. The project will focus on reservoirs located in agriculturally-dominated landscapes, with specific initial focus on Nebraska. Standards are particularly difficult to establish for lakes located in areas highly modified by humans since few, if any, reservoirs represent non-impacted reference conditions. Nebraska has a broad diversity of water resources, environments and landscapes, and is representative of many mid-continent regions of the U.S. Moreover, the state has a rich set of data with which to work.

Our recent $1.22 million EPA STAR project entitled "Development and Implementation of a Comprehensive Lake and Reservoir Classification Strategy for Nebraska as a Model for Agriculturally Dominated Ecosystems" has established UNL as a leader in lake and reservoir classification and we are now in an exceptional position to evaluate the effect of agricultural land use on the water bodies of the Midwest. We have developed an unprecedented water quality database that includes physical, chemical (including nutrients), and biological data for over 400 Nebraska lakes and reservoirs and have acquired state-of-the-art equipment and expertise in water quality monitoring and analysis. Moreover, through our collaboration with UNL's Center for Advanced Land Management Information Technologies (CALMIT), we have developed unique and essential approaches to using geographic information systems (GIS) and remote sensing for water quality characterization, geospatial database development, watershed analysis, spatial modeling and decision support.

We propose to use these databases, tools, and capabilities to develop hydroecoregions within a consistent ecological and hydrological framework. The smallest or fourth level

division of USGS hydrologic units (i.e. hydrologic cataloging units or 8-digit HUC) developed by Seaber *et. al.*, (1987), does not conform to the topographic hydrologic boundaries of the terrain (e.g., Omernik, 2003). However, the Nebraska Department of Natural Resources developed 11-digit HUC's to address the limitations of the 8-digit HUC's. We propose to (a) extract watershed characteristic data (e.g., slope, soil erodibility, soil cation exchange capacity, soil clay content, elevation, total precipitation, degree growing days) from these existing 11-digit HUC's using the zonal summary in ARCMAP GIS, (b) convert the data file to MS Excel, (c) statistically group (classify) HUC's with similar landscape characteristics into hydroecoregions, and (d) compare these regions to the 65 watersheds that were delineated in our previous lake and reservoir classification project to ensure that they HUC-derived hydroecoregions adequately represent watersheds. The Pffafstetter hydrologic unit is the second potential grouping unit we propose to investigate. This unit is advantageous as they exist for the continental US and are consistent across state boundaries, which may make this approach more applicable to other areas of the country. However, the 11-digit HUC's are preferable in Nebraska as these units are already used as management tools. Classification results from either of these hydrologic units can be used to create a hydroecoregion map for Nebraska which will facilitate the grouping the 600 or more unclassified reservoirs in the state, as well as subsequent modeling efforts. This map will also aid in identifying the best location for new reservoir construction in order to minimize watershed impacts on water quality.

Research Progress (Year 1). GIS watershed characterization work has been completed using 8-digit Hydrologic Unit Codes (HUCs). Initial analysis on available watershed GIS datasets proved U.S. Geological Survey (USGS) 8-digit HUCs was a more complete and accurate portrayal of Nebraska watersheds when compared to Nebraska Department of Natural Resources (NE DNR) 11-digit HUC GIS dataset. Hence, the USGS 8-digit HUC dataset was used for the watershed characterization.

First, the data was downloaded and clipped to the Nebraska state boundary. From this, individual HUCs were extracted and projected. In all, there are eighty-six 8-digit HUCs that partially or completely underlie the Nebraska State boundary (Figure 1). Next, national GIS datasets of elevation, slope, soils, and 1992 land cover were downloaded from appropriate agencies' websites and clipped to the Nebraska boundary. Raw data from NE weather stations was obtained and converted into a GIS layer.

All datasets were checked for completeness, accuracy, and consistency before being projected into the NE Stateplane coordinate system. Weighted-average calculations were performed on soils data layers in order to display three-dimensional information in a two-dimensional map.

