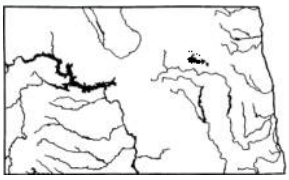
2017-2018

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



Newsletter

The National Institutes for Water Resources

https://www.ndsu.edu/wrri/

From the Director

Greetings and welcome to the 2017-2018 issue of North Dakota Water Resources Research Institute (NDWRRI) newsletter! By the time, you read this letter, I am no longer at North Dakota State University (NDSU). I have joined University of Nevada, Las Vegas as a professor in the Department of Civil and Environmental Engineering and construction and the founding Director of Water Resources Research Program since January 1, 2018. It was a difficult decision for me to leave NDSU after 15 years of positive experiences. The NDWRRI position was one of the memorable engagements during my time at NDSU. I enjoyed working with NDSU and University of North Dakota (UND) faculty, staff, and students as well as several North Dakota State agencies and personnel. These individuals and entities made my job easy during my three years as the Director of the Institute. Dr. Xuefeng (Michael) Chu has taken over the Director position from me. Some of you might have heard from him already. He is well qualified for the position and will take great care of the Institute. One of the mandates of the Institute as required by Section 104 of the *Water Resources Research Act of 1984* is to reach out to the water resources community in North Dakota. This newsletter partially fulfils the mandate.

For the past few years, we have several new junior faculty with expertise related to water that have joined the two research universities in the State. They are considered Institute affiliated faculty. Three of them, Dr. Stephanie Day (Geosciences, NDSU), Dr. Amitava Chatterjee (Soil Sciences, NDSU), and Dr. Taufique Mahmood (Geology & Geological Engineering, UND), are featured in this newsletter in "Meet our Faculty" section. Other sections/stories include introduction of the 2017-2018 NDWRRI Fellows and highlights of the 2016-2017 Fellowship research projects. In addition, you will find lists of recent water related publications from the United States Geological Survey (USGS), State Water Commission (SWC) and the Institute, and stories on events participated by affiliated faculty and Fellows, and the 6th Annual Distinguished Water Seminar hosted by the Institute.

The Institute would like to thank ND SWC for their supplemental support that is about 20% of the base grant from USGS. The Institute has continuously received advices and help from the State Advisory Committee consisting of Steven Robinson, USGS ND Water Science Center; William Schuh, ND SWC; and Peter Wax, ND Department of Health. Their valuable guidance especially on Institute's research priorities, Fellowship funding allocation, and assistance in securing support from ND SWC contributes to the success of the Institute.

It was my privilege and honor serving as the NDWRRI Director. If you are in Las Vegas, please contact me. As always, thank you for your interest in the Institute and for some of you for being part of it. Please enjoy the 2017-2018 newsletter.

Farewell,

Eakalak Khan

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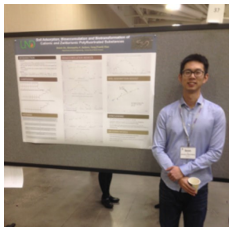
Advisor: Xiaodong Zhang, Earth System Science and Policy, UND

Fellow: Ali Rashid Niaghi

Title: Crop Evapotranspiration Measurement by Eddy Covariance, Bowen Ratio, and Soil Water Balance for a Control Drained and Subirrigated Field

Advisor: Xinhua Jia, Agricultural and Biosystems Engineering, NDSU



Fellow: Bosen Jin

Title: Perfluoroalkyl Substances in Surface Runoff of the Red River Basin

Advisor: Frank Xiao, Civil Engineering, UND

Fellow: Cody Ritt

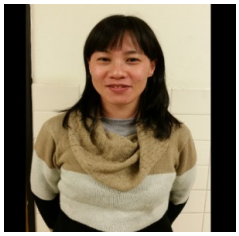
Title: Molecularly Imprinted Polymers for Phosphate Removal from Wastewater

Advisor: Achintya Bezbaruah, Civil and Environmental Engineering, NDSU

Fellow: Diane Van Hoy

Title: Hydrological Responses to Climate Change in a Terminal Lake Basin

Advisor: Taufique Mahmood, Geology and Geological Engineering, UND



Fellow: Hoang Pham

Title: Application of Green Iron Nanoparticles Synthesized Using Barley Polyphenols to Combat Lake Eutrophication Problem

Advisor: Achintya Bezbaruah, Civil and Environmental Engineering, NDSU

Fellow: Kendall Grimm

Title: Modeling of Runoff Contributing Areas and Hydrologic Connectivity and Applications in North Dakota

