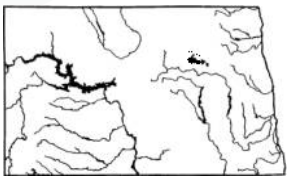
May 2010

North Dakota Water Resources Research Institute
North Dakota State University
Fargo, ND 58108-6050



Newsletter

The National Institutes for Water Resources

http://www.ndsu.edu/wrri

From the Director

Welcome to the 2010 issue of North Dakota Water Resources Research Institute newsletter!

North Dakota experienced record floods again this year. North Dakota congressional delegation has urged President Obama to declare a major disaster in 22 counties and Spirit Lake reservation so they would become eligible for federal assistance to repair infrastructure and implement flood prevention measures. While temporary flood protection measures were put in place, communities were discussing the need for long-term protection. Fargo-Moorhead area in the Red River basin was better prepared and organized this time. While the flood fighting was on, the public and the officials were continually engaged in discussions with the Corps of Engineers on the diversion options around Fargo-Moorhead either through Minnesota or through North Dakota. The prolonged discussions resulted in the selection of the 35000 cubic feet per second North Dakota diversion as the locally preferred option. The Corps also continues to study the 20,000 cubic feet per second Minnesota option. Currently, the debate is focused on to decide who and how the cost of $1.3 billion of North Dakota diversion will be shared. Many believe basin-wide flood control measures will serve long term protection better. Concerns of the communities downstream of the diversion are legitimate and need to be addressed. One potential solution may be to consider upstream retention using several small dams to offset the negative effects of the diversion on the downstream communities. In the meanwhile, Corps has begun the process of seeking permission from the landowners affected by the proposed diversions to allow surveyors to enter their property to gather data on soil and ground conditions, wetlands, environmental issues, etc.

In this issue, the recipients of 2010 NDWRRI Fellowship are introduced. Also, last year's Fellowship research projects are highlighted. Four selected Institute faculty are also featured in this issue. We encourage you to visit the Institute website, www.ndsu.edu/wrri or contact the respective Fellows, advisors, or principal investigators for details of research projects.

Again this year, North Dakota State Water Commission extended its support of 15% of the USGS annual base grant to the Fellowship program of the Institute. As in the previous years, the State Advisory Committee provided valuable help in setting Institute's research priorities and reviewing Fellowship applications.

Institute faculty and fellows presented the results of their research in several conferences and symposia as in the past years. Their recent publications and presentations can be found in this issue. Technical reports of several Fellowship projects are available on the Institute web site. Several WRRI Fellows graduated and moved on to accept responsible positions in various water-related areas of employment.

G. Padmanabhan, Director
North Dakota Water Resources Research Institute
Phone: 701 231 7043 e-mail: G.Padmanabhan@ndsu.edu

Inside this issue:

Upcoming Events

Challenges of Change, American Society of civil Engineers/Environmental and Water Resources Institute conference, May 16-20, 2010, Providence, Rhode Island http://content.asce.org/conferences/ewri2010/index.html

Third US Geological Survey Modeling Conference, US Geological Survey, Denver, Colorado, June 7-11, 2010. http://geology.usgs.gov/modeling2010/

Annual Conference and Exposition 10, American Water Works Association, Chicago, Illinois, June 20-24, 2010. http://www.awwa.org/files/ace10/ACE10RegInfo.pdf

Watershed Management 2010, American Society of civil Engineers/Environmental and Water Resources Institute conference, August 23-27, 2010, Madison, Wisconsin http://content.asce.org/conferences/watershedmanagement2010/

25th Annual Water Reuse Symposium, Water Environment Federation, Washington DC, September 12-15, 2010 http://www.wef.org/Conferences/page_details.aspx?id=6064&linkidentifier=id&itemid=6064

The Minnesota 2010 Annual Water Resources Conference, River Center, St. Paul, MN, October 19-20, 2010. http://wrc.umn.edu/waterconf/

AWRA Annual Water Resources Conference, American Water Resources Association, Philadelphia, Pennsylvania, November 1-4, 2010
http://awra.org/meetings/Philadelphia2010/index.shtml

TMDL 2010: Watershed Management to Improve Water Quality, American Society of Agricultural and Biological Engineers (ASABE), Baltimore, MD, November 14-17, 2010.
www.asabe.org/meetings/TMDL2010

2011- *International Perspective on Sustainable Environmental and Water Resources Management*, American society of Civil Engineers / Environmental and Water Resources Institute 4th developing nations conference, January 4-6, 2011, Biopolis Conference Center, Singapore.

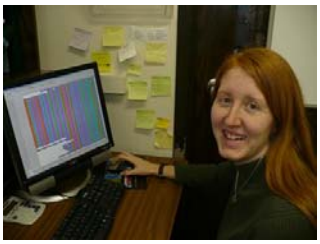
http://content.asce.org/conferences/singapore2011/index.html

Institute Director participates in ASCE/EWRI International conference

Institute director, G. Padmanabhan, professor of civil engineering, presented a paper “Modeling phosphorus transport via surface runoff in Songkhla Lake Basin, Thailand” at the American Society of Civil Engineers (ASCE) Environmental and Water Resources Institute (EWRI) international conference, Chennai, India, January 5-7, 2010. The theme of the conference was “International perspective on current and future state of water resources and the environment.” The conference was attended by approximately 400 professionals from more than 24 countries. There were 300 oral technical presentations and 70 poster presentations. Penjai Sampongchiakul, a faculty from Prince Songkhla University, Thailand, and Kitipan Kitboomrang, a graduate of Environment and Hazardous Waste Management program of Chulalongkorn University, Thailand, are the co-authors of the paper. In addition to his involvement in reviewing abstracts and final papers for the conference, Padmanabhan also chaired a session on non-point source pollution at the conference.

Padmanabhan is currently a member of the steering committee for the upcoming ASCE/EWRI conference “Watershed Management 2010: Innovations in Watershed Management Under Landuse and Climate Change” to be held in August 23-27, 2010 in Madison, Wisconsin.

