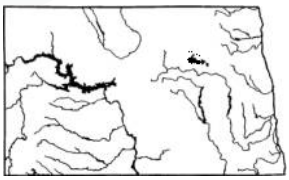
August 2009

North Dakota Water Resources Research Institute
North Dakota State University
Fargo, ND 58105



Newsletter

The National Institutes for Water Resources

http://www.ndsu.edu/wrri

From the Director

Welcome to the 2009 issue of NDWRRI newsletter. In this issue, we highlight the 2008 Fellowship research projects and feature three selected Institute faculty. 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.

For the past few months, North Dakota has been experiencing floods of record proportions. It is water everywhere. Communities have been fighting floods. Flood protection is in everybody's mind. Ice in the Missouri River had to be dynamited to protect Bismarck. The U.S. Army Corps of Engineers took the unprecedented step of closing the release gates at the Garrison dam. After fighting a massive flood, options of diversion around Fargo and West Fargo either through Minnesota or through North Dakota is being discussed in Fargo by officials and public. Also under consideration are other permanent flood protection measures such as higher dikes and more retention. Another flooding problem to the north near the Canadian border has been the Pembina "road" dike constructed by Canadian government. This 30-mile long road holds back water on the North Dakota side of the border during flood conditions. Recently, Gov. John Hoeven requested U.S. State Department officials to seek removal of the dike. We need protection from flood to give our communities peace of mind. But flood control is easier said than done. Many believe flood control measures need to be considered on a watershed-wide basis. A watershed authority along the lines of Tennessee Valley Authority that would govern water quality and retention issues has been suggested for Red River basin by the City of Fargo. Governance change to watershed-wide water management approach is being emphasized.

We are grateful to North Dakota State Water Commission for continuing its support to the Fellowship program of the Institute by matching 15% of the USGS annual base grant. The Institute continues to meet its mission by dedicating most of the Federal allotment funds toward competitive graduate student research fellowships. As in the previous years, the Advisory Committee consisting of representation from three major water agencies – the State Health Department, the State Water Commission, and the U.S. Geological Survey – provided valuable help in setting Institute's research priorities and reviewing Fellowship applications. The 2009-10 Fellowship recipients and their projects are also highlighted in this issue.

Institute faculty and fellows presented the results of their research in several conferences and symposia. Their publications and presentations are listed. 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

- Floodplain Management Association Annual Conference, Investing in Floodplains for Future Generations: Innovation in Land Use Strategies, Green Infrastructure, Technology and Community-Based Partnerships, September 8-11, 2009, The Fairmont, San Jose, California. http://www.floodplain.org/conference.php

- From Dust Bowl to Mud Bowl – Sedimentation, Conservation Measures and the Future of Reservoirs, Soil and Water Conservation Society, September 14-16, 2009 in Kansas City, Missouri at the Westin Crown Center Hotel. www.swcs.org/sedimentation

- 7th International Conference on Pharmaceuticals and Endocrine Disrupting Chemicals in Water, National Ground Water Association, September 22-23, 2009, Baltimore, Maryland https://info.ngwa.org/servicecenter/Meetings/MeetingDetail.cfm?meetingid=834&feecatuid=2791&datecatuid=1267

- 2009 Theis Conference—Ground Water and Climate Change, National Ground Water Association, October 2-5, 2009, Boulder, Colorado https://info.ngwa.org/servicecenter/Meetings/MeetingDetail.cfm?meetingid=826&feecatuid=2762&datecatuid=1256

- The Minnesota 2009 Annual Water Resources Conference, River Center, St. Paul, MN, October 26-27, 2009. http://wrc.umn.edu/waterconf/

- North Dakota GIS Users' Conference, November 2-4, 2009, Alerus Center, Grand Forks, North Dakota. http://www.nd.gov/gis/news/2009-conference.html

- 45th Annual Water Resources Conference, American Water Resources Association, November 8 -12, 2009, Seattle, Washington

  http://www.awra.org/pdf/AWRA2009Seattle.pdf

- 2010 International Low Impact Development: *Redefining Water in the City*, American Society of civil Engineers/ Environmental and Water Resources Institute conference, April 11 - 14, 2010, Westin San Francisco Airport Hotel, San Francisco, California

  http://content.asce.org/conferences/lid10/

- National Water Quality Monitoring Conference: Monitoring From the Summit to the Sea, April 25-29, 2010, Denver, Colorado. http://acwi.gov/monitoring/

- 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

- 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/

New 2009 State Water Plan Now Available

The Water Commission recently completed a new 2009 North Dakota State Water Management Plan (SWMP). The overall purpose of the new SWMP is to: provide information regarding current and projected water use; identify areas where water is generally available for new beneficial uses; identify goals and objectives for water resource management and development; identify potential water resource management and development projects and programs; provide current information regarding the Water Commission's revenue sources for water project development; serve as a formal request for funding from the Resources Trust Fund; and broadly identify water resource management and development opportunities and challenges, and provide recommendations to address them.

http://swc.state.nd.us/4dlink9/4dcgi/GetSubCategoryRecord/News%20and%20Information/State%20Water%20Management%20Plan

The Institute Awarded Nine Graduate Fellowships for the Year 2009-2010

Fellow: Dimuthu Wijeyaratne

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

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

Fellow: Harjyoti Kalitia

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

Title: "Iron Imprinted Polymer for Removal and Monitoring of Arsenic "

Fellow: Qigang Chang

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

Title: "Development of GAC-NZVI Adsorbent for Arsenic Removal "

Fellow: Rabiya Shabnam

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

Title: "Interactions between Microorganisms and Metal Nanoparticles: A New Approach for Groundwater Remediation "

Fellow: Sita Krajangpan

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

Title: "Modification of Iron Nanoparticles by Amphiphilic Polysiloxane Graft Co-Polymer for Arsenic, TCE, and RDX Remediation"

Fellow: Halis Simsek

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

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

Fellow: Brianna Schneck

Adviser: John McEvoy, AES Vet & Micro Sci., North Dakota State University and Mark Clark, Biological Sciences, North Dakota State University

Title: "Source Tracking of Cryptosporidium in Rural Watersheds"

Fellow: Chase Christenson

Adviser: Scott Korom, Geology and Geological Engineering, University of North Dakota