Computer programs were written to extract slope, elevation, land use, growing degree, precipitation, soil chemistry, and soil erodability data to individual HUC boundaries. It is interesting to note the 2001 National Land Cover Dataset (NLCD) was released for download during this process (Figure 1). This data was also downloaded, projected, and extracted to HUC boundaries in addition to 1992 land cover data.

Finally, the GIS summary statistics tool was utilized to calculate an area-weighted average of each parameter (excluding land use) within individual HUC boundaries. The summarized GIS data was converted into a Microsoft Excel format to show the soils, weather, topography, and land use statistics for each of the 86 HUCs (Figure 2). Next, the

summary statistics tool was used to calculate categorical land use percents of each watershed for 1992 and 2001, and values converted into Excel format.

Much work was done in initial hydrologic model research, with actual modeling scheduled to begin in July, 2007. It was determined that a GIS-based sediment delivery ratio model will be built to simulate sediment-bound contaminant transport to reservoirs at the base of a watershed. After the model is calibrated and validated to existing data, model scenarios will be run to simulate natural, best-attainable, and cost-effective scenarios according to varied land use parameters.

Timeline: (1) Extract landscape characteristic data for each aggregate level (March-Aug, 2006); (2) Statistically group aggregate levels with similar landscape characteristics into hydroecoregions (Sept-Nov, 2006); (3) Identify the appropriate aggregate levels for hydroecoregion development (Dec-Feb, 2007).

Anticipated Outcomes. Through this proposal we will strengthen our posture at UNL as an international center-of-excellence in water quality assessment, and the application of advanced geospatial information technologies in water science and management, and, thus, enhance our competitive stature with respect to generation of external funding. In the process of implementing this proposal we will develop methods that will serve to enhance natural resource management, sustainable agriculture and environmental quality in Nebraska and other agricultural regions. We will work closely with the EPA, Nebraska Department of Environmental Quality, agricultural and environmental non-government agencies, and other partners to ensure that the fruits of our research are brought to bear, in the earliest possible timeframe, on what is arguably one of the highest priority issues which currently challenges these organizations. The Nebraska Department of Environmental Quality (NDEQ) has adopted the nutrient benchmarks (as determined by our ECA lake classification research) for the lakes and reservoirs of the state and other agencies from states in the region are interested in applying this approach. We anticipate that these real outcomes and benefits will continue.

Extramural Funding Opportunities. In early October 2005, J. Holz met with program officers from EPA and USDA regarding their interest in our on-going research interests in determining appropriate water quality expectations in agricultural regions. Both agencies expressed significant interest in the project and we specifically intend to apply for a USDA Integrated Programs grant to define reference conditions by modeling the hydroecoregions developed in this proposal.

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Figure 1: Map layout of Nebraska 8-digit Hydrologic Unit Code Boundaries and 2001 National Land Cover