The Institute Awarded Ten Graduate Fellowships for the Year 2010-2011



Fellow: Brianna Schneck

Title: Source Tracking of Cryptosporidium in Rural Watersheds

Advisor: John McEvoy, Microbiology and Mark Clark, Biological Sciences, North Dakota State University

Fellow: Qigang Chang

Title: Development of GAC-NZVI Adsorbent for Arsenic Removal

Advisor: Wei Lin, Civil Engineering, North Dakota State University

Fellow: Dimuthu Wijeyaratne

Title: Chemical Fingerprinting of Sediments and Water of the Souris River for Identification of Diffuse Pollution Sources

Advisor: Marinus Otte, Biological Sciences, North Dakota State University

Fellow: Halis Simsek

Title: Fate of Biodegradable Dissolved Organic Nitrogen in Fargo Waste Water

Advisor: Eakalak Khan, Civil Engineering, North Dakota State University

Fellow: Adam Guy

Title: The Impact of Rural and Urban Flooding on Water and Soil Quality in the Red River Valley of the North

Advisor: Thomas DeSutter
AES School of Nat Res Sciences, North Dakota State University

Fellow: Andrea Hanson

Title: Uptake and Effects of Environmental Estrogens on Growth of Fish

Advisor: Mark Sheridan, Biological Sciences and Jordan A Engberg, Biological Sciences, North Dakota State University

Fellow: Anusha Balangoda

Title: Studies of Seasonal Succession of Cyanobacteria and Green algae Heinrich-Martin Impoundment, North Dakota

Advisor: Wei Lin, Civil Engineering, North Dakota State University

Fellow: Dhritikhama Roy

Title: Plant-based Biopolymers for Entrapping Metal Nanoparticles for Arsenic Removal: Biodegradation and Treatability Studies

Adviser: Achintya Bezbaruah, Civil Engineering, North Dakota State University

Fellow: Ishara Rijal
Title: Reference Evapotranspiration and Actual Evapotraspiration Measurements in North Dakota

Adviser: Xinjua Jia, Agricultural and Biosystems Engineering, North Dakota State University

Fellow: Harjyoti Kalita

Title: Iron Imprinted Polymer for Removal and Monitoring of Arsenic

Adviser: Achintya Bezbaruah, Civil Engineering, North Dakota State University and Bret Chisholm, Center for Nanoscale Science and Engineering, North Dakota State University

2009-2010 NDWRRI Fellowship Research Highlights

Dimuthu Wijeyaratne

Pinpointing the sources of polluted suspended sediments is critical for pollution abatement and regulation. In her research, Wijeyaratne traces sediments acting as phosphate sources to the Souris River using the 'chemical fingerprinting' technique. Chemical fingerprinting identifies the distribution of chemical elements within a matrix and thus defines its unique signature in comparison to similar matrices. It provides a sediment profile, which can then be used for direct sediment source tracing. Sediment quality is an important environmental concern because sediments may act both as a sink and a source of constituents to the overlying water column and biota. Chemical fingerprinting will provide a relatively low cost, rapid tool for sediment tracking, without the need for addition of exotic chemicals such radio-tracers or dyes to natural ecosystems.

Harjyoti Kalita

Solid phase extraction is one of the most promising technologies for the removal of various metal ions (contaminants) from aqueous medium. Though there are different solid phase extraction methods, ion imprinted polymers (IIP) are potential candidates with high probability of success. They are low cost, compatible with different environments, and have high selectivity relative to the conventional solid sorbents. Ion imprinted polymer (IIP) can be used to remove both As(III) and As(V) simultaneously at a very low cost. Kalita's research focus is to develop an IIP for the removal of As (III) and As(V). The outcomes from Kalita's work will be very relevant to North Dakota rural areas, small community treatment plants, and individual households. Available technology to remove arsenic include conventional processes for oxidation of As(III) to As(V), coprecipitation and adsorption, absorption, ion exchange method, and membrane filtration. Most of the available methods fail to remove As (III) unless it is oxidized to As(V). Though there are instrumentation techniques available to detect aqueous arsenic, these techniques need bulky instruments, high cost for analysis, and significant operator expertise. Kalita's research also focuses on developing a simple, reliable and cost effective detection technique (with detection limit $\leq$ 10 ppb).

Qigang Chang

On January 22, 2001, the USEPA revised the maximum contaminant level (MCL) of arsenic downward from 50µg/L to 10µg/L. The new regulation presents a major compliance challenge to the existing water supply systems, especially the small rural community systems that until recently had few regulation requirements. There is an urgent need to develop safe and affordable technologies to meet the new drinking water standard in small rural communities in North Dakota. Granular Activated Carbon (GAC) is an excellent stable adsorbent widely used in water treatment process, especially for organic contaminants. But GAC alone only exhibits limited adsorption capacity to arsenic. Chang's research hypothesizes that GAC-NZVI (nano zero valent iron) could be synthesized with desired amount of nano iron which are stable and highly reactive. GAC-NZVI could be a promising adsorbent to treat trace arsenic in drinking water by inheriting advantages from GAC and NZVI while devoid of their drawbacks. GAC-NZVI could be directly used in existing GAC fixed-bed system without additional extension and separation. Organic compounds may still have access to the huge specific surface of GAC so that GAC-NZVI will retain the ability to remove odor, taste, and color. The GAC-NZVI adsorbent could meet the stringent drinking water standard of arsenic at affordable cost and help rural communities of North Dakota to comply with federal regulations.

Halis Simsek

Simsek, in this study, focuses on quantifying biodegradable dissolved organic nitrogen (BDON) in effluent from the Fargo Wastewater Treatment Plant (WWTP). It is expected that the Fargo WWTP may be subjected to a more stringent regulation on N discharge permit. The plant can use the results of this study for operational changes and process upgrade to meet the future regulation. For the first time, the potential impacts of N discharge from the Fargo WWTP on the quality of the Red River will be evaluated. Quantifying effluent BDON is the first step necessary for reducing its impacts on the Red River.

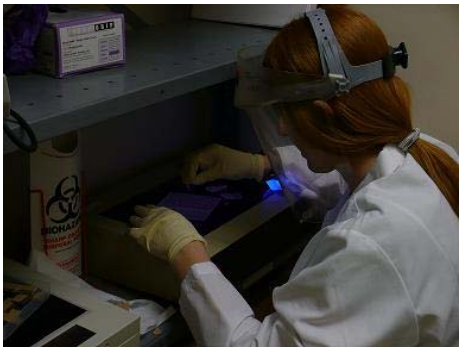
Rabiya Shabnam

Environmental nanoscience is one of the fastest emerging areas in the field of contaminant remediation. Encapsulation of iron nanoparticles and microorganisms in alginate capsules will lead to possible use of these 'micro-reactors' to degrade groundwater contaminant plumes when used in permeable reactive barriers. Though Zero Valent Iron nanoparticles (nZVI) have been extensively used for remediation, their efficacy has been evaluated only by excluding their possible interactions with environmental microorganisms. Shabnam's research is based on the hypothesis that symbiotic relationships develop between introduced nZVI and microorganisms. Nanoparticles can reduce a contaminant as the first step in the degradation process and microorganism can preferentially take over the process and reduce/oxidize the degradation byproduct(s) to benign end products or vice-versa. The study explores possible uses of such relationships for enhanced environmental contaminant removal using experiments in 'micro-reactors' made of biopolymers (e.g., alginate). Shabnam encapsulated nZVI and specific microorganisms in alginate microcapsules to study their growth, viability, and interactions. Shabnam used TCE as the target contaminant in the initial studies. Other contaminants of concern were used based on the results from the initial studies. The results of this study may prove useful for the development of household treatment systems for drinking water.