Title: "Effects of Iron Bacteria on Subsurface Tile Drains: Influence on Nutrient Transport"

Fellow: Joseph Vistad

Adviser: Howe Lim, Civil Engineering, University of North Dakota

Title: "Regional Flood Frequency Analysis in the Missouri River Basin Based on L-moments and GLS Regression"

2008-09 NDWRRI Fellowship Research Highlights

Fellow: Dimuthu Wijeyaratne

Sediments are a valuable source of information regarding the occurrence, magnitude and trend of human-associated environmental contaminants because they integrate erosion products from throughout the catchment area. Sediments consist of a large number of elements, many potentially contributing to water pollution. 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 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. Dimuthu and her adviser propose in this study to determine the chemical fingerprint for the Souris River sediments by assessing the surface and depth variation in sediment signature, use the fingerprinting technique to identify sediment transport (source and sink sites) along the Souris Rive, and apply the chemical fingerprinting technique to determine sources and sinks of P and other significant elements. In August 2008, sediment samples from the top layer of the riverbed were collected from small tributaries along the Upper Souris River. The samples were taken from inside tributaries, and from 50 m upstream and 50 m downstream in the Souris River. The homogenized sediment samples were acid digested and analyzed using a Spectro genesis ICP-OES for about 53 elements. The fingerprints were developed for each site sampled in August 2008 and development of a model to describe data is in progress.

Dimuthu's adviser is Dr. Marinus Otte, Department of Biological Sciences, North Dakota State University.

Fellow: Harjyoti Kalita

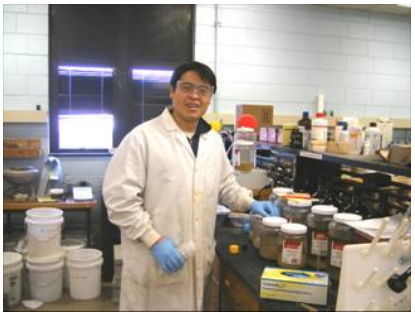
Arsenic present in water is a serious environmental and health concern because of the toxicity of arsenic on human and on other living organisms. Arsenic usually occurs naturally in groundwater although some arsenic based pesticides and preservatives may also contribute. The U.S. EPA has set 0.010 parts per million (10 µg/L) as the arsenic standard for drinking water in 2006. The maximum contaminant level or MCL of 10 µg/L has created an urgent need of new technology for arsenic sensing and removal from water. Arsenic is present in water in tri- and penta-valent forms. Different Processes are presently used to remove arsenic. However, most of the conventional arsenic removal processes can not remove As(III) and As(V) simultaneously. They can treat either As(III) or As(V), and, hence, a pretreatment in the form of oxidation or reduction is needed. The need for an additional unit process adds to the capital and operation costs of treatment. To overcome this limitation Harjyoti and Dr. Bezbaruah in this study propose to synthesize ion-imprinted polymer for the removal of both As(III) and As(V) simultaneously. Cross-linkers will be used in the polymer which can bind both As(III) and As(V) and reduce As(V) to As(III). Hence, arsenic removal could be done in one step. This research will proceed further on to develop sensors with low response time and high arsenic detection efficiency. Thus far, Harjyoti and Dr. Bezbaruah have synthesized thiol- arsenic complex and imprinted the complex in styrene-divinyl benzene copolymer. The polymer material was filtered and then dried in vacuum to get the ion-imprinted polymer (IIP). The effects of various parameters (e.g., pH, temperature, different cross-linker, reaction time) have been analyzed to determine the optimal conditions. ICP-OES analysis was carried out to see the binding of arsenic with the polymer. The IIP developed will find potential use in large and small water treatment plants including point-of-use treatment units. Ion-imprinted chemical sensor technology will have potential applications in clinical diagnostics, environmental and food analyses as well as in illicit drugs detection, genotoxicity and chemical weapons.

Figure 1. Thiol- arsenic complex synthesized.

Figure 2. Arsenic ion-imprinted polymer synthesized.

Harjyoti's advisers are Dr. Achintya Bezbaruah, Department of civil engineering, North Dakota State University, and Dr. Bret Chisholm, Center for Nanoscale Science and Engineering, North Dakota State University.

Fellow: Qigang Chang



Qigang'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 avoiding 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 study has determined that high amounts of iron could be impregnated in GAC with an even-distribution. A new impregnation method has been developed. GAC-Iron has been characterized by Scanning Electron Microscopy (SEM) coupled with Energy Dispersive X-ray unit. SEM analyses indicated that 12.62% iron evenly distributes inside GAC Darco 20×50. Nano-level iron particles were observed in SEM images. X-ray Diffraction analyses indicated that iron can exist inside GAC both in crystal structure (α-FeOOH) and amorphous status. GAC-NZVI is a promising adsorbent that could be used to remove arsenic from drinking water at existing facilities without further expansion.

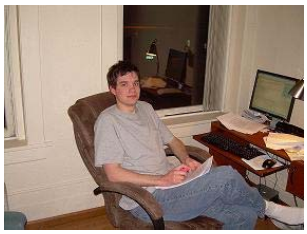
Qigang's adviser is Dr. Wei Lin, Department of civil engineering, North Dakota State University.

Fellow: Rabiya Shabnam

Nanoparticles are attractive for remediation of various contaminants because of their unique physico-chemical properties. Zero-valent iron (nZVI) is the most popular among the metal nanoparticles used in environmental remediation. Though nZVI have been extensively used for remediation, their efficacy has been evaluated excluding their possible interactions with environmental microorganisms. The present 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 by-product(s) to benign end products or vice-versa. The purpose of this study is to experimentally prove that microorganisms and nanoparticles develop symbiotic relationships and such relationships can be simulated under specific environmental conditions. Progress has been made in design and production of alginate microcapsules. The capsules have been optimized for their size and properties (e.g., membrane thickness, bursting strength) for various alginate concentrations, dropping velocities, and gelation times . Entrapment of nZVI and sample microorganisms into alginate capsules has been achieved. Tracer studies using nitrate, ammonia, various polysaccharides and pesticides are underway. Successful entrapment of iron nanoparticles and microorganisms in alginate capsules will lead to possible use of these micro reactors for degrade contaminated groundwater plumes when used as permeable reactive barriers.