Advisor: Xuefeng Chu, Civil and Environmental Engineering, NDSU

Fellow: Marina Martin

Title: Endoxifen in Wastewater and Surface Water in North Dakota: Detection and Biodegradation

Advisors: Eakalak Khan, Civil and Environmental Engineering & John McEvoy, Microbiological Sciences, NDSU

Fellow: Mohsen Tahmasebi Nasab

Title: Development of a Macro-Scale Physical-Based Gridded Hydrologic Model (GHM) and Applications in North Dakota

Advisor: Xuefeng Chu, Civil and Environmental Engineering, NDSU

Fellow: Nicholas Lindstrom

Title: Enhanced Natural Wetland Growth Due to Nearby Constructed Wetlands in the Northern Prairie Pothole Region

Advisor: Frank Xiao, Civil Engineering, UND

Fellow: Swati Sharma

Title: Nutrient Removal from Domestic and Livestock Wastewaters Using Integrating Electro-coagulation and Biological Processes

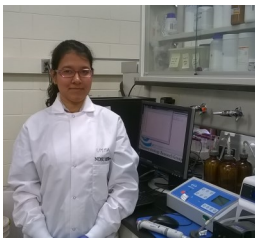
Advisor: Halis Simsek, Agricultural and Biosystems Engineering, NDSU

Fellow: Umesh Acharya

Title: Study On-farm Evaluation of Interactive Effect of Subsurface Tile Drainage, Tillage and Crop Rotation on Nitrate Leaching

Advisor: Amitava Chatterjee, Soil Sciences, NDSU

The Institute Awarded Fifteen Graduate Fellowships for the Year 2017-2018



Fellow: Umma Salma Rashid

Title: Removal of Trichloroethylene and Fluoride from Water by Nanoscale Zero-valent Iron Supported on Novel Activated Carbon

Advisor: Achintya Bezbaruah, Civil and Environmental Engineering, NDSU

Fellow: Zachary Phillips

Title: Holocene Palaeoflood and Glacial Isostatic Adjustment (GIA) Influence on Fluvial Geomorphology of the Red River Basin

Advisor: Stephanie Day, Geosciences, NDSU

Fellow: Yavuz Fidantemiz

Title: Effect of Water Level on Soybean Growth with High Salinity Water

Advisor: Halis Simsek, Agricultural and Biosystems Engineering, NDSU

Upcoming Events

American Water Works Association, Annual Conference & Exposition, Las Vegas, NV, June 11 - 14, 2018

Water Environment Federation, Nutrient Symposium, Raleigh, NC, June 18 - 21, 2018

Water Environment Federation Technical Exhibition and Conference (WEFTEC), New Orleans, LA, September 29 - October 3, 2018

WaterSmart Innovations, Las Vegas, NV, October 3 - 5, 2018

Minnesota Water Resources Conference, St. Paul, MN, October 16 - 17, 2018

American Water Resources Association Annual Water Resources Conference, Baltimore, MD, November 4 - 8, 2018

National Ground Water Association, Groundwater Week/Summit, Las Vegas, NV, December 3 - 6, 2018

2016 — 2017 NDWRRI Fellowship Research Highlights

***Afshin Shabani**: Modeling Water Balance and Flows of Sediment and Nutrient in Devils Lake Watershed Using SWAT*

The rising water level in Devils Lake has raised concerns regarding both water quantity and quality; however, most of the previous studies on the Devils Lake flooding have been focused on its water balance. The goal of this study is to better understand how the water quality of the lake, particularly its sulfate concentration, changes with a rising water level by simulating both water quantity and quality. We further analyzed impact of artificial pumping on the water quality of the Sheyenne River. The SWAT and CE-QUAL-W2 models were selected for this simulation because of their proven capacity in simulating hydrology (SWAT) and water quality (CE-QUAL-W2) in tributaries and lakes. To the best of our knowledge, the spatial distribution and temporal changes of the sulfate concentration in Devils Lake have never been simulated before. The coupled model performed well in simulating daily flow in tributaries with $E_{NS} > 0.5$ and $|PBIAS| < 25\%$, and reproduced the lake water level with a root mean square error of 0.35 m for the study period from 1995 to 2014. The water temperature and sulfate concentration simulated by coupled model for the lake are in general agreement with the field observations. The model results show that the operation of the two outlets since August 2005 has lowered the lake level by 0.70 m, while raised sulfate concentration in the Sheyenne River from ~100 to >500 mg l^{-1}. However, the coupled model simulation shows increasing sulfate concentration of Devils Lake from west to east, which makes operation of the east outlet more of a concern for degrading the water quality in the Sheyenne River. One possible solution proposed by this study to mitigate Devils Lake water level and Sheyenne River water quality degradation is to reduce the east outlet operation to < 8 m^3 s^{-1} and upgrade the west outlet capacity by at least 2 m^3 s^{-1}. This scenario would meet the ND state standard of 450 mg l^{-1} for stream Class IA.