Sita Krajangpan

Zero valent iron (Fe0) nanoparticles (nZVI) have been used for groundwater remediation of various contaminants because of their unique physiochemical properties. Various chlorinated aliphatic hydrocarbons, explosive materials, and arsenic have been successfully remediated by nZVI. However, nZVI are not only highly reactive with the contaminants, but also rapidly react with surrounding media in the subsurface and other non-target compounds. Thus, significant loss of nZVI reactivity occurs before the particles reach the target contaminant. Targeted delivery of the nZVI is essential for remediation of contaminants in the subsurface using iron nanoparticles. The final goal of this new delivery vehicle is remediation of TCE and arsenic (As) in groundwater environment. Functionalized amphiphilic polysiloxane graft copolymers (APGC) are an ideal class of polymers for an effective delivery system of nZVI. The hydrophilic graft will increase colloidal stability of nZVI in an aqueous medium. The hydrophobicity of the polysiloxane polymer backbone will protect the nZVI from excessive oxidation by water/non-target compounds. Krajangpan successfully synthesized APGC coated nZVI (CnZVI) in her research. She compared the colloidal stability comparison between CnZVI and bare nZVI. Shelf-life of CnZVI (over 7 month-periods) showed stable colloidal stability. Ionic strength study showed no significant change in colloidal stability and TCE removal. SEM/EDX was used to study surface corrosion of the metal particles. The results indicate that CnZVI markedly protects nZVI surface from undesired corrosion.

Brianna Schneck



The Upper Midwest has the highest incidences of human cryptosporidiosis in the U.S. There is therefore a critical need to determine Cryptosporidium sources and transmission dynamics in this region. One of the studies in which Schneck had participated has shown that most human cryptosporidiosis in the region is caused by C. parvum, a species associated with humans and cattle. However, the traditional model, describing Cryptosporidium movement from livestock to humans via water, appears over-simplistic in light of recent evidence of wildlife sources of contamination. Cryptosporidium species associated with wildlife are not human pathogens and are not a public health threat. To better understand the human health significance of Cryptosporidium in rural watersheds, we need to determine the source of the contamination. Schneck addresses this need by quantifying the impact of the wildlife and cattle sources in rural watersheds in the region. Schneck expects the output from this project will be critical to the guidance of future policies on the control of Cryptosporidium transmission in water.

Chase Christenson

Subsurface agricultural drainage, a continually growing practice, has allowed the reclamation of unproductive land since the earliest of settlements. Despite it's agricultural benefits, agricultural drainage bypasses the reduced zones where denitrification is likely to occur, contributing to higher nitrate yields as it is discharged directly to surface water. Previous research has shown an inverse correlation between denitrification potential (electron donors) and grain size. The correlation between distinguishable facies of differing depositional environments would enable extrapolation of findings at the Oakes Test Area (OTA) to areas with similar geological makeup and history. Modeling of natural systems requires simplification. This facies-based relationship will allow for simplification of contaminant transport modeling. Christenson examines of potential nutrient uptake by tile-drain bacteria. The study will provide information that aids the development of a procedure for subsurface drainage cleaning that optimizes hydraulic efficiency and reduces nutrient transport.

Joseph Vistad

The Interagency Advisory Committee on Water Data of the United States Geological Survey published Bulletin 17B "Guidelines for Determining Flood Flow Frequency," which sets out the methods to be used for finding extreme event flows for all streams in the United States. The intent of Bulletin 17B was to give a standardized method of flood frequency calculation in the United States. The Bulletin has served its purpose extremely well since its final revision in 1982, however; the time has come for updates using today's technology and modern statistical methods. Vistad uses two such methods in his research: GLS regression and L-Moment based Index flood methods will be used to evaluate the flood quantiles for various regions. The research will provide a good alternative and comparison to the current Bulletin 17B procedures. It is believed that with the flexibility of distributions, the estimates provided by the proposed study will be more robust and can be used with greater confidence.

Featured Institute Researchers

Dr. Xinhua Jia is an Assistant Professor in the Department of Agricultural and Biosystems Engineering at North Dakota State University. She received her B.S. in agronomy and worked as a research scientist for many years in Northwest China. In 2004, she earned her Ph.D. in Agricultural and Biosystems Engineering at the University of Arizona in Tucson, Arizona. She then worked as a postdoctoral research associate in water resources engineering at the University of Florida in Gainesville, Florida. She joined the ABEN Department at North Dakota State University as a water resources engineer in 2007, with 75% research and 25% teaching responsibilities. She teaches a course Natural Resource Management Systems in the Natural Resource Management program and Small Watershed Hydrology and Modeling course in the Agricultural and Biosystems Engineering program. She will teach a new course, Drainage and Wetland Engineering, in Fall 2010.

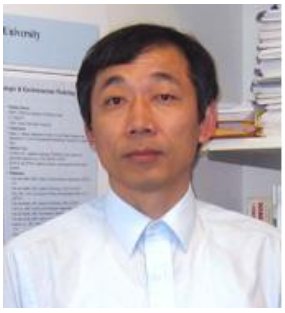
Dr. Jia's primary research interests are on evapotranspiration (ET) measurement, irrigation and drainage, small watershed hydrology, and water quality. Her research focus is on the study of the impact of water availability on crop production and natural resources. Current projects include water management, water quality, and soil quality studies in relation to subsurface drainage and subirrigation. Dr. Jia has conducted a comprehensive water mass balance study with emphasis on validation of ET estimates by a satellite-based remote sensing model using a suite of ground-based ET measurements. One of her M.S. students is the recipient of a North Dakota Water Resources Research Institute Fellowship. The Fellowship research is to evaluate the ET differences under different water management practices and to compare different ET methods of estimation and measurement.

Dr. Howe Lim is an Assistant Professor in the Department of Civil Engineering, University of North Dakota. He has been practicing and conducting research in hydrology and hydraulics for the last 25 years. His research interests include flood frequency analysis, flood management, hydrologic and hydraulic modeling, data mining, stochastic hydrology, and environmental hydraulics. Dr. Lim has worked on regional flood frequency analysis for a number of years. His most recent work in this area is on the regional flood frequency analysis of the Red River Basin. Dr. Lim has built a 30 ft by 3 ft tilt adjustable research flume in his hydraulic research laboratory. This facility has allowed Dr. Lim in carrying out two hydraulic model studies sponsored by the North Dakota State Water Commission. A special stilling basin for a dam spillway was completed in 2008. Another study is currently being conducted to develop the design criteria for a semi-permeable rubble mould weir. Dr. Lim also has interest in the applications of multi-resolution spectral analysis in water resources engineering. This research deals with the use of wavelets and cepstrum analysis in pipe leak detections, trend analysis of the water level at Devils Lake, ND, and filtering tidal series from the observed stage hydrographs of a river in Malaysia. Other research projects include storm pattern analysis, and engineering reviews of a large river barrage project. Dr. Lim teaches graduate courses on open channel hydraulics, applied hydraulics, and surface water hydrology and the undergraduate courses fluid mechanics, hydraulic engineering, and hydrology. Seven graduate students are currently working with Dr. Lim on research projects. Dr. Lim is a current member of American society of Civil Engineers (ASCE) and American Geophysical Union, and has served on the review panels for a number of professional journals. He was awarded the 2009 ASCE Outstanding Reviewer.