Rabiya's adviser is Dr. Achintya Bezbaruah, Department of civil engineering, North Dakota State University.

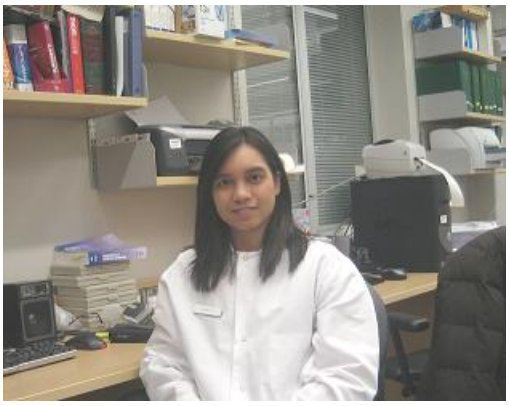
Fellow: Jay Thompson



Pesticide contamination of groundwater remains an ongoing area of concern. One promising pesticide remediation technology is reductive dechlorination by iron filings or powder. This technology has been successful in both the lab and field. However, limitations inherent in this process have limited its use. Recent research has shown that nanoscale zero valent iron (nZVI), with its high surface area and reactivity, can overcome many of these limitations. Although particle properties can vary greatly with synthesis method, typical particles have diameters less than 100 nm. This property results in extremely high specific surface area, which greatly speeds reactions and can eliminate potentially harmful byproducts. Additionally, nZVI can be injected directly into an aquifer, eliminating the need for the expensive excavation associated with iron filings. Research completed with support of the 2007 NDWRRI program has successfully characterized the synthesized nZVI and described pesticide (alachlor) degradation as a pseudo-first order reaction. However, the proposed model does not account for changes in nZVI surface chemistry, due to oxidation and possibly boron content. Jay's research attempts to create a more mechanistic model that can be applied to a broader set of situations. Kinetic trials on E/E nZVI have been completed. The completed research may have applications in the development of an inexpensive on-site pesticide waste treatment system. Such a system could potentially treat low-volume, high-concentration pesticide wastewater and rinsewater much more economically than the centralized treatment system used presently.

Jay's adviser is Dr. Achintya Bezbaruah, Department of civil engineering, North Dakota State University.

Fellow: Sita Krajangpan



Zero-valent iron nanoparticles (nZVI) have been used for groundwater remediation of various contaminants because of their unique physiochemical properties. Various chlorinated aliphatic hydrocarbons, explosives, and metals have been successfully decontaminated with nZVI. However, nZVI are not only highly reactive with the contaminants, but also rapidly react with surrounding media in the subsurface (dissolved oxygen and/or water) and other non-target compounds. Thus, significant loss of nZVI reactivity occurs before the particles reach the target contaminants. Additionally, strong magnetic interactions between particles cause agglomeration, limiting colloidal stability and reduction in reactive surface area. For nZVI to effective, the particles should remain dispersed, protected from non-target compounds, and suspended for longer time. The inherent problems associated with bare nZVI can be overcome by designing a delivery vehicle. Considering the requirements of an effective delivery vehicle for nZVI, functionalized amphiphilic polysiloxanes are an ideal class of polymers for this application. Amphiphilic polysiloxane graft co-polymers (APGC) have been synthesized by hydrosilylation of hydride-functional polysiloxanes, poly ethylene glycol (PEG) and *tert*-butyl acrylate (tBA) (supported by 2007 NDWRRI fellowship). The water-soluble grafts, PEG, allow for dispersibility and colloidal stability in an aqueous medium. The hydrophobicity of the polysiloxane polymer backbone protects the nZVI from excessive oxidation by creating a barrier to water while also creating an affinity of the coated nZVI for the water/contaminant interface. The polymer also readily allows permeation of contaminants to the nZVI surface. This research is in continuation of the work completed for the 2007 NDWRRI Fellowship program. The nZVI, APGC, and CnZVI were successfully synthesized and characterized. The colloidal stability comparison between CnZVI and bare nZVI were completed. Batch experiments using CnZVI were conducted with replications and showed promising results in As, TCE, and NO3–N removal as compare to 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. The results from this project will stimulate further research for the development of target specific delivery vehicles for contaminants of environmental concern.

Sita's advisers are Dr. Achintya Bezbaruah, Department of civil engineering, North Dakota State University, and Dr. Bret Chisholm, Center for Nanoscale Science and Engineering, North Dakota State University.

Fellow: Yuhui Jin

Bacteria can grow or re-grow in distribution systems of drinking water. In fact, potable water is a major source of some bacterial colonization: for example, *L. pneumophila* and *E coli.* etc. The *L. pneumophila* in potable water can replicate rapidly and increase in virulence. Given the low infectious dose of pathogenic bacteria, the presence of even a single bacterium in potable water may pose a serious health risk. Therefore, sensitive and rapid detection of bacteria in water is critical. However, the current definitive method for the detection of bacteria is the culture of the organism, which requires about 24 hours for bacterial growth. This method is too slow to meet the public need. The PCR-based method can detect bacteria within six hours, but the method requires pre-enrichment of the target bacteria. Yuhui in this study investigated a method to specifically identify pathogenic bacteria at a single bacterium level within 30 minutes in water samples. The method will be accurate, rapid and sensitive to meet the public need. In the first step, the quantum dot-like luminescent silica nanoparticles were developed. These luminescent silica nanoparticles can be excited by a single wavelength excitation source, and give out light with different emission wavelength. This property will benefit the simultaneous detection of different kind of bacteria targets. In the second step, lab-made bacteria samples have been detected by these quantum dot-like luminescent silica nanoparticles by spectro-fluorometer and fluorescence microscope. Samples from North Dakota water systems are being studied by using this method.

Yuhui's adviser is Dr. Julia Zhao, Department of Chemistry, University of North Dakota.

EPA Releases Drinking Water Infrastructure Assessment Report

Local water utilities must make significant investments to install, upgrade, or replace equipment in order to deliver safe drinking water and protect public health. Every four years, EPA conducts a survey of the anticipated costs of these investments and reports the results to Congress. The results are also used to help determine the amount of funding each state receives for its Drinking Water State Revolving Fund program, which funds the types of projects identified in the survey.