***Alexis Steinman**: A Comparison of Wetlands across the Urban - Peri-Urban - Rural Gradient*

Limited research has been conducted on urban wetlands nationally and internationally. Research efforts have never focused on urban or peri-urban wetlands in North Dakota. This project provided the first opportunity to establish: 1) the first understanding of urban wetlands in North Dakota; 2) baseline data on urban and peri-urban wetland water quality; 3) a complete survey of vegetation composition across the gradient (annual/ biennial/ perennial, introduced/native); and 4) an initial comparison of wetlands across the rural, peri-urban, and urban gradient in North Dakota. Wetland water quality parameters differed spatially across the rural, peri-urban, and urban gradient and between sampling time periods. These findings indicate a relationship between urban development and water quality, and stresses the importance of taking samples on a regular basis to assess water quality changes over time. Water quality parameters results at peri-urban and urban sites were significantly different than at rural sites. Unexpectedly, water quality parameters gathered at the peri-urban wetlands were consistent and similar between sampling periods, whereas the parameters from rural and urban wetlands were highly variable. Further research is necessary to determine if peri-urban wetland sites have the potential to become useful tools to buffer disturbances from urban development. Wetland vegetation differed by zone and as a whole across the rural to urban gradient. Anthropogenic disturbances and alterations influenced the plant species distribution and composition of the study's thirty wetlands. Species richness increased within the peri-urban wetlands due to intermediate levels of disturbance and the introduction of ornamental species, whereas species richness declined in the urban wetlands in comparison to rural wetlands.

2016 — 2017 NDWRRI Fellowship Research Highlights

Bahareh Shoghli: Impacts of Climate Change on Embankment Dams in the Upper Midwest Region: Critical Design Parameters and Adaptation Measures

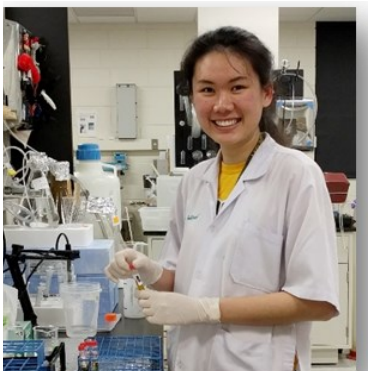
Many dams were designed and built at the beginning of the last century. Some specific questions to be answered would include: (1) how would the dams perform under a possible new climate regime. (2) to what extent is the safety of the dams being compromised under the new hydrologic regimes? (3) how the induced changes in the sedimentation rate in the basin may influence the operation of dams in return to the dam safety issue? Construction of a dam leads to the creation of an artificial reservoir, which normally decreases the flood peak discharge downstream of the dam. However, climate change will increase the magnitudes of extreme flood peak events generated by hydrologic processes at the upper watershed, which may result in an increased probability of overtopping the dam. In the first step of this study, ArcSWAT model was established for Sheyenne-Lake Ashtabula watershed area and the calibration- validation of hydrologic runoff from the watershed was performed using SWAT-CUP. Statistical results in terms of NSE and PBIAS have allowed us to infer our simulation as in the category of "good simulation." Because of the special climatic conditions in North Dakota, there are discrepancies among observed and simulated data during a few extreme spring-melt events. Artificial neural networks were employed to improve the deficiencies of the software used in modeling the snowmelt process.