Dr. Tom DeSutter is an Assistant Professor in the Department of Soil Science at North Dakota State University. He has BS and MS degrees from South Dakota State University and a PhD from Kansas State University. Dr. DeSutter was a Research Agronomist with the USDA-ARS National Soil Tilth Laboratory in Ames, IA before joining NDSU in 2006. Currently, Dr. DeSutter supervises four graduate students and three undergraduate students and has supported many undergraduate research projects in his laboratory.

Currently, Dr. DeSutter has numerous research projects including: the potential agricultural uses for flue gas desulfurization gypsum, a potential coal combustion byproduct, in the northern Great Plains; fate and transport of manure-borne hormones in the environment; distribution of total Hg in the soils of ND and in hydric soils in the Prairie Pothole Region; cadmium distribution and speciation in ND soils; the influence of road grinding slurry on soil physical and chemical properties and also plant health; bioavailability of ractopomine, an animal pharmaceutical, in wheat and alfalfa; soil salinity and sodicity; swine odor; the potential use of sub irrigation in tile drainage systems; and water availability and usage rights in Central Asia.

Dr. DeSutter has one student that was recently awarded a NDWRRI fellowship: Adam Guy (M.S., in progress). Adam's research project focuses on the water quality of the Red River during the 2009 flood in the Fargo-Moorhead area and also the quality and quantity of the sediment remaining after flood waters receded.



Dr. Xuefeng (Michael) Chu is an assistant professor of water resources engineering in the Department of Civil Engineering at North Dakota State University. He has a Ph.D. in hydrologic sciences from the University of California, Davis. As a hydrologist and faculty member, Dr. Chu worked with Annis Water Resources Institute at Grand Valley State University in Michigan before he joined NDSU in 2008.

Dr. Chu has his research emphasis on several areas of water resources including watershed, hydrologic and environmental modeling, overland flow and infiltration, integrated modeling of flow and multi-phase contaminant transport in surface and subsurface environments, and groundwater modeling and management. In recent years, Dr. Chu has been actively involved in more than a dozen research projects. He has developed three Windows-based hydrologic and environmental modeling software packages. Dr. Chu is a recipient of the 2007 National Science Foundation Faculty Early Career Award, which supports his studies on hydrologic fundamentals. He received a North Dakota NASA EPSCoR Seed award in 2009. With the NSF CAREER and NASA EPSCoR grants, he set up an overland flow research laboratory. Dr. Chu and his students are currently engaged in both experimental and modeling studies on surface characterization and overland flow generation. The focus is on developing multi-scale methods and a state-of-the-art Windows modeling system to quantify microtopography-controlled overland flow processes.

Recent Publications and Presentations by Institute Fellows and PIs

Publications

Ratpukdi, T., Bezbaruah, A., Rice, J., Chilom, G., and Khan, E. Rapid Natural Organic Matter Fractionation Using a Novel Solid Phase Extraction Technique. Accepted for Publication in Water Environment Research.

Bezbaruah, A.N., Krajangpan, S., Chisholm, B.J., Khan, E., Bermudez, J.J.E., (2009). Entrapment of Iron Nanoparticles in Calcium Alginate Beads for Groundwater Remediation Applications, Journal of Hazardous Materials, 166, 1339-1343.

Johnson, B.H., Padmanabhan, G., (2010) Regression estimates of design flows for ungaged sites using bankfull geometry and flashiness, Catena, 81 (2010), pp. 117-125

Kalita, H., Chisholm, B.J., Bezbaruah, A. N. (2009). Effects of different graft copolymer constituent groups on sedimentation characteristics of coated iron nanoparticles, PMSE Preprints, 100, 683-685.

Krajangpan, S., Chisholm, B.J., Kalita, H., and Bezbaruah, A.N., (2009) Challenges in Groundwater Remediation with Iron Nanoparticles: Enhancement Colloidal Stability (Chapter 8) in Nanotechnologies for Water Environment Applications (Eds: Tian C. Zhang, , Rao Y. Surampalli, Keith C. K. Lai, Zhiqiang Hu, R. D. Tyagi, and Irene M. C. Lo), American Society of Civil Engineers/ EWRI, pp. 191-212. ISBN:
978-0-7844-1030-1

Pease, L.M., Oduor, Peter G., and Padmanabhan, G. (2010) Estimating sediment, nitrogen, and phosphorous loads from the Pipestem Creek watershed, North Dakota, using AnnAGNPS. Computers and Geosciences, Volume 36, Issue 3, March 2010, Pages 282-291

Jin, Y., Lohstreter, S., Pierce, D.T., Parisien, J., Wu, M., Hall, C. III, Zhao, J. X., .Silica Nanoparticles with Continuously Tunable Sizes: Synthesis and Size Effects on Cellular Imaging,. Chem. Mater., 2008, 20 (13), 4411-4419.

Krajangpan, S., Jarabek, L., Jepperson, J., Chisholm, B., Bezbaruah, A. (2008). Polymer modified iron nanoparticles for environmental remediation. Polymer Preprint, 49, 921.

Hill, C. and Khan, E. (2008) A Comparative Study of Immobilized Nitrifying and Co-immobilized Nitrifying and Denitrifying Bacteria for Ammonia Removal from Sludge Digester Supernatant. Water, Air, and Soil Pollution, April 2008.

Gibbs, P. S., R. Kasa. J. Newbrey, S. R. Petermann, R. E. Wooley. H. Vinson, and W. Reed. (2007) Identification, antimicrobial resistance profiles, and virulence of members from the family Enterobacteriaceae from the feces of yellow-headed blackbirds (Xanthocephalus xanthocephalus) in North Dakota. Journal of Avian Diseases 51:649-655.

Hearne, R. (2007). Evolving Water Management Institutions in the Red River Basin, Environmental Management. 40(6):842-852.

Jin, Y., Kannan, S., Wu, M., Zhao, X. 2007. Toxicity of luminescent silica nanoparticles to living cells. Chem. Res. Toxicol. Published on web 07/13/07.