The third report to Congress, released in 2009, is based on data collected from utilities in 2007. EPA found that the nation's 53,000 community water systems and 21,400 not-for-profit noncommunity water systems will need to invest an estimated $334.8 billion between 2007 and 2027.

North Dakota Department of Health Releases 2008 Drinking Water Compliance Report

Information about North Dakota's public water systems is available in the newly released 2008 Drinking Water Compliance Report prepared by the North Dakota Department of Health.
North Dakota public water systems maintain an excellent Safe Drinking Water Act (SDWA) compliance record. In 2008, the Department of Health issued 285 certificates of compliance to operators and public water systems. All SDWA violations incurred in North Dakota in 2008 are included in the report. Also listed are violations recorded in 2009 and based on 2008 monitoring data.

A summary of the report can be viewed on the department's website at http://www.ndhealth.gov/mf.

USGS/NIWR National Competitive Grants

Robert Hearne (PI)

Robert Hearne, Department of Agricultural Economics, North Dakota State University, completed a project "Assessing the Effectiveness of Local Water Institutions in Water Management" funded (2005-08) by USGS/ NIWR 104 (G) National Competitive Program.
The research focused on the Red River of the North Basin in Minnesota and North Dakota.

Results of this research should support decision makers throughout the North America. Specific objectives of the research included:

1) Develop a set of objective and subjective criteria and indicators to evaluate the effectiveness of local water management institutions;

2) Review the different governmental and nongovernmental institutions in the basin, classify their current goals and activities as well as their chartered purposes, and identify overlaps as well as functions that are not being addressed;

3) Identify and evaluate the characteristics of local water institutions that have a demonstrated capability to meet local goals and wider goals of the greater river basin, including water quality monitoring and participation in the establishing TMDLs;

4) Assess the use of: 1) scientific and technical information provided by USGS and other agencies; 2) extension education and training programs; and 3) other support provided by governmental and non-governmental agencies and organizations;

5) Identify the characteristics of institutions that successfully evolve to meet new challenges;

6) Analyze preferences of a sample of residents and stakeholders toward watershed management issues and the types of institutions they trust; and

7) Disseminate results to various forums including local workshops, extension materials, and scientific journals.

Three MS students, David Torpen (Agribusiness and Applied Economics), Craig Kritsky (Agribusiness and Applied Economics), and Nirodha de Silva (not pictured) (Natural Resource Management) were supported under this project.

Scott Korom (PI)

Scott Korom (Adviser) and Brijesh (Fellow) at Graduation

Scott Korom, Department of Geology and Geological Engineering, University of North Dakota, and Paul Capel, USGS, St. Paul, Minnesota are the PI and Co-PI, respectively, of another USGS/ NIWR 104 (G) National Competitive Program funded (2006-09) project "Collaborative Research on in situ Denitrification and Glyphosate Transformation in Ground Water: NAWQA Eastern Iowa Basins Study Unit."

Contamination of ground water by nitrate and pesticides is widespread in some areas of the country and can threaten drinking water supplies. It is well known that the most important removal mechanism of nitrate and most pesticides from ground water is biodegradation, but the *in situ* transformation rates are largely unknown. In this study, stainless steel chambers forming *in situ* mesocosms (ISMs) of aquifer sediments were installed below the water table at the NAWQA agricultural chemicals study sites in the glaciated region of Iowa to examine denitrification in an area characterized by high dissolved iron concentrations and to measure the transformation rate of the extensively-used herbicide, glyphosate. The objectives for the research included:

1. Measure the denitrification and glyphosate transformation rates in the two ISMs.
2. Determine whether the denitrification is better fit by zero-order or first-order reaction rates.
3. Determine what donors are contributing electrons for the denitrification and their relative amounts.
4. Incorporate the results of the two ISMs into the existing databank of nine other ISM sites in glacial outwash aquifers in the Upper Midwest.
5. Update the available data of the apparent isotopic enrichment factor for ^{15}N in nitrate versus denitrification rate among of ISM sites.
6. Update the nitrate vulnerability index and extrapolate the findings to similar, unmonitored agricultural and environmental settings.

One MS student, Brijesh Maharjan (Geology and Geological Engineering), graduated with the support from this project.

Brijesh Maharjan (in the white hat) at the Iowa field site. Erik Smith (USGS) in the red hat.

Featured Institute Researchers

Dr. Marinus Otte

Dr. Marinus Otte is a Professor in the Department of Biological Sciences at NDSU, where he leads the Wet Ecosystem Research Group. The research group currently includes one Research Assistant Professor, three Ph.D. students, and two undergraduate students. One of Dr. Otte's Ph. D students is currently a North Dakota Water Resources Research Institute Fellow receiving financial support.

Dr. Otte's interests in ecology, ecophysiology and ecotoxicology focus on elemental uptake and metabolism in plants, particularly in relation to metals and sulfur in wetlands. He obtained both his M.S. (1986) and Ph.D. (1991) from the Department of Plant Ecology and Ecotoxicology at the Vrije Universiteit, Amsterdam, The Netherlands. After obtaining his Ph.D., Marinus worked at the University of South Carolina, Columbia, on sulfur metabolism of *Spartina alterniflora* in coastal salt marshes. He subsequently worked at University College Dublin, Ireland, from 1992 until 2006 when he joined NDSU.

Dr. Otte's current research projects use multi-element analysis as a tool to understand processes underlying mobility and cycling of elements in the environment, and as a tool to underpin management of natural systems. This is used on a wide range of scales, from the microscopic level of the rhizosphere of plant roots to the macro-level of ecosystems and landscapes. Ongoing projects include metal mobility in North Dakota soils, phosphate removal by a constructed wetland from dairy processing wastewater in Ireland, sediment tracking in the Souris River (part funded by ND WRRI), submerged aquatic vegetation of MN shallow lakes, and elemental uptake by wetland plants associated with hot springs in Yellowstone National Park.