Benjamin York: Effect of Glacial Isostatic Adjustment on Rivers and Drainage Basins in the Red River Valley

The purpose of this research is to determine if tributaries within the former glacial Lake Agassiz basin are asymmetric. The study further documented if asymmetry was the result of 1) changing watershed boundary; 2) a shifting river channel position; or 3) a combination of both a changing watershed boundary and a shifting river channel. Asymmetry of each watershed was determined by comparing the following landscape measurements: Transverse Topographic Symmetry Factor (TTSF), Asymmetry Factor (AF), and the total net change between pre-adjustment watersheds and current watersheds. Along with the measurements listed above, paleo-channels were identified in the Red River Valley to determine if there has been a uniform shift in drainage between Lake Agassiz stages and isostatic adjustment. Twelve of the sixteen watersheds (Forest, Goose, Otter Tail, Park, Rush, Sand Hill, Snake, Tamarac, Turtle, Two Rivers, and western Wild Rice) analyzed in this thesis have TTSF values that are positive, while the remaining four watersheds (Buffalo, Maple, Red Lake, and Wild Rice) have negative values. A higher positive value indicates a river that lies farther north relative to the center of the watershed. Watersheds displaying the most asymmetry based on TTSF are farther north in the Red River Valley. Similarly, AF values reveal that the most asymmetric watersheds are also located near the northern part of the Red River Valley and suggest greater tilting has occurred, compatible with isostatic adjustment. Furthermore, analysis of the change in watershed boundaries revealed that all but one displays a northward shift in watershed boundary. Finally, paleo-channels were identified and associated with the current Turtle, Elm, Sand Hill, Buffalo, western Wild Rice, and Maple rivers, which flowed into the paleo-Red River. Six of the seven paleo-channels identified lie north of their current river channel, showing that rivers have shifted south. These results suggest that the asymmetry identified using the TTSF and AF values would result from a shifting river rather than a shifting watershed. This does not imply that a shift in watershed did not take place, but rather that the asymmetry observed is not solely the result of a change in watershed boundary.

2016 — 2017 NDWRRI Fellowship Research Highlights

Boonsiri Dandumrongsin: Contribution of Soluble Microbial Products on Dissolved Organic Nitrogen and its Biodegradability in Wastewater Effluent



In this research, the contributions of soluble microbial products (SMPs) on effluent dissolved organic matters (EfOM), including dissolved organic nitrogen, dissolved organic carbon and their biodegradability under different organic loading rates (OLRs) were investigated. Synthetic domestic wastewater and actual primary domestic wastewater from the Fargo wastewater treatment plant were used to feed lab-scale moving bed biofilm reactors (MBBRs). The lab-scale MBBR removed more than 80% of soluble chemical oxygen demand (SCOD). The synthetic wastewater fed reactors can remove SCOD up to 90% due to glucose was used as a C-source. Proteins are found as a major component (50 - 80%) of SMP. The result of this study by measuring protein and carbohydrate concentrations showed that the amount of SMPs is increasing proportionally with OLR. Excitation–emission matrix (3DEEM) fluorescence results showed that the small protein structure like amino acids are found in the influent but not found in the effluent while humic acids are found in the effluent. This result suggests that EfOM was mainly produced during the biological treatment system. Organic matter concentration in the effluent decreased since it was used as nutrients. Similarly, the amount of organic matter produced was less than uptaken by bacteria during biological treatment process. However, the residue organic matter in the effluent shows more complexity than the influent organic matter as evidenced by increasing of aromaticity. Humic acid can be found in the effluents of both the synthetic and raw primary wastewater. However, humic acid concentration in the effluent of the raw primary wastewater was higher. OLR and temperature were found having an important effect on organic removal efficiency of the system and protein was released more when having higher concentrations of toxic substances present in the system.

Courtney Jackson: Effects of Climate Change, Agricultural Land Use Change, and Dynamic Contributing Area on Streamflow Input to Devils Lake: A Case Study of the Mauvais Coulee Sub-Basins