Presentations

Guy, A., T. DeSutter, F. Casey, J. Leitch, R. Kolka, N. Derby, H. Hakk, and K. Horsager. (2009). The impact of rural and urban flooding on water and soil quality in the Red River Valley of the North. ASA, CSSA, and SSSA Meeting, Pittsburgh, PA, November 2009.
(Poster).
(Also in Annual meeting abstracts [CD-ROM]. ASA, CSSA, and SSSA Meeting, Madison, WI.)

Ishara Rijal, Xiao Pang, and Xinhua Jia. (2009). Soil moisture distributions for subsurface drainage and subirrigation soils. 2009 ASABE/CSBE North Central Intersectional Conference, September 18-19, 2009. Brookings, SD.
(Podium)

Ishara Rijal, X. Jia, D. D. Steele, T. Scherer, X. Zhang, and X. Pang. (2009). Comparison of reference and actual evapotranspiration in North Dakota (ND). ASABE 2010 Annual International Meeting, June 20-23, 2010, Pittsburg, PA.
(Abstract)

Kalita, H., Chisholm, B. J., Bezbaruah, A. N. (2009). Synthesis of Ion Imprinted Polymer to Remove Arsenic from Water, ND EPSCoR Conference, Fargo, North Dakota, September 2009.
(Poster)

Leelaruban, N., Akyuz, A.,Oduor, Peter G., and Padmanabhan, G. (2010) Geospatial Analyses of Drought Impact and Severity in North Dakota, USA Using Remote Sensing and GIS, 18th Conference on Applied Climatology, AMS 90th Annual Meeting, 17-21 January 2010, Atlanta, GA.
(Poster)

Pennil, C. C., Clark, M.E., Schneck, B.L., Giddings, C.W., and McEvoy, J.M. (2009). High prevalence of Cryptosporidium andersoni in surface water during a major spring flooding event. III International Giardia and Cryptosporidium Conference, Orvieto, Italy, Oct.11-15, 2009.
(Poster)

Rabiya Shabnam, Senay Simsek, Jay M Thompson, Eakalak Khan, Achintya Bezbaruah. (2009). Contaminant Diffusion and Degradation Studies with Alginate Encapsulated Iron Nanoparticles. American Chemical Society Meeting, Salt Lake City, Utah, March 2009.
(Poster)

Schneck, B.L., Pennil, C.C., Lanctot, V.T., Giddings, C.W., Clark, M.E., and McEvoy, J.M. (2009). Cryptosporidium genotypes in Midwestern mammals. III International Giardia and Cryptosporidium Conference, Orvieto, Italy, Oct.11-15, 2009.
(Poster)

Wijeyaratne D., Jacob, D and Otte, M. (2010). Chemical fingerprinting and determination of tributary contribution of trace elements in the upper Souris River, ND 7th Annual Northern Plains Biological Symposium, April 2010. Fargo, ND.
[Poster]

Institute Publications

The following Technical Reports of Fellowship Projects can be accessed via the Institute web site: http://www.ndsu.edu/wrri:

Technical Report No. ND09-01 Brijesh Maharjan
Technical Report No. ND09-02 Yuhui Jin

Thesis and Dissertations

Hill, C. (2008). A Comparative Study of Immobilized Nitrifying and Co-immobilized Nitrifying and Denitrifying Bacteria for Ammonia Removal from Sludge Digester Supernatant. M.S. in Environmental Engineering, North Dakota State University, fargo, ND.

Ratpukdi, T. (2009). Removal of Natural Organic Matter (NOM) by Ozone and Ultraviolet Based Advanced Oxidation Processes: Development of NOM Fractionation Technique, Process Performances, and Bromate Formation. Ph.D. in Civil Engineering, North Dakota State University, Fargo, ND.

Muskie Fellow from Uzbekistan

As a participant in the Edmund S. Muskie Graduate Fellowship Program, Sardorbek Musayev of Uzbekistan arrived at North Dakota State University at the beginning of Fall 2009. Musayev studies natural resources management and will take what he learns back to his country to help improve water resources.

Two rivers supply most of Uzbekistan's water, and the country has been confronting water -shortage issues for decades. Heavy agricultural use and mismanaged distribution has led to both quantity and quality issues. Before becoming a Muskie Fellow, Musayev worked for Oasis FES, Ltd., a soil, water and plant testing lab in Tashkent, Uzbekistan's capital.

The U.S. Congress established the Muskie program in 1992 to encourage economic growth in former Soviet countries. The Muskie fellowship is a program under the Bureau of Educational and Cultural Affairs of the U.S. Department of State and is administered by the International Research and Exchanges Board. The program provides opportunities for graduate students and professionals from Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan for study in the United States.

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G. Padmanabhan, Director of the NDWRRI, and Carolyn Grygiel, Director of Natural Resources Management program, NDSU co-advise Musayev. In addition to taking courses in water resources and natural resources management fields, Musayev has been participating in social and co-curricular activities on- and off-campus since his arrival.

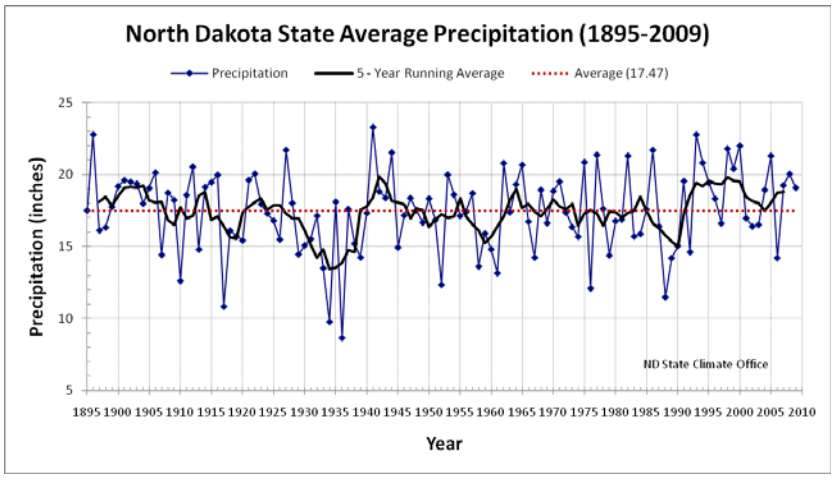
In the summer, Musayev will be interning at the Center for Research in Water Resources, University of Texas at Austin, Austin, Texas. The topic of research is allocation of water in the Syr Darya basin of Central Asia. Hailing from Uzbekistan, the geographic region is of direct interest to Musayev. The Internship will complement Musayev's course work in water resources and natural resources management with practical application.