Dr. Achintya Bezbaruah

Dr. Achintya Bezbaruah hails from the highest rainfall zone in the world, Assam state in northeast India. It is, therefore, no coincidence that he is in the business of water. An assistant professor of civil engineering at North Dakota State University, Dr. Bezbaruah passionately works on environmental nanotechnology for water contaminant remediation. Prior to joining NDSU in 2005 he worked for URS Group, one of the largest engineering consulting firms in the US. At URS he mostly worked on groundwater remediation and contaminant fate and transport modeling. One of his signature remediation designs is a three-cell constructed wetland at Offutt Air Force Base at Bellevue, Nebraska. The subsurface-flow vegetated wetland treats groundwater trichloroethylene (TCE) to the regulatory limits. A Ph.D from the University of Nebraska, Dr. Bezbaruah received his MS degree from the Indian Institute of Technology and BS from Assam Engineering College in India. Prior to moving to the USA he worked as an Assistant Professor at Assam Engineering College for more than a decade. He is the recipient of ISCA Young Scientist's Award (India, 1987), Canham Graduate Scholarship (WEF, USA, 2001), and most recently Centennial Research Award (NDSU, 2007).

Dr. Bezbaruah's research group consisting of several North Dakota Water Resources Research Institute supported Graduate Research Fellows currently focuses on a number of projects related to manufactured nanoparticles in water environment. One of the contributions of his group is the invention of an amphiphilic polysiloxane graft copolymer for effective delivery of iron nanoparticles for groundwater remediation. With patents pending, NDSU is presently negotiating with a manufacturing company for commercial production of the new delivery vehicle. This delivery vehicle is expected to have ramification in sensing, electronics and drug delivery. Another research project is in the frontier area of microorganism-nanoparticle interactions. This collaborative research is expected to improve understanding of the area of impact of iron nanoparticles on endemic bacteria. Another of his recent collaborative project is focused on wetland plant-nanoparticle interactions. Yet another project is on an arsenic ion-imprinted polymer for simultaneous removal of As (III) and As(V). There is presently no technology to remove both the species of arsenic in single unit process. Arsenic in drinking water is a problem very dear to Dr. Bezbaruah as it is a major concern in North Dakota and also in his birth place in Assam, India. Dr. Bezbaruah keeps track of his graduate students after graduation and speaks proudly and highly of his graduate students.

Dr. Bezbaruah is actively involved with the organization Market Place for Kids which promotes entrepreneurship among K-12 students. Dr. Bezbaruah works with the organization for popularizing nanotechnology. He also volunteers as a chess and soccer coach in West Fargo schools.

Dr. Adnan Akyüz

Dr. Adnan Akyüz is an Assistant professor of Climatology, Department of Soil Science at NDSU. He is also the North Dakota State Climatologist. Dr. Akyüz teaches meteorology, climatology and microclimatology courses. He is currently active in research dealing with El Niño Southern Oscillation (ENSO) impact on North Dakota's climate, climate change impact on growing seasons in the Northern Plains, and drought assessment and drought impact in North Dakota.

Dr. Akyüz earned his MS and Ph.D. degrees in Atmospheric Science at the University of Missouri-Columbia in 1988 and 1994 respectively. He also holds a BS degree in Meteorological Engineering from Istanbul Technical University, Istanbul, Turkey. Before joining the North Dakota State University faculty, Dr. Akyüz served as the Missouri State Climatologist for 8 years in Columbia, Missouri. He also held a position with the National Weather Service as a climate services specialist in Kansas City, Missouri for 2 years.

Dr. Akyüz also serves as the Director of the North Dakota Agricultural Weather Network (NDAWN) Center. The Center oversees the operation of 72 automated weather stations scattered across the region. The NDAWN stations measure wind speed and direction, air temperature, rainfall, solar radiation, pressure (31 stations), atmospheric moisture and soil temperatures under bare and turf at 10 cm (4 inch) depth. The Center provides daily summaries consisting of maximums and minimums as well as time of occurrence, and various totals or averages for all variables in English or Metric units. Measured and calculated variables along with complete descriptions are available. The NDAWN Center web site: http://ndawn.ndsu.nodak.edu/ allows direct access to NDAWN data in various special and temporal scales. The voice modem accommodates those who do not have internet access. The NDAWN Center has assisted many North Dakotans in making weather critical decisions concerning their crops, livestock, and livelihood.

Dr. Akyüz was recently awarded a USDA grant to study climate change and its local impacts on changing growing seasons in the northern plains of the US. He will investigate how climate change affects regional net returns for different crops and what this means for rotational cropping choices. Relative profitability of individual crops is one criterion among several influencing farmer decisions about crop rotation choices. Farmers in the traditional wheat-growing areas of the Northern Plains are growing fewer acres of wheat. The shift to row crops, including corn, in recent years has been dramatic. Yields of some competing crops have been rising faster than wheat. Underlying these more rapid yield gains are improved genetics. However, there is also evidence that a lengthening of the growing season as climate change occurs may have a role in the crop rotation choices that farmers are making. For example, a lengthening of the growing season allows the use of longer-season corn varieties than would otherwise be the case. Typically, longer-season varieties have higher yields, leading to increased profitability relative to wheat. If a shorter-season variety had to be used it might not have been profitable to replace wheat. Preliminary results show that the growing seasons in North Dakota has lengthened 12 days on the average during the last 115 years. However, the pilot study did not show any significant trend in precipitation. Air temperature and the air's water vapor holding capacity have a well known relationship. Since the total amount of liquid water did not change over the time, Dr. Akyüz theorizes that the frequency of heavy precipitation must be increasing during the last 115 years.

Dr. Peter Oduor

Dr. Peter Oduor is an Assistant Professor of Geology and Geography in the department of Geosciences at North Dakota State University. He has a PhD from University of Missouri-Rolla (Currently Missouri University of Science and Tech). Dr. Peter Oduor conducts research in two distinct areas, (a) Reverse osmosis and hyperfiltration systems using argillaceous matrices, and (b) geospatial based research using Geographic Information Systems (GIS) and Remote Sensing. Dr. Oduor and his graduate students have recently looked at (i) solute exclusionary properties of shales with an aim of providing a corollary to Kupferschiefer mineralization, (ii) survivability of Archae microbes at water-sediment interface, intra- and inter-sediment matrices to determine how they would be ideally suited for biostimulated remediation of wastewater, (iii) novel ways of wastewater remediation using amalgamated matrices and composite membranes, (iv) forestry inventory and management with a future perspective on adoption of BMPs to protect significantly impaired watersheds within North Dakota. Drs. Oduor and Padmanabhan, professor in civil engineering, were recently awarded a grant to quantify areas that would significantly contribute to sediment or nutrient loads for Lower James and Knife River watersheds. Their recent research on sediment load quantification with Lyndon Pease (an NDSU MS graduate) for Pipestem Creek was recently accepted for publication in Computers and Geosciences Journal.