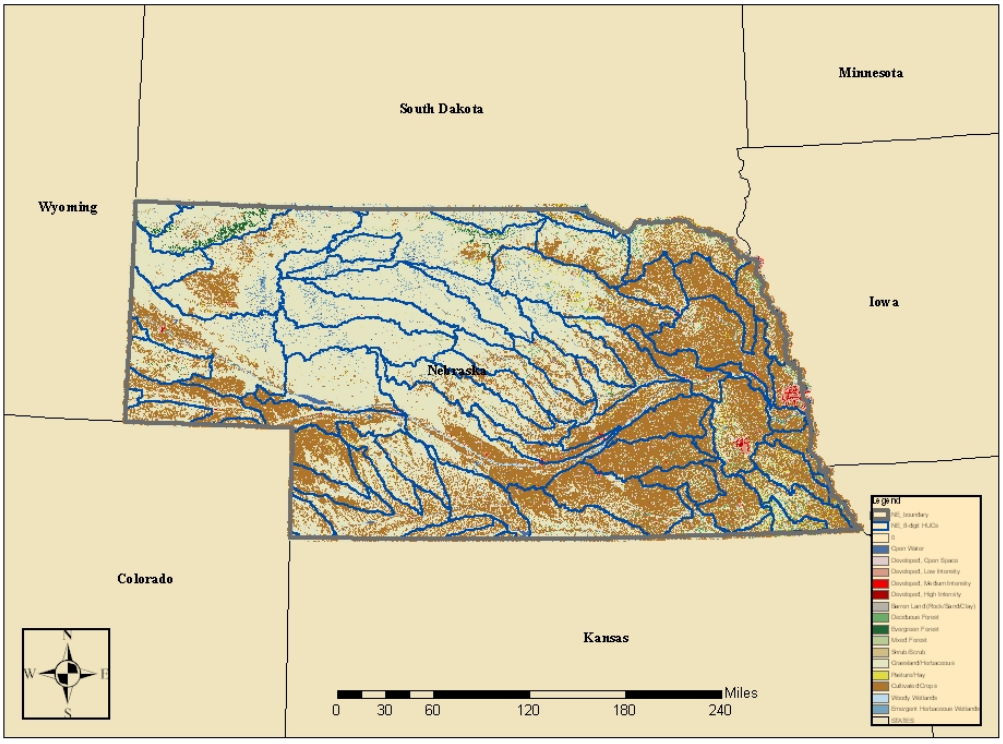

Figure 2: Summary statistics for individual HUC topography, soil, and climate characteristics