Finding Comfort in Climatology

As the Red River of the North rises, so does the anxiety among the people living along the river. Last year the Red River reached record breaking stage levels in Fargo and Oslo; the second highest crest in Halstad, Drayton and Pembina; and the third highest crest in Wahpeton and Grand Forks. Major flood stage in Wahpeton occurred on Sunday, March 14 and in Fargo on Wednesday, March 17. The Red River in Fargo crested at 36.99 feet, within 4 feet of the record level of 40.84-foot stage set last year. It was also the 7th highest crest historically. In 113 years of recorded history, there are only four periods when back-to-back major floods occurred (including the current major flood). The U.S. Geological Survey's gauge recorded the major flood stage in Fargo (at or above 30 feet) during the following years: 1965-66, 1978-79, 2006-07, and 2009-10. Major flooding was observed in Fargo-Moorhead during the following years: 1882, 1897, 1965, 1966, 1969, 1975, 1978, 1979, 1989, 1997, 2001, 2006, 2007, 2009, and 2010. We have had 5 major floods since 2000. This statistic may raise even more concerns among our citizens.

A climatologist may be able to provide some comfort to the community. For example, take a look at the figure below. It shows the annual precipitation history in terms of 5-year running averages. Wet and dry periods lasting between 5 to 10 years can be easily identified. The latest wet period started in 1992 and continued with varying intensities up until this year. It also shows that we are at the tail-end of the most current wet period. We have seen semi-accurate to not-so-accurate climate forecasts for local, regional, and global temperatures, but because of limitations in forecasting skills we are unable to accurately forecast precipitation. Forecasting precipitation is far more complicated than forecasting temperatures. Therefore some climate forecasts for precipitation are tied to temperature for one well-understood relationship: as the air temperature rises, it allows containing more moisture. We know North Dakota is warming by 0.26°F per decade on average. This may be interpreted that we are, on average, 2.6°F warmer in North Dakota today than we were 100 years ago. We also know that our growing seasons are lengthening by 1.2 days per decade. In other words, on average, North Dakota has 12 additional days to grow certain crops today that we could not 100 years ago. The warming trend observed locally since the 1890's did not impact the precipitation pattern in North Dakota. Therefore, we know that even if the temperatures rise in the future at the same rate as they have been during the past 30 years (which we have no reason to believe), precipitation may not follow the temperature. As a result, the Figure below is the best tool we have for assessing multi-decadal variation in precipitation.

Yes, one can see comfort in the figure below. The end of the wet period which started in 1992 may be in sight.



---- Dr. Adnan Akyuz, North Dakota State Climatologist

Recent USGS Reports and Web Pages

Access a new USGS webpage on REDOX that highlights publications and a decision-support tool for determining aquifer vulnerability to contamination
http://oh.water.usgs.gov/tanc/NAWQATANCRedox.htm

Sullivan, D.J., Vecchia, A.V., Lorenz, D.L., Gilliom, R.J., and Martin, J.D., 2009, Trends in pesticide concentrations in corn-belt streams, 1996–2006: U.S. Geological Survey Scientific Investigations Report 2009–5132, 75 p.
http://pubs.usgs.gov/sir/2009/5132/

Ryberg, K.R., Emerson, D.G., and Macek-Rowland, K.M., 2009, Solid precipitation measurement intercomparison in Bismarck, North Dakota, from 1988 through 1997: U.S. Geological Survey Scientific Investigations Report 2009–5180, 24 p.
http://pubs.usgs.gov/sir/2009/5180/

Damschen, W.C., and Lundgren, R.F., 2009, Occurrence of emerging contaminants in water and bed material in the Missouri River, North Dakota, 2007: U.S. Geological Survey Fact Sheet 2009–3007, 3 p.
http://pubs.usgs.gov/fs/2009/3007/

Ryberg, Karen R., and Hiemenz, Gregory, 2009, Summary and Analysis of Water-Quality Data for the Arrowwood National Wildlife Refuge, East-Central North Dakota, 1987-2004: Scientific Investigations Report 2009-5017, 92p

Interactive Google Map of North Dakota Real-time Streamgages
-- URL http://nd.water.usgs.gov/floodinfo/RTsitemap.html

New Rapid Deployment Streamgages in critical areas of the Upper Red River Basin
URL -- http://nd.water.usgs.gov/floodinfo/upper_red.html

New Rapid Deployment Streamgages in critical areas of the Missouri River Basin
URL -- http://nd.water.usgs.gov/floodinfo/missouri.html

New Rapid Deployment Streamgages in critical areas of the James River Basin
URL -- http://nd.water.usgs.gov/floodinfo/james.html

NDWRRI Institute faculty teach a graduate course in Thailand

G. Padmanabhan, Director of NDWRRI and professor of civil engineering, and Thomas DeSutter, assistant professor of soil science, taught a course “Soil and Watershed Management” in the “Environmental and Hazardous Waste Management” graduate program at Chulalongkorn University, Bangkok,Thailand, Feb. 1-26. This is the second time the National Center of Excellence for Environmental and Hazardous Waste Management, Bangkok, invited Padmanabhan and DeSutter to teach the four-week course. The Center draws faculty and researchers from a consortium of seven universities in Thailand. Faculty from several other US universities also teach in the program.

Research Projects Receiving Follow-on Funding

Dr. Francis Casey has been successful obtaining follow-on-funding from the NSF and USDA based on the type of research conducted by the NDWRRI Fellow Mary Schuh "Farm-scale reconnaissance of estrogens in subsurface waters" under his guidance.

Dr. Scott Korom obtained funding through USGS 104(G) program under the proposal Collaborative Research on In Situ Denitrification and Glyphosate Transformation in Ground Water: NAWQA Eastern Iowa Basins Study Unit, USGS. The successful proposal had strong connections to the research conducted by his advisee NDWRRI Fellow Tedros Tesfay under the Fellowship project Modeling Groundwater Denitrification by Ferrous Iron Using PHREEQC.

Dr. Malcolm Butler’s advisee NDWRRI Fellow Anthony Potthoff's research “Evaluation of walleye to suppress fathead minnow populations in Type IV & V wetlands” led to two subsequent grants, from the Minnesota Department of Natural Resources. He also received a grant to support another of his advisee NDWRRI Fellow Wei Zheng's work on the baseline study of Aquatic Macroinvertebrates in the Red from the US Bureau of Reclamation.

WaterSMART Initiative

Secretary of the Interior Ken Salazar on February 22, 2010 signed a Secretarial order establishing a new water sustainability strategy for the United States "WaterSMART". The "SMART" in WaterSMART stands for "Sustain and Manage America's Resources for Tomorrow."