Recently, Dr. Oduor has been busy building 2 laboratories: (a) Water quality and analyses laboratory where he has analytical instruments such as Ion Chromatograph, Solute Delivery Modules with High Pressure purification systems, an FTIR, and in situ field analyses kits (pH, DO, Spectrometers etc) (b) a geospatial laboratory (Warren Kress Geography Laboratory) where he has 64 bit PCs with 8 – 32 Gigabytes of RAM, a Dell PowerEdge® Server with 6 Terabytes of disc space, flatbed scanners, GPS units (Garmin and Trimble), and new cutting edge GIS software for 3D-4D modeling.

Dr. Oduor at fieldwork

Recent USGS Reports

USGS released a new report, *Factors affecting water quality in selected carbonate aquifers in the United States, 1993-200* (available at http://water.usgs.gov/nawqa/pubs/carbonate/ with maps and other companion materials).

USGS scientists sampled for 151 chemical constituents or physical properties in about 1,000 wells and springs across 20 states, mainly in the eastern and central United States. The majority of the wells sampled in the study are used as drinking water sources, either for domestic or public supply. Therefore, these results are particularly relevant to drinking-water quality issues. Other sampled wells not used for drinking water included livestock wells, irrigation wells, and monitoring wells. Carbonate aquifers are the largest sources of drinking water for public supply of any bedrock aquifer, providing about 20 percent of the groundwater supplied as drinking water to the Nation.

In general, findings show that carbonate aquifers provide water of acceptable quality for human use and consumption in the majority of wells sampled across the U.S. With few exceptions, chemicals detected in groundwater from carbonate aquifers were low, generally below human-health benchmarks. Radon and nitrate were among the few contaminants with elevated concentrations in samples from wells tapping these important aquifers. Findings also show that factors other than land use can affect groundwater quality. For example, natural geochemistry is a factor influencing radon occurrence. Radon concentrations exceeded the proposed drinking-water standard of 300 picocuries per liter in 58 percent of the samples where radon was analyzed. Natural factors controlling aquifer confinement, groundwater residence times, and the presence of organic carbon can help to minimize the transport of contaminants to an aquifer or enhance degradation of contaminants to innocuous forms prior to entering wells.

Recent Publications and Presentations by Institute Fellows and PIs

Publications

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., Chisholm, B.J., **Kalita, H.**, and Bezbaruah, A.N. 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 for Civil Engineers/EWRI, pp. 191-212, 2009. ISBN: 978-0-7844-1030-1

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

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.

Hearne, R. and C. Kritsky. In Press. Characteristics of Active Local Water Management Districts In the Red River Basin. *Water Policy*.

McEwen, D.C. and Butler, M.G. 2008. Impacts from Water-Level Regulation on Benthic Community Structure in Namakan Reservoir and Rainy Lake, Voyageurs National Park. Natural Resource Technical Report NPS/NRPC/WRD/NRTR-2008/129.

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.

Torpen D. and R. Hearne. (2008) "Stakeholder Preferences for Water Management Alternatives in the Red River Basin." Agribusiness and Applied Economics Report N0. 639. Department of Agribusiness and Applied Economics, North Dakota State University. April, 2008.

Presentations

Hearne, R. and **C. Kritsky**. Characteristics of Active Water Management Organizations in the Red River Basin. Presented at the Western Agricultural Economics Association Annual Meeting. Big Sky, Mt. June 2008

Hearne, R. 2008. Lessons for Improved Local Water Management. Paper presented at the 2008 Spring Extension Conference. Bismark, ND. March 2008.

Hearne, R. and D. Torpen. Stakeholder Preferences for Water Management Alternatives in the Red River Basin. Paper Presented at the W-2133 Annual Meeting Kona Hi., February 2008.

Jin, Y.;* Lohstreter, S.; Wu, M., Parisien, J.; Zhao, X. Preparation of luminescent silica nanoparticles with controllable sizes. In 100th North Dakota Academy of Science Annual Meeting, Grand Forks, ND, April 24, 2008. (Oral)

Yuhui Jin got the Denison Award, first place award for Graduate student presentation, in the 2008 North Dakota Academy Sciences Annual Meeting.

Jin, Y.;* Parisien, J., Wu, M., Zhao, X. Multiple bacteria detection using multicolor fluorescent silica nanoparticles based on FRET. In North Dakota Water Resources Research Institute conference, Bismark, ND, April 15, 2008. (Oral)

Jin, Y.;* Lohstreter, S.; Wu, M., Parisien, J.; Zhao, X. Manipulation of silica nanoparticles on the continuous spectrum. In The Pittsburgh Conference, New Orleans, LA, March 2, 2008. (Oral)

Kalita, H., Chisholm, B., J., Bezbaruah, A., N. "Ion-imprinted Polymers: A new Approach to Remove Arsenic from Drinking Water". AWWA, Surface Water Conference, April 2008 (Poster Presentation).

Korom, S. F., Network of in situ mesocosms: Aquifer denitrification, 8th Annual Meeting on Agricultural Contaminants: Sources, Fate, and Transport, USGS, Ames, IA, March 18 – 20, 2008.

*Korom, S. F., and **R. J. S. Klapperich**, Electron donor concentrations in eastern North Dakota shale formations. 53rd Annual Midwest Ground Water Conference, September 29 – October 2, 2008, Dubuque, Iowa.

Krajangpan, S., Chishlom, B., Bezbaruah, A., RFT-247, Novel Polymer Modified Iron Nanoparticles for Environmental Remediation, provisional patent application filed Feb. 2009.