HUC number	mean_elev (feet)	Mean_Slope (degree	Soil CEC-mean	Soil CACO3-mean	Permeability-mean	Slope-mean	KFACT	Annual preci	growing degree-mean
1012010	1141.48	2.77	26.93	1.78	0.08	13.10	0.38	17.0	4796.45
1012010	1227.08	2.46	16.95	1.64	1.31	11.26	0.33	15.4	4459.87
1014020	1156.84	4.40	11.37	1.77	1.70	15.53	0.30	16.7	4697.71
1014020	973.38	1.52	4.19	0.40	11.93	14.50	0.15	18.7	4798.82
1015000	516.39	2.50	19.76	5.81	2.14	11.07	0.32	22.9	5047.13
1015000	1395.61	1.04	7.99	0.90	4.16	12.82	0.23	15.6	4524.52
1015000	1178.99	2.61	6.52	0.79	7.53	10.60	0.22	17.0	4723.35
1015000	838.41	2.27	5.18	0.41	10.76	14.19	0.16	20.8	4957.22
1015000	1030.56	2.37	3.41	0.16	12.26	18.04	0.15	19.0	4810.98
1015000	682.26	3.33	8.72	0.87	8.55	8.96	0.20	21.7	4826.01
1015000	549.42	1.61	12.50	1.00	7.30	7.71	0.23	23.0	5170.07
1017010	453.96	2.00	16.56	2.72	2.42	8.79	0.32	24.8	5333.11
1018000	1223.18	1.74	5.62	1.09	6.78	8.82	0.23	16.4	5068.94
1018001	1313.98	2.11	3.30	1.25	3.77	7.44	0.31	15.0	4844.25
1018001	1377.47	3.97	6.70	1.44	4.01	7.93	0.26	16.1	4844.31
1018001	1050.23	2.40	4.01	0.36	10.50	13.83	0.18	18.6	5125.44
1019001	1232.38	1.85	8.31	0.31	2.13	5.07	0.29	18.4	5346.89
1019001	1550.84	1.35	10.58	1.57	1.67	8.19	0.28	17.0	4461.99
1019001	1367.62	0.98	8.94	0.67	1.70	4.28	0.30	17.4	4830.90
1019001	1473.27	1.74	11.85	0.99	1.44	4.72	0.30	16.6	4579.98
1019001	1027.83	1.74	6.36	0.51	3.62	5.62	0.29	18.1	5259.97
1020010	799.81	0.93	5.05	0.29	4.61	8.25	0.29	22.3	5291.97
1020010	693.33	1.62	4.30	0.10	1.82	8.08	0.35	24.1	5284.88
1020010	528.34	0.37	5.11	0.26	3.81	3.74	0.28	26.4	5604.55
1020020	482.55	0.83	17.97	1.23	1.45	4.75	0.32	27.7	5425.58
1020020	359.96	1.10	22.01	1.19	1.87	4.97	0.28	30.1	5577.03
1020020	395.24	2.16	21.95	0.02	1.02	5.37	0.33	29.2	5674.59
1021000	1066.77	3.63	3.57	0.19	12.32	14.55	0.15	19.8	4886.96
1021000	1045.14	4.17	3.38	0.11	12.65	17.32	0.15	20.0	4981.08
1021000	710.51	1.60	4.43	0.10	4.84	12.70	0.30	23.8	5142.05
1021000	803.42	2.52	3.76	0.07	4.92	12.84	0.30	22.9	5115.45
1021000	768.02	1.65	3.72	0.01	4.16	14.37	0.32	23.6	5042.53
1021000	912.10	2.10	3.60	0.14	12.21	15.89	0.15	21.6	5022.71
1021000	654.13	1.91	4.94	0.07	2.67	11.12	0.34	24.0	5191.46
1021000	783.63	1.20	3.54	0.12	12.45	17.33	0.15	23.0	5114.22
1021000	570.94	1.81	9.15	0.70	4.99	6.84	0.28	25.9	5269.58
1021001	645.80	1.02	6.56	0.44	8.58	10.43	0.22	24.4	5088.09
1022000	636.19	0.79	6.88	0.34	9.81	6.40	0.19	23.6	5050.91
1022000	528.16	0.87	11.46	0.72	6.21	4.39	0.25	25.2	5237.82
1022000	447.81	1.73	18.01	0.76	1.95	4.86	0.32	28.0	5327.38
1022000	454.73	1.80	19.51	0.37	1.33	5.19	0.33	27.3	5322.04
1023000	368.05	2.96	27.44	4.78	1.08	7.82	0.31	28.1	5462.73
1023000	351.94	2.38	21.67	2.25	1.34	7.16	0.30	29.1	5616.76
1024000	342.01	2.59	22.02	1.69	1.11	5.79	0.32	32.3	5681.10
1024000	273.84	0.04	28.31	14.45	1.60	1.05	0.27	33.0	5878.25
1024000	303.22	2.74	24.07	6.06	1.29	9.15	0.29	33.4	5935.33
1024000	350.46	1.39	18.11	0.07	0.70	4.61	0.35	31.7	5772.81
1024000	369.15	1.64	20.23	1.03	0.64	5.76	0.36	32.9	5894.40
1024000	354.05	0.97	18.80	0.37	0.68	5.17	0.35	32.6	5873.46
1025000	1028.54	1.53	3.38	0.60	3.51	3.82	0.31	17.0	5679.94
1025000	1030.34	0.79	5.61	0.22	8.11	8.54	0.19	17.8	5605.52
1025000	922.78	0.58	5.89	0.79	6.28	4.23	0.23	19.0	5680.67
1025000	886.84	1.64	4.40	0.19	2.53	6.08	0.33	20.4	5550.04