The WaterSMART Secretarial Order has several parts, all of which are focused on improving water conservation and helping water and resource managers make wise decisions about water use, including:

- A national framework to integrate and coordinate water sustainability efforts of the Department and its federal, state and private partners WaterSMART expands the Bureau of Reclamation's various grant programs and its studies of entire river basins. WaterSMART will also give a big boost to the U.S. Geological Survey's National Water Census, which will be conducted for the first time in 30 years.
- A WaterSMART Clearinghouse for the American public. Through the clearinghouse, the Department will provide leadership and assistance to state and local governments, tribal nations, and others in water conservation and sustainable water strategies. The clearinghouse will bring all stakeholders together to identify best practices in water conservation, incentives, and the most cost-effective technologies.
- Criteria that the Department applies to identify and support energy projects and actions that promote sustainable water strategies. WaterSMART will identify the water footprint of various energy technologies and make sure that it is considered as part of any decision process on the development of such technologies.
- A water footprint reduction program for facilities and water-consuming operations to reduce overall consumption of potable water by 26 percent by 2020 and industrial, landscaping, and agricultural water by 20 percent by 2020.

The program will make recommendations for enhancements to information collection, analysis and delivery where needed.

A complete copy of the Secretarial order can be found at http://doi.gov/news/pressreleases/upload/WaterSMARTOrder.pdf

WaterSMART Program: http://www.usbr.gov/WaterSMART/

North America's Prairie Potholes Vulnerable to Warming Climates

According to an article published in the jounal BioScience, the loss of wetlands in the prairie pothole region of central North America due to a warmer and drier climate will negatively affect millions of waterfowl that depend on the region for food, shelter and raising young. A new wetland model developed by the authors to understand the impacts of climate change on wetlands in the prairie pothole region projected major reductions in water volume, shortening of the time water remains in wetlands and changes to wetland vegetation dynamics in this 800,000-square kilometer region in the United States (North and South Dakota, Montana, Minnesota and Iowa) and Canada. Many wetland species -- such as waterfowl and amphibians -- require a minimum time in water to complete their life cycles. For example, most dabbling ducks -- such as mallards and teal-- require at least 80 to 110 days of surface water for their young to grow to where they can fly and for breeding adults to complete molting, the time when birds are flightless while growing new feathers. In addition, an abundance of wetlands are needed because breeding waterfowl typically isolate themselves from others of the same species. The authors note that their model allowed a more comprehensive analysis of climate change impacts across the northern prairies because it simultaneously examined the hydrology and vegetation dynamics of the wetland complex, which are both important for the wildlife that depend on the prairie potholes for part or all of their life cycles. These findings may serve as a foundation for managers and policy makers to develop management plans to prepare for and adapt to climate change in the prairie pothole region.

W. Carter Johnson, Brett Werner, Glenn R. Guntenspergen, Richard A. Voldseth, Bruce Millett, David E. Naugle, Mirela Tulbure, Rosemary W. H. Carroll, John Tracy, and Craig Olawsky. "Prairie Wetland Complexes as Landscape Functional Units in a Changing Climate," BioScience, 60(2):128-140. 2010

Web site provides contour maps

To assist with flood fight

Red River Basin residents can now generate individual property maps with accurate 2-foot elevation contours online at http://www.internationalwaterinstitute.org/lidar.htm. The Web mapping service is made available through a partnership between the Tri-College University International Water Institute, Minnesota Department of Natural Resources and Houston Engineering Inc. To view, create or print custom maps, click on the "RRB LiDAR Product Viewer" icon at the bottom of the Web page. The elevation data used to create the contours resulted from the Red River Basin Mapping Initiative. The initiative began in 2008 with a goal of developing a high-resolution digital elevation model for the Red River of the North Basin south of the U.S. and Canada border using Light Detection and Ranging (LiDAR). The $5 million project covers more than 41,000 square miles of data and includes 15 local, state and federal funding partners.

EPA Releases Baseline Study of U.S. Lakes

The U.S. Environmental Protection Agen-cy (EPA) has released its most comprehensive study of the nation's lakes to date. The draft study, which rated the condition of 56 percent of the lakes in the United States as good and the remainder as fair or poor, marked the first time EPA and its partners used a nationally consistent approach to survey the ecological and water quality of lakes. A total of 1,028 lakes were randomly sampled during 2007 by states, tribes and EPA. Degraded lakeshore habitat, rated "poor" in 36 percent of lakes, was the most significant of the problems assessed. Removal of trees and shrubs and construction of docks, marinas, homes and other structures along shorelines all contribute to degraded lakeshore habitat. Nitrogen and phosphorous are found at high levels in 20 percent of lakes. Excess levels of these nutrients contribute to algae blooms, weed growth, reduced water clarity, and other lake problems. EPA is very concerned about the adverse impacts of nutrients on aquatic life, drinking water and recreation.

The survey included a comparison to a subset of lakes with wastewater impacts that were sampled in the 1970s. It finds that 75 per-cent show either improvements or no change in phosphorus levels. This suggests that the na-tion's investments in wastewater treat-ment and other pollution control activities are working despite population increases across the country.

Sampling for the National Rivers and Streams Assessment is underway, and results from this two-year study are expected to be available in 2011.

The National Lakes Assessment draft report: http://www.epa.gov/lakessurvey/pdf/nla_report_low_res.pdf

EPA's Office Of Water Facebook Page

A new Facebook page, "Water Is Worth It," was launched by U.S. Environmental Pro-tection Agency's Office of Water to provide a public forum to share information, encourage discussion and raise awareness about the value of water and water-related resources. The page is found by searching for "Water Is Worth It" at www.facebook.com.

So, You Live Behind a Levee!

Levees are built near rivers and lakes to reduce flooding risk. What does it mean to live behind one? American Society of Civil Engineers has published a new public education booklet, *So, You Live Behind a Levee!*. It cov-ers issues such as flood size and risk, signs of trouble, ways to reduce risk, and how to prepare for and respond to emergencies. You can download a free copy by clicking http://content.asce.org/ASCELeveeGuide.

Today's Missouri River: A North Dakota Perspective

This 8-page full-color report provides general information on the Missouri River, particularly the North Dakota portion of the river. It discusses the benefits of the river, and summarizes some of the most pressing issues of the river basin.

Joint Water Resource Boards

The majority of water resource districts in North Dakota are established along county boundaries. Because water does not respect political boundaries, cooperation is sometimes required among many water resource districts to manage water at the watershed level. For this reason, the North Dakota Legislature enacted the Joint Exercise of Powers Statute - establishing the ability to form joint water resource districts in 1975. The Red River Joint Water Resource District (RRJWRD) was the first joint district to be created. It was originally formed in 1979 to address flooding problems in the Red River Valley, when individual water board members felt that a joint board was needed to provide a coordinated and cooperative approach to water management in the North Dakota portion of the Red River Basin. It was also determined that it would be much easier for one entity to effectively represent the region and to implement a comprehensive water management plan.

Water Projects in the State

A wide variety of water programs are on-going throughout North Dakota. Here are some.