Krajangpan, S., Jarabek, L., Jepperson, J., Chisholm, B., Bezbaruah, A. April 10 2008. The Use of Multifunctional Polymers to Effective Deliver Iron Nanoparticles to Subsurface Contaminants. 235th ACS National Meeting, New Orleans, LA. [Poster]

Krajangpan, S., Bezbaruah, A., Chisholm, B. April 2008. Effective Delivery of Modified Iron Nanoparticles by Amphiphilic Polysiloxane Graft Copolymer for Groundwater Remediation. The 2008 Surface Water treatment Workshop, Moorhead, MN. [Poster]

Krajangpan, S., Bezbaruah, A., Chisholm, B. August 2008. Groundwater Remediation using Polymer coated iron nanoparticles. The 2008 2nd Annual Joint Student Environmental Conference. North Dakota, ND. [Presentation]

Krajangpan, S., Bezbaruah, A., Chisholm, B. October 2008. Increased Efficacy of Zero-valent Iron Nanoparticles in Groundwater Remediation: Development of Polymeric Delivery Vehicle. The 2008 International Environmental Nanotechnology Conference: Applications and Implications, Chicago, IL. [Poster]

Krajangpan, S., Bermudez, J.J.E., Bezbaruah, A.N., Chisholm, B.J., Khan, E. August, 2008. Nitrate Removal by Entrapped Zero-Valent Iron Nanoparticles in Calcium Alginate, 12th International Conference on Integrated Diffuse Pollution Management (IWA DIPCON 2008), Khon Kaen University, Thailand. [Presentation]

Maharjan, B., and S. F. Korom, Correlation of Electron Donor Concentrations in Aquifer Sediments with Sediment Properties: USGS ACT Site near New Providence, Iowa, 53rd Annual Midwest Ground Water Conference, September 29 – October 2, 2008, in Dubuque, Iowa:

McEwen, D.C. and Butler, M.G. 2008. Impacts on aquatic invertebrate communities of altered drawdown magnitude and timing of spring refill in a managed reservoir within Voyageurs National Park, Minnesota Presentation given at the 93rd Annual Conference of Ecological Socieity of America Meeting, Milwaukee, WI, 3-8 August 2008.

Butler, M.G. and **D.C. McEwen.** 2008. Predicting aquatic insect growth rates and voltinism as a function of temperature and body mass. Presentation given at the 93rd Annual Conference of Ecological Society of America Meeting, Milwaukee, WI, 3-8 August 2008.

Clark, W.H., **McEwen, D.C.**, and M. Clark. 2008. Land-use effects on white sucker (*Catostomus commersoni*) life history and diet in portions of North Dakota and Minnesota. Presentation given at the 93rd Annual Conference of Ecological Socieity of America Meeting, Milwaukee, WI, 3-8 August 2008.

McEwen, D.C., and M.G. Butler. 2008. Application of metabolic theory to the determination of life-span, growth rate, and secondary production of benthic macroinvertebrates. Presentation given at the Annual Conference of American Society of Limnology and Oceanography, St. Johns, Newfoundland, 8-13 June 2008.

Paradeis, B.L., E.S. DeKeyser, and D.R. Kirby. 2008. Abstract:Assessment of Plant Community Structure and Function of Restored Prairie Pothole Wetlands. Society of Wetland Scientists 29th Annual Meeting, Washington, D.C.

Paradeis, B.L., E.S. DeKeyser, and D.R. Kirby. 2008. Abstract: Plant Community Composition of Restored Prairie and Wetlands in the Prairie Pothole Region. 3rd Western Wetland Monitoring and Assessment Workgroup Training Workshop, Rapid City, SD.

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

Rabiya Shabnam, Achintya Bezbaruah, Senay Simsek, Eakalak Khan, John McEvoy, Yildirim Bora Suzen. "Use of Biopolymer to Encapsulate Iron Nanoparticles: Diffusion and Treatability Studies." International Environmental Nanotechnology Conference, Chicago, October 2008. http://www.emsus.com/nanotechconf/abstracts_posters_n-z.htm (Poster)

Rabiya Shabnam, Achintya Bezbaruah, Senay Simsek, Eakalak Khan. "Biopolymer Encapsulated Metal Nanoparticles and Microorganisms for Environmental Remediation." Presented at Annual Joint Student Environmental Conference, August 2008.NDSU. (Presentation)

Rabiya Shabnam, Achintya Bezbaruah, Senay Simsek, Eakalak Khan. "Encapsulation of Iron Nano Particles and Microorganisms with Alginate for Environmental Remediation." AWWA Surface Water Conference, Moorhead, MN, April 2008 (Poster).

Wijeyaratne D., Jacob D and Otte M. (2008) Chemical Fingerprinting of Sediments of the Souris River to assess the transport of phosphorous and other pollutants 5th Annual Northern Plains Biological Symposium, April, 2008. 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. ND08-01 Eben Spencer
Technical Report No. ND08-02 Damion Knudsen
Technical Report No. ND08-03 Thunyalux Ratpukdi
Technical Report No. ND08-04 Jay Thompson
Technical Report No. ND08-05 Breanna Paradeis
Technical Report No. ND08-06 Mary Schuh
Technical Report No. ND08-07 Brent Hanson
Technical Report No. ND08-08 Seth Lynne
Technical Report No. ND08-09 Ryan Klapperich
Technical Report No. ND08-10 Ali Tackette

Thesis and Dissertations

De Silva, Nirodha. 2008. Assessing the Organizational Effectiveness of Conservation Districts in the Red River Basin in Minnesota and North Dakota. M.S. Thesis. Natural Resources Management. North Dakota State University.

Salinas Klapperich, R. J., 2008. Electron Donor Potential of Eastern North Dakota Shale Formations. MS Thesis. University of North Dakota, 103 pp.

Kritsky, Craig. 2008. Identifying Beneficial Attributes of Water Management Organizations. M.S. Paper. Agribusiness and Applied Economics. North Dakota State University.

Maharjan, B., 2008. Correlation of Electron Donor Concentrations in Sediments with Sediment Properties: New Providence, Iowa. MS Thesis. University of North Dakota, 52 pp.

McEwen, Daniel Clayton. 2008. Impacts of Water Level Regulation on Macroinvertebrate Communities in the Littoral Zone of Lakes. Ph. D. Dissertation. December 2008. North Dakota State University.

Paradeis, Breanna. 2008. Plant Community Composition of Wetlands Located on Restored and Native Prairie. MS Thesis. May 2008. North Dakota State University.

Schuh, Mary. 2008. Farm-Scale Reconnaissance of Estrogens in Subsurface Waters. MS Thesis. November 2008. North Dakota State University

Thompson, Jay. 2008. Chlorinated Pesticide Remediation Using Zero-valent Iron Nanoparticles. MS Thesis. May 2008. North Dakota State University.