1025000	978.42	0.83	7.93	0.30	2.84	4.52	0.31	19.0	5404.42
1025000	1019.10	0.86	8.54	0.30	5.16	5.47	0.26	18.5	5267.65
1025000	915.09	1.13	4.35	0.11	4.93	9.16	0.28	19.9	5321.36
1025000	858.90	1.69	2.65	0.00	3.89	13.64	0.33	20.7	5333.22
1025000	716.27	1.03	2.04	0.04	1.42	8.98	0.35	22.5	5616.98
1025001	678.73	1.90	3.96	0.02	1.32	8.11	0.35	23.0	5954.91
1025001	737.16	2.61	3.38	0.03	1.30	8.68	0.36	22.4	5890.85
1025001	651.02	1.45	1.42	0.10	1.32	6.97	0.34	23.0	5843.24
1025001	603.00	1.08	7.31	0.34	1.57	6.29	0.34	25.4	5615.88
1026001	635.05	3.06	3.81	1.91	1.30	9.22	0.33	25.0	5760.72
1027020	506.37	0.66	7.00	0.00	1.31	1.42	0.33	27.5	5615.68
1027020	428.30	0.60	22.93	0.02	0.94	3.48	0.35	30.1	5782.40
1027020	520.80	1.13	12.93	0.00	1.31	1.85	0.34	27.1	5584.83
1027020	467.75	1.34	33.34	0.00	1.21	4.54	0.34	28.7	5724.92
1027020	416.03	1.11	19.91	0.00	0.62	4.21	0.37	31.3	5789.87
1027020	547.39	0.96	22.74	0.02	1.46	4.15	0.35	27.2	5638.44
1027020	446.15	0.80	29.95	0.34	1.18	5.29	0.34	29.9	5839.74

Information Transfer Program

Water Center Educational Materials/Information Transfer Plan

Basic Information

Title:	Water Center Educational Materials/Information Transfer Plan
Project Number:	2006NE130B
Start Date:	3/1/2006
End Date:	2/29/2008
Funding Source:	104B
Congressional District:	1
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	None
Principal Investigators:	Kyle D. Hoagland, Steven W. Ress

Publication

1. Newsletters: The Water Current newsletter is in its 38th year of continuous publication. The 16-20-page newsletter is published quarterly in full-color in a magazine-style format. It has a free subscriber-based distribution of approximately 3,000 copies per issue, more than 95 percent of which represent requested subscriptions. An annual reader survey is published each spring. Water-related research, extension, education and outreach faculty and key staff are featured in each issue. Guest columns and commentaries are published on a regular basis. An information-based column by the UNL Water Center's director is published in each issue. Special, theme-oriented issues are published occasionally. Past themes have centered on the U.S. Army Corps of Engineers work in the Missouri River basin, Nebraska's irrigation districts and companies, and drought-related topics. Virtual copies of the newsletter online in PDF form at http://watercenter.unl.edu. The UNL Water Center is also a primary contributor of water-related news and feature articles in the quarterly UNL School of Natural Resources' Resource Links newsletter.
2. Water Center informational brochures: All full color. Updated and produced annually. These include, but are not limited to, the mission and programming of the UNL Water Center, Water Resources Research Initiative (WRRI), Great Plains CESU, UNL Water Sciences Laboratory and other units or programs affiliated with the Water Center.
3. Water Center Pocket Resources Directory: A color, accordion-fold pocket brochure listing key NU, federal, state and local water resource agencies and points of contact for the public. Fourth edition published this year.
4. Water Center fact sheets: Used to inform and to promote both general themes, such as the Water Center itself, or to announce specific programs, seminars, courses, etc. All produced in full color.
5. A range of publications produced outside the UNL Water Center, particularly fact sheets, research project results and other print materials from USGS, Nebraska Department of Environmental Quality, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, local Natural Resources Districts and University of Nebraska-Lincoln Extension, are available through the Water Center and School of Natural Resources web sites.
6. News Releases: The Water Center produces about 40 press releases annually which focus on research results or significant progress, extension programs, educational opportunities, public tours, seminars, lectures and symposiums and other matters of public impact involving the Water Center, Water Resources Research Initiative or School of Natural Resources. Conferences, seminars, tours, collections of waste pesticides, pesticide container recycling and other activities are similarly announced using press releases. The releases support a wide variety of UNL water-related research and outreach that cross departmental and academic disciplines. The Water Center is well known as a willing and reliable source among local and state reporters specializing in covering water and natural resources-related news. Calls from journalists looking for University of Nebraska sources for fast and reliable information on water and natural resource topics are common and frequent. The Water Center makes wide use of electronic and broadcast journalism sources, as well as the more traditional print (newspaper) sources.