Numerous methods are available to attempt to separate the individual effects of natural climate variation from human landscape change upon the streamflow record. These methods include statistical regression approaches, physically-based modeling, application of the SWAT model, the ecohydrological approach, and various implementations of the Budyko Hypothesis. These later two approaches, in particular, have been frequently implemented, with dozens of papers in the hydrological literature over the 15+ years. Both approaches are based upon a formulation of the annual water balance equation in which storage change (DS) is assumed equal to zero. Further, they identify a baseline period within which streamflow variation is assumed to be driven only by climate variations (Q = f(climate)), and a post-change period, in which both climate and human drivers operate (Q = f(climate, human)). Both approaches utilize relationships established during the baseline period to partition changes in streamflow during the baseline and post-change periods (DQ) into climate and human components (DQc, DQh). Thus, stationarity of climate during the baseline and post-change periods is assumed. Demonstration of the suitability of these approaches to the Prairie Pothole Region would provide a helpful tool to water resource managers. Both the ecohydrological and Budyko framework approaches produced physically unrealistic findings for the Mauvais Coulee streamflow record. In particular, the Budyko approach estimated that 90 percent of the change in streamflow was due to human factors. This is, by far, the largest percentage reported in the literature using this methodology. Several factors made these approaches unsuited to the Devils Lake Basin, in particular, and the glaciated plains, more generally. First, the period-of-record for streamflow at Mauvais Coulee (1956-2015) samples a period of non-stationary climate. The data show that the region experience a shift between two hydroclimate modes, as suggested by the paleoclimatological and historical records. The baseline and post-change periods traverse two separate climate modes, making the baseline period an unsuitable period from which to estimate streamflow changes during the post-change period. All such approaches must demonstrate climatic stationarity, and not assume it. Second, the streamflow record at Mauvais Coulee experiences a non-linear precipitation-streamflow relationship. This results from two major factors. First, the assumption that DS is zero over the study period is clearly not satisfied. The study covers a drought to deluge period in which groundwater and vadose zone storage is emptying during the earlier portion of the study period, and filling during the latter portion of the study period. Thus, the sensitivity coefficients of streamflow to precipitation and potential evapotranspiration are incorrect estimates in both periods. Second, the study area experiences principles of fill-spill hydrology, such that wetland complexes are not filled nor connected to one another in the earlier portion of the study, but progressively experience greater filling and connectivity during the latter portion of the study. The effective basin area contributing to measured streamflow is dynamic over time, and often substantially less than the gross basin contributing area.

2016 — 2017 NDWRRI Fellowship Research Highlights

Debjit Roy: Snowmelt water infiltration into frozen soil in the Red River of the North Basin

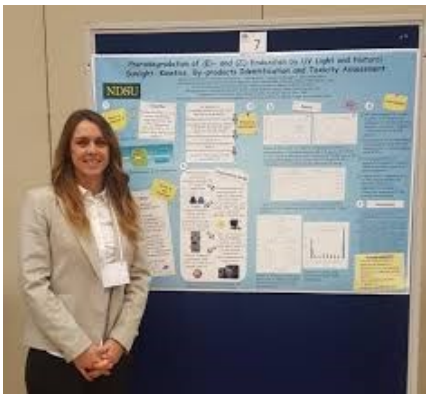
The research project focuses on snowmelt infiltration measurement and simulation into frozen soil of the Red River Basin (RRB). The specific objectives of the research study are: 1) To measure infiltration amount/rate into frozen soil at field and compare to that of the unfrozen soil; 2) To measure infiltration amount/rate into frozen soil at different soil moisture conditions at laboratory; and 3) To simulate infiltration rate in frozen soil by available hydrological model and compare outputs with field observed data. To measure infiltration rate relationship with hydraulic conductivity in frozen condition for different soils of RRB and incorporate that relationship in an existing hydrological model. The infiltration rates in a frozen silty clay loam soil of RRB for initial moisture condition θ_{pwp}, initial moisture condition $\theta_{pwp} \leq \theta \leq \theta_{fc}$ and initial moisture condition θ_{fc}, respectively were measured in this study. Because of low soil moisture content in the soil with θ_{pwp}, the soil was comparatively dry with high pore space. Water infiltrated in that soil quickly and infiltration rate decreased sharply. The ice content did not contribute much to soil moisture, resulted in higher infiltration rate in that soil. Water infiltration was comparatively slower in the soil with $\theta_{pwp} \leq \theta \leq \theta_{fc}$ as melted ice water increased soil moisture content in that soil and reduced the infiltration rate by filling the pore spaces in the soil. Soil with θ_{fc} had highest soil water content among all soils with low pore space. The ice content in the soil blocked the pore space after freezing and restricted the water movement. So, the infiltration rate was found very low in that soil. As the soil reached saturation very rapidly, infiltration amount was very low in that soil compared to other soils with θ_{pwp} and $\theta_{pwp} \leq \theta \leq \theta_{fc}$, respectively. The observed infiltration data were fitted with nonlinear equation with three parameters: $i_t = 0.060 + 0.68 * e^{-0.16*t}$ with $R^2 = 0.87$ for θ_{pwp}; $i_t = 0.010 + 0.42 * e^{-0.12*t}$, with $R^2 = 0.84$ for $\theta_{pwp} \leq \theta \leq \theta_{fc;}$ and $i_t = 0.027 + 0.53 * e^{-0.54*t}$ with $R^2 = 0.75$ for θ_{fc}. The average final infiltration rate was close to predicted rate for θ_{pwp}, was higher than predicated rate for $\theta_{pwp} \leq \theta \leq \theta_{fc}$ and was lower than predicted rate for θ_{fc}. The infiltration curves over time shifted downwards with the shifting of soil from dry to wet. The θ_v changing over time and with temperature resulted due to the combined effects of infiltrating water addition and melted ice water contribution during phase change of water to the soil profile. The θ_v changing varied along the soil profile with time. In the soil with θ_{pwp}, θ_v changed with temperature gradually due to less water addition from melted ice. But in the soil with $\theta_{pwp} \leq \theta \leq \theta_{fc}$, θ_v changed rapidly after temperature reached at 0°C as ice changed to liquid water and added to existing soil water content. The soil with θ_{fc} already had soil water content at field capacity and less pore space, so the addition of infiltration water and melted ice water did not change much θ_v with temperature increase in that soil. Comparison between Soil Water Release Curves of before experiments and after experiments indicated that soil aggregates were destroyed and macropore number was reduced greatly which changed the water holding capacity of that soil from saturation to field capacity.