Flood Hazard Mapping

As part of its activities related to the National Flood Insurance Program (NFIP)...FEMA has begun the transition from Flood Map Modernization (Map Mod) to Risk Mapping, assessment, and Planning (Risk MAP) in fiscal year (FY) 2009. The vision for Risk MAP is to work collaboratively with State, local, and tribal entities to deliver quality data that increases public awareness and lead to action that reduces risk to life and property.

With FY 2009 Congressional appropriations for Flood Hazard Mapping, FEMA is initiating flood map update projects to address gaps in required engineering and mapping for high flood risk areas impacted by coastal flooding, levees, and other flood hazards (e.g., lakes, rivers, and ponds). The Risk MAP FY 09 Flood Mapping Production Plan provides the strategy for selection of FY 09 Risk MAP flood map update projects and the planned schedule for their completion. It identifies those counties for which flood map update projects are being nitiated in FY 2009 and the type of flood hazards being addressed by the engineering and mapping project (coastal, levee, other riverine flood hazards). Projects were selected in FY 2009 to leverage established Cooperating Technical Partner (CTP) relationships. Those counties including CTP maintenance activities are identified in the Risk MAP FY 09 Flood Mapping Production Plan.

The Risk MAP FY 09 Flood Mapping Production Plan is available on FEMA's Flood Hazard Mapping Web site at http://www.fema.gov/plan/prevent/fhm/rm_main.shtm Interested parties with questions pertaining to the updated strategy and planned schedule for flood mapping projects are encouraged to contact their appropriate local and State officials, who are working with one of FEMA's 10 Regional Offices.

New Missouri River Organization Formed

The Missouri River basin states and tribes have formed a new organization, to be used as a forum for dialogue on Missouri River basin issues. The Missouri River Association of States and Tribes (MoRAST) is a regional interstate organization formed by joint resolution of the governors of North Dakota, South Dakota, Wyoming, Montana, Nebraska, Iowa, and Kansas, and the Intertribal Water Rights Coalition. The organization website is www.mo-rast.org.

Fox Hills-Hell Creek Aquifer Pressure Declining

A flowing well in western North Dakota.

The Fox Hills-Hell Creek aquifer is a vital source of water for livestock, domestic, municipal, and industrial uses in western North Dakota. The aquifer is artesian, which allows wells in low-lying areas to flow. The pressure in the aquifer is declining at an average rate of approximately one foot per year. If the current trend continues, a majority of the flowing wells installed in the aquifer will stop flowing within the next 60-90 years.

On a ten-year frequency, the State Water Commission monitors flowing well pressure changes in the aquifer and publishes the results in reports and brochures. Reports and brochures on flowing Well pressure changes in 1) Billings, Golden Valley, and Slope Counties, 2) McKenzie County, and 3) the Knife River Basin were recently published. Procedures to minimize pressure decline are described in the brochures.

To download a brochure, click here: http://www.swc.state.nd.us/4dlink9/4dcgi/GetSubCategoryRecord/Reports%20and%20Publications/Flowing%20Wells%20Brochures

To download a report, click on http://www.swc.state.nd.us/4dlink9/4dcgi/GetSubCategoryRecord/Reports%20and%20Publications/Water%20Resource%20Investigations and choose WRI No 42, WRI No 43, or WRI No 44.

Nutrient Concentrations Remained Stable in Many Streams from 1993 to 2003

The U.S. Geological Survey National Water-Quality Assessment program conducted national- and regional-scale trend assessments (1993 to 2003) of nutrient concentrations and loads in streams and how these trends corresponded to changes in streamflow and nutrient sources, such as fertilizer applications, animal manure, population, and atmospheric deposition. Phosphorus and nitrogen concentrations remained relatively stable in about half of the streams assessed nationwide from 1993 to 2003; however, the pattern did vary in some regions, including increases in phosphorus concentrations in more than half of the streams assessed in the Mississippi/Atchafalaya River Basin. Linking trends in stream nutrient levels to changes in nutrient sources will enhance our understanding of the effectiveness of land management actions.

Regional-scale assessments of examined trends in nutrient and suspended-sediment concentrations and loads in the Upper Mississippi, Ohio, Red, and Great Lakes River Basin, Missouri River Basin, Lower Mississippi, Arkansas-White-Red, and Texas-Gulf River Basin, and the Pacific Northwest River Basin.
http://water.usgs.gov/nawqa/pubs/nutrient_trends/

Manitoba Border Dike

Pembina County

For decades, Pembina County residents have had to deal with flooding caused by a 30-mile-long dike on the Manitoba side of the international boundary. Gov. John Hoeven on May 5, 2008 hand delivered a number of photographs to U.S. State Department officials illustrating flooding in Pembina along the Canadian road functioning as a dike along the international border.

http://swc.state.nd.us/4dlink9/4dcgi/GetSubCategoryRecord/News%20and%20Information/Manitoba%20Border%20Dike

EPA unveils a new website "Watershed Central"

The US EPA recently unveiled a web site designed to provide state, local, and voluntary watershed management entities with a variety of tools and information that will aide in successful watershed management.

According to EPA, Watershed Central's stakeholders and data providers include:

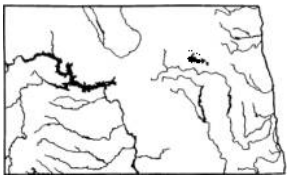
- Local watershed management groups
- Regulated entities subject to EPA's various clean water act provisions
- EPA Headquarters and the Office of Water
- EPA regional water and water management offices
- Fish and Wildlife Service and National Marine Fisheries Service on issues related to electronic access to data submitted
- States
- Tribes
- Public

Watershed Central includes a feature called a wiki for information sharing by all watershed management practitioners. The wiki includes case studies, information on watershed organizations and various watershed management tools.
http://www.epa.gov/watershedcentral/

Strategic Plan Available

The 2009-2011 State Water Commission and Office of the State Engineer Strategic Plan is available now for download. The new Strategic Plan contains descriptions and overviews of the agency's major projects and programs.

http://swc.state.nd.us/4dlink9/4dcgi/GetSubCategoryRecord/News%20and%20Information/09-11%20Strategic%20Plan%20Completed



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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.