2006 USGS Report
Information Transfer Program:

UNL Water Center,
University of Nebraska-Lincoln

Information Transfer Program:

The University of Nebraska-Lincoln (UNL) Water Center has a tradition of ambitious and proactive information transfer programming utilizing USGS, and other funding sources. The UNL Water Center, arguably, has one of the most comprehensive, aggressive and up-to-date information transfer programs of any of the more than 50 Water Resources Research Institutes nationwide. The UNL Water Center combines experienced and dedicated research, extension and teaching faculty and staff, the latest technologies and techniques, and a comprehensive, needs-based programming itinerary to provide diverse, science-based information to a broad and ever-expanding clientele.

Information supports a variety of research, extension, outreach and education programming sponsored or co-sponsored by the Water Center, the Water Resources Research Initiative, the UNL School of Natural Resources, and the University of Nebraska's Institute of Agriculture and Natural Resources.

Common vehicles used to convey this information include print, electronic, broadcast and Internet, along with conferences, symposiums, seminars, colloquiums, tours, displays and other public events. Information can be found in the form of newsletters, brochures, press releases, proceedings, research briefs, several Internet web sites, radio and television coverage, videotape/DVD and others.

Electronic Resources:

All print materials produced by the UNL Water Center are available online at http://watercenter.unl.edu . The Water Center also co-sponsors, designs and maintains the following related Internet web sites:

Water Sciences Laboratory (WSL):
http://waterscience.unl.edu

Great Plains Cooperative Eco-Systems Studies Unit (CESU):
http://greatplains.cesu.unl.edu/

Water Law, Policy and Science Conference:
http://snr.unl.edu/waterconference/

Water Resources Research Initiative (WRRI):
http://wrri.unl.edu/

Each of the above sites was redesigned to comply with UNL-wide design guidelines in 2006. Each site is vigorously scrutinized and maintained to ensure that it is up-to-date and provides information useful to the public.

Conferences, Seminars, Tours and Retreats:

Water Law, Policy and Science Conference: Conducted annually in March or April. Co-sponsored primarily by the Water Center, Water Resources Research Initiative, College of Law, Department of Geosciences, School of Natural Resources and various other UNL entities. The conference is designed to explore pertinent current issues related to emerging state and regional water and environmental law, policy and research. Now in its third year, the conference attracts 150 to 200 attendees and features noted national and regional experts on water issues. News releases, brochures, a printed program, radio spots and web-based information are produced in support of this event.

Water and Natural Resources Seminars: A series of 12 to 14 free weekly public lectures from January to April each year. Co-sponsored by the School of Natural Resources, Institute of Agriculture and Natural Resources and other UNL departments and units. The series may be taken for graduate or undergraduate credit or as free public lectures. Individual lectures attract an audience of 60-100, as well as approximately 10 registered students. News releases, mailings, brochures, posters and web-based information are produced in support of this long-standing series.

Summer Water and Natural Resources Tour. Co-sponsored by the Nebraska Water Conference Council, Kearney Area Chamber of Commerce, Nebraska Association of Resources Districts, Nebraska Public Power District, Central Nebraska Public Power and Irrigation District and other public, private and commercial entities. The annual tour is conducted in June or July and is used to educate and inform on current water and natural resource issues effecting Nebraska. Typically limited to 50 participants (due to logistics). Attendees can include state legislators and congressional staff. News releases, mailings and a brochure are produced in support of this event.

Fall Research Colloquium. Held in conjunction with UNL's School of Natural Resource Sciences. Brings water and natural resource faculty, staff and students together to share in research results/significant progress.

Faculty/Staff Retreats: Another vehicle to present completed and/or significant progress research activity to colleagues, take time for interdisciplinary brainstorming to develop research programming and secure funding and to foster an increased sense of collegiality among professionals dispersed throughout the state.

Educational Displays:

The Water Center makes frequent public displays in association with conferences, symposiums, agricultural trade shows, educational open houses and water and environmental festivals.

In addition, Water Center staff makes presentations and have seats on steering committees for annual educational and informational festivals such as "Earth Wellness Festival," "Husker Harvest Days" (one of the largest commercial agricultural expos in the country), "Gateway Farm Expo" and others.