Luisa Torres: Holistic Risk Assessment of Surface Water Contamination Due to Lead-210 Found in Produced Water from Unconventional Oil Production in North Dakota

This research proposes the combination of statistical methods to analyze risks to human health due to improper management of produced water, the major by-product of hydraulic fracturing. The research focuses on the Bakken Shale located in North Dakota but data from other States is used as needed. The objectives of the research are: 1) To review different risk assessment techniques and select the most applicable ones to onshore unconventional oil and gas development; 2) To conduct a risk assessment from an engineering perspective on human exposure to Ra-226 in produced water from the Bakken Shale; 3) To develop a holistic risk assessment method by incorporating social awareness and perception with risk characterization of surface water contamination due to Pb-210 in produced water from the Bakken Shale; and 4) To understand the factors that shape social risk perception and awareness of produced water from different stakeholders in ND. A risk assessment of radium-226 was performed from a technical perspective only. The simulated total annual effective dose rate of Ra-226 for an adult in ND is above the global average effective dose rate via food and drinking water. A second assessment, focused on lead-210, combined technical analysis with risk perception and awareness of ND residents. Although findings from this study include a low probability of a produced water spill reaching surface water, the consequence of this event could have a great impact since the simulated concentration of Pb-210 in drinking water was found to be higher than the recommended value established by the World Health Organization. Finally, results from the survey conducted for this research indicate that the most important variables that seem to positively or negatively influence the risk perception and awareness of produced water are the images and thoughts associated with produced water, level of knowledge about produced water handling and content, and knowing how to proceed in case of a spill of produced water.

2016 — 2017 NDWRRI Fellowship Research Highlights

Marina Martin: Isolation and Identification of Endoxifen Bacterial Degraders in Wastewater



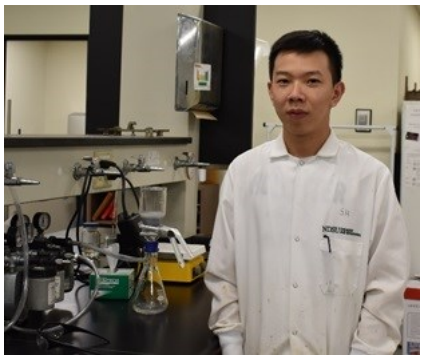
Endoxifen is an active metabolite responsible for the effectiveness of tamoxifen, a chemotherapeutic drug widely used for endocrine responsive breast cancer and chemo-preventive long-term treatment. Endoxifen is not completely metabolized in human body and is actively excreted. As a result, endoxifen is released to the water environment via wastewater treatment plants (WWTPs). The aim of this research is to determine for the first time the presence and levels of endoxifen in North Dakota water bodies and to test biodegradation as a method to remove endoxifen. For this purpose, an extraction and detection method for endoxifen has been developed and bacteria strain(s) from WWTPs capable of degrading endoxifen into less hazardous compound(s) will be isolated and identified. Thirty-seven bacterial strains were isolated from a mixed bacterial culture from a WWTP. The culture was incubated in synthetic wastewater enriched with endoxifen at a concentration of 1 mg/L for 40 days. Isolated bacteria were incubated in a selective minimal salt media (MSM) enriched with Luria-Bertani broth (LB) (0.001%) and endoxifen at 10 mg/L. Bacteria growth was observed and an aliquot of the selective MSM was plated in MSM Agar enriched with endoxifen at 10 mg/L. Resultant colonies were incubated together as a mixed bacterial culture in MSM containing endoxifen (15 mg/L) as the sole carbon source. Bacterial growth was monitored by plate counting and endoxifen concentration is determined by liquid-liquid extraction and posterior injection to Liquid Chromatography-Fluorescence Detector (LC -FLD). Bacteria showed growth but more analyses are needed in order to reach a final conclusion.