Dam Safety - The National Dam Safety Program was initiated through the Corps of Engineers after the failure of the Taccoa Falls Bible College Dam in 1978. The North Dakota State Water Commission's Dam Safety Program was initiated to continue on with this program of inspecting dams and writing reports assessing the safety of the dams. The SWC's program inspects 66 significant dams on a rotational basis, so that every dam on the list is fully inspected at least once every eight years. Every year 120 dams are given a partial inspection to check on the status of the dam after the spring snowmelt runoff is over. Other dams in North Dakota are inspected on an "as needed" basis, such as when a dam is built, rehabilitated, or when the public has a concern about a dam.

MR&I Water Supply - In 1986, the federal government authorized the Municipal, Rural and Industrial (MR&I) water supply program, funded partially by a $200 million federal grant, which has helped many North Dakota water systems obtain a clean, reliable supply of water for residences, farms, schools, hospitals and industries. An additional $200 million has been authorized in the Dakota Water Resources Act of 2000 (DWRA) to help further meet statewide water requirements. In spite of the work completed, many water systems need assistance.

Northwest Area Water Supply - Another part of the arid west-central section of North Dakota is waiting for the same taste of clean, clear water that many of their neighbors to the south are already enjoying. Many cities and rural areas in the NAWS project area have domestic water supplies with less than desirable quality.

Water from Lake Sakakawea will be pumped as far north as Sherwood, to Bottineau in the east, and Divide County in the west. The city of Minot in Ward County will also get its water from the Northwest Area Water Supply project. Like the Southwest Pipeline and the other MR&I programs, the $115 million Northwest Area Water Supply project will be funded at 65% with federal funds from Garrison and 35% with local funds provided by the communities that will use the water. After construction, the cost of operating the water delivery system is borne by the user who purchases the water.

Southwest Pipeline - Less than 15 inches of rain falls on southwestern North Dakota each year. That's not nearly enough to keep wells in the area from running dry and streams and reservoirs from emptying out. In 1977, the State Water Commission began studying the difficult task of bringing enough clean water to the southwest. The subsequent pipeline has already brought water to a number of threatened communities in the southwest. More are waiting for the project to be completed. The pipeline brings water from Lake Sakakawea, the giant reservoir created by the Garrison Dam, to Dickinson. In Dickinson the water is treated and sent on its way to Mott, New England, Richardton, Golden Valley, and other communities including the city of Dickinson. That means that tens of thousands of homes, farms, schools, and other facilities have a reliable supply of clean water.

Water Management Planning - The State Water Commission (SWC) has initiated the process of developing a Water Development Report for the 2011-2013 biennium. To make this process a success, the Water Commission needs help from project sponsors in identifying North Dakota's potential water management projects and programs, the timing of their implementation, and their estimated costs. To collect this information, the Commission has sent project information forms to water boards, cities, rural/regional water system managers, and other known water project and program sponsors. As in the past, the product of this effort will become the foundation of the Commission's budget request to the Governor and Legislature.

Cloud Modification and Its Impact on Agricultural Economy

A recent study by Dean Bangsund and Larry Leistritz at North Dakota State University shows the North Dakota Cloud Modification Project is providing a major impact to the western ND agricultural economy. A summary of the report findings can be accessed via:

http://www.swc.state.nd.us/4dlink9/4dcgi/GetSubContentPDF/PB-1950/Jun09.pdf

Report on Energy-Water Nexus

In response to concerns about the nation's energy dependence on imported oil, climate change, and other issues, the federal government has encouraged the use of biofuels. Water plays a crucial role in all stages of biofuel production—from cultivation of feedstock through its conversion into biofuel. As demand for water from various sectors increases and places additional stress on already constrained supplies, the effects of expanded biofuel production may need to be considered. Government Accountability Office (GAO) recently on November 2009 submitted a report to the House Science and Technology Committee on this topic titled:

Energy-Water Nexus: Many Uncertainties Remain about National and Regional Effects of Increased Biofuel Production on Water Resources. GAO-10-116, November 30, 2009.
Full report and a summary of highlights can be accessed by visiting the following web sites:
Full Report: http://www.gao.gov/cgi-bin/getrpt?GAO-10-116
Highlights: http://www.gao.gov/highlights/d10116high.pdf

Public-Supply Well Vulnerability

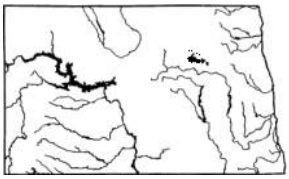
New USGS groundwater studies explain what, when, and how contaminants may reach public-supply wells. All wells are not equally vulnerable to contamination because of differences in three factors: the general chemistry of the aquifer, groundwater age, and direct paths within aquifer systems that allow water and contaminants to reach a well. The USGS tracked the movement of contaminants in groundwater and in public-supply wells in four aquifers in California, Connecticut, Nebraska and Florida. The importance of each factor differs among the various aquifer settings, depending upon natural geology and local aquifer conditions, as well as human activities related to land use and well construction and operation. Findings in the four different aquifer systems can be applied to similar aquifer settings and wells throughout the Nation.

USGS Fact sheets and video podcast about public-supply well vulnerability can be found on the website:
http://oh.water.usgs.gov/tanc/NAWQATANC.htm .

NOAA Launches Landmark Climate.gov Portal

National Oceanic and Atmospheric Agency (NOAA) has unveiled a new Web site – http://www.climate.gov – that serves as a single point-of-entry for NOAA's extensive climate information, data, products and services. Known as the NOAA Climate Portal, the site addresses the needs of five broadly-defined user groups: decision makers and policy leaders, scientists and applications-oriented data users, educators, business users and the public.

Highlights of the portal include an interactive "climate dashboard" that shows a range of constantly updating climate datasets (e.g., temperature, carbon dioxide concentration and sea level) over adjustable time scales; the new climate science magazine *Climate-Watch*, featuring videos and articles of scientists discussing recent climate research and findings; and an array of data products and educational resources.



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Children and Floods

Even though they are too young to understand all the flood-related statistics, elementary school children are aware of the sense of urgency and fear they see or hear in discussions during our recent flood fights. Even we, as adults, find it difficult to maintain a cool, calm composure as we not only deal with the current flood situation, but also as we reflect on the disruption we experienced in our lives during several recent past floods. So, Dr. Adnan Akyuz, ND State Climatologist and Institute affiliate faculty, recently visited with the school children to talk about floods.

North Dakota Water Resources Research Institute (NDWRRI)

The Institute was founded in 1965 by authority of Congress as one of the 54 Institutes throughout the nation and is administered through the United States Geological Survey. The NDWRRI receives funding through section 104 of the *Water Resources Research Act of 1984* and it applies its Federal allotment funds to research that fosters: A) the entry of new research scientists into the water resources field, B) training and education of future water resources scientists, engineers, and technicians; C) the preliminary exploration of new ideas that address water problems or expand understanding of water and water-related phenomena; and D) the dissemination of research results to water managers and the public.