Promotional Items:

Promotional items are distributed at many of the events the Water Center is involved in. These include fishing lures, umbrellas, golf balls, key chains, pencils, lanyards, University-published books, etc. Most carry Water Center and UNL logos and contact information. They are designed and procured for general distribution and targeted toward student recruitment. Some are produced for specific functions and events.

Support for the UNL Pesticide Education Office:

The Water Center handles press relations and publicity for federal-restricted use pesticide educational programming conducted by the UNL Pesticide Education Office in the UNL Department of Agronomy and Horticulture. This unit was once part of the UNL Water Center. These efforts include publicity for very successful statewide plastic pesticide container recycling and waste pesticide collection programs that are closely linked to groundwater quality issues.

Support for Water Outreach Coordinator:

This year, the UNL Water Center added a permanent staff position for a Water Resources Outreach Coordinator. This position works closely with water and natural resource-related state agencies, Natural Resources District (NRDs) as a conduit for research-based education conducted by UNL. The UNL Water Center's information dissemination program works closely with this position to help produce materials appropriate for use by state senators and their staffs, state department heads, NRD managers needing a one-stop shop for UNL-based information on water and natural resources.

Primary Information Dissemination Clientele:

U.S. Department of Agriculture
U.S. Environmental Protection Agency
U.S. Geological Survey
U.S. Bureau of Reclamation
U.S. Army Corps of Engineers
U.S. Bureau of Land Management
Nebraska Department of Natural Resources
Nebraska Department of Agriculture
Nebraska Department of Health and Human Services System
Nebraska Department of Environmental Quality
Nebraska Environmental Trust Fund

Nebraska Association of Resources Districts (and 23 individual NRDs)
Nebraska Congressional delegation
Nebraska State Senators
Public and private power and irrigation districts
The Audubon Society
The Nature Conservancy
Nebraska Alliance for Environmental Education
Nebraska Earth Science Education Network
Other state Water Resources Research Institutes
University and College researchers and educators
NU students
Public and parochial science teachers
Farmers
Surface and groundwater irrigators
Private citizens

Cooperating Entities:

In addition to primary support from the USGS, the following agencies and entities have helped fund information dissemination (communications) activities by the UNL Water Center during the past year.

U.S. Environmental Protection Agency
U.S. Department of Agriculture
Nebraska Department of Environmental Quality
Nebraska Research Initiative
Nebraska Game and Parks Commission
National Water Research Institute
Nebraska Water Conference Council
Nebraska Public Power District
Central Nebraska Public Power and Irrigation District
Farm Credit Services of America
Kearney Area Chamber of Commerce
Nebraska Association of Resources Districts
UNL Institute of Agriculture and Natural Resources
UNL Agricultural Research Division
UNL College of Agricultural Sciences and Natural Resources
UNL School of Natural Resources
UNL Water Resources Research Initiative

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	2	0	0	0	2
Masters	4	2	0	0	6
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	7	2	0	0	9

Notable Awards and Achievements

Publications from Prior Projects

1. 2004NE73B ("Investigation of Groundwater Interactions with Surface Hydrologic Systems in River Valleys -- Using Modeling and Field Approaches") - Articles in Refereed Scientific Journals - Chen, Xunhong; 2007, Hydrologic Connections of a Stream-Aquifer-Vegetation Zone in South-Central Platte River valley, Nebraska; Science Direct, Volume 333, 554-568.
2. 2002NE28B ("Investigation of Directional Hydraulic Conductivities of Streambeds and Evaluation of Their Roles in Stream-Aquifer Interactions") - Articles in Refereed Scientific Journals - Song, Jinxi; Xunhong Chen, Cheng Cheng, Scott Summerside, and Fujiang Wen, 2007, Effects of Hyporheic Processes on Streambed Vertical Hydraulic Conductivity in Three Rivers of Nebraska, Vol. 34.