Mohammad Enayet Hossain: Biopolymers for Phosphate Removal from Eutrophic Lakes

This research entailed developing a novel sorbent for phosphate removal and reclamation from eutrophic lakes and subsequently using reclaimed phosphate in agriculture. Novel iron (Fe) cross-linked alginate (FCA) beads were synthesized and used for aqueous phosphate removal. The beads were found to remove lower concentrations of phosphate very fast from the solution. About 80-97% phosphate was removed within 3 h for lower concentrations of phosphate. Phosphate removal was not affected by the presence of competing ions and compounds. The FCA beads were also used in real-life situation (e.g., in eutrophic lakes), and the beads were found to remove 81-100% of phosphate from lake waters. The maximum sorption capacity (78.7 mg PO_4^{3-}-P/g of beads) and the point of zero charge (9.2) of the beads make the beads an ideal candidate for eutrophic lakes. The cost analysis showed that the beads are also very affordable compared to other sorbents. Assuming a factor of safety of 4 (i.e., adsorption capacity is only 25% of the experimental value) the cost comes to $0.36 per g P removed. Used or spent FCA beads were used for plant studies to see the bioavailability of P and Fe and to evaluate the potential use of spent FCA beads as slow-release phosphorus and iron fertilizers. Spent FCA beads were found to support biomass production to a certain extent indicating that the phosphorus and iron were available for plant uptake. This research indicates that these FCA beads are promising as a phosphate remover and as a slow-release non-conventional phosphate fertilizer. While these spent FCA beads were not meant for the primary source of phosphate and iron fertilizer, they can certainly be used as supplementary sources of phosphorus and iron. Because of the biodegradable nature, the phosphate-laden FCA beads could be applied directly to soil as a fertilizer. The concept and findings from this research can be used to develop new technologies to combat eutrophication of water bodies, to form a supplementary source of phosphorus.

2016 — 2017 NDWRRI Fellowship Research Highlights

Soklida Hong: Glutaraldehyde Removal from Flowback and Produced Waters Using Photolysis



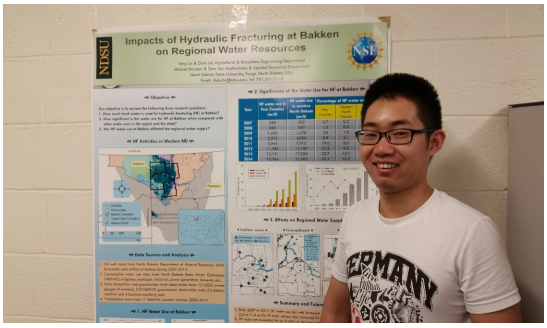
In unconventional oil and gas extraction, hydraulic fracturing has been applied to induce cracking network in low-permeability shale to allow trapped oil and/or gas flow to the production wells. It requires injection of fluid at extremely high pressure and flow rate. Most of the injected fluid along with formation water, collectively known as produced waters, return to the surface just after the hydraulic fracturing process and throughout the entire life-span of production well. Hydraulic fracturing fluid is mainly water (98-99%) and proppant (mostly sand, 1-1.9%); however, several chemicals, including biocides, are added to the water to increase hydraulic fracturing performance. After hydraulic fracturing, biocides are also periodically injected to the wellbores to prevent microbial growth that causes corrosion to the infrastructure. Glutaraldehyde (GA) is the most common biocide accounting for 80% of all shale fracturing in the United States. It is a harmful chemical to environment, humans and aquatic organisms. GA also inhibits microbial activity in produced waters making bioremediation a non-viable option. In this study, photolysis was used to remove GA from brine simulating produced waters since the technology has small footprint and is easy to operate and effective against organic compounds. GA can be photolyzed by UV at all studied conditions with the removal ranging from 52 to 85% within one hour irradiation. Photolysis of GA followed pseudo-first order kinetics. The degradation rate of GA was substantially affected by light intensity (112-224 W), initial GA concentration (0.1-1 mM) and salt concentration (0-300 g/L) but minimally influenced by pH (5-9). Photolysis rate constant of GA at 0.1 mM in 200 g/L of salt at pH 7 was 0.0269 min^{-1} with a quantum yield of 0.0549 under 224 W illumination. The degradation rate of GA increased with increasing incident light intensity and decreasing pH. Increasing in initial GA concentration resulted in decreasing rate of GA. Interestingly, salt concentration affected the GA degradation rate. At lower salt concentrations, a notable retardation of GA degradation rate was observed; however, as salt concentration increased the degradation rate of GA also increased. In quenching experiments, it is found that photolysis of GA was governed by the following mechanisms: direct photolysis and indirect photolysis via •OH and $^1O_2$ photooxidation. Oligomers were identified as the main photolytic byproducts and GA photolytic pathways were proposed.

Swati Sharma: UV Light Effect on Bioavailability of Dissolved Organic Nitrogen in a Trickling Filter Process

Dissolved organic nitrogen (DON), a complex structure, in wastewater has been a major environmental concern especially for receiving waters. Understanding the biodegradability (BDON) and bioavailability (ABDON) characteristics of wastewater derived DON is important to achieve successful removal of DON from anthropogenic sources using bacterial and algal inocula. The purpose of this study is to evaluate the impact of hydraulic retention time on biodegradability and bioavailability of wastewater derived DON using integrated two moving bed biofilm reactors (MBBRs). The MBBR media (plastic white media, about 1 inch in diameter) are used in the reactors to support the growth of bacteria and algae. Various hydraulic retention times (HRTs) at 1, 3, and 6 days have been investigated on primary effluent samples collected from the city of Fargo wastewater treatment plant (WWTP). The samples are further incubated in batch reactors with bacteria and alga + bacteria for 21 days to investigate the utilization of bio-available/degradable DON. A significant reduction in DON has been observed when the reactors are run at an HRT of 3 days. In the second phase of the experiments, the samples were collected from the second MBBR reactor exposed to UV light to determine photodegradable DON (PDON) and further incubated to determine photo biodegradable DON (PBDON) and photo bioavailable DON (PABDON). For the experiments, 500 ml of samples from reactor-2 effluent was transferred into a quartz flask and two 40 watt and 254 nm wavelength of UV lamps were used to irradiate the samples continuously for 6 days. PDON values were determined after UV light exposure and the samples were further incubated for 21 days to determine PBDON and PABDON. The optimum removal of organic nitrogen can be achieved at an average HRT of 3 days. About 40% of DON was bioavailable to bacteria and algae. Lower HRTs may result in inefficient removal whereas HRTs higher than 6 days could result in low nutrient uptake and cell lysis. From the algae + bacteria seeded samples, it can be understood that wastewater derived DON in receiving waters can be taken up by algae in the presence of bacteria. This facilitates our conclusion that algae can uptake higher level of wastewater derived DON in receiving waters in the presence of bacteria. The photodegradability of DON using UV light has been conducted in batch study to understand the fate of DON when exposed to UV light continuously for 6 days. Results showed that, using UV light to the reactor effluents can further degrade DON to a significant level. Thus, working towards reduction in the level of DON should be considered a primary concern in the treatment plants before its discharge to the receiving water bodies.

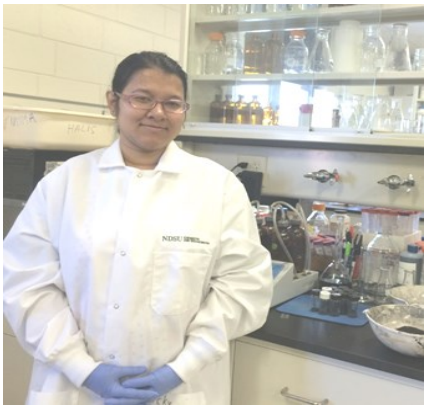
2016 — 2017 NDWRRI Fellowship Research Highlights

Tong Lin: Assessing the Impacts of Hydraulic Fracturing at Bakken on Regional Water Resources



In this project, we analyzed the Bakken oil well completion data, North Dakota water use data, groundwater level and streamflow observations data to estimate the water uses for hydraulic fracturing at Bakken and their impacts on region water resources. We are in the process of developing an agent-based model to better understand the water depot based water allocation system in western North Dakota. From 2008 to 2014, the annual industrial water use for shale oil development in the Bakken ranged from 520 MG (2.0 Mm^3) to 10,200 MG (38.5 Mm^3), approximately 85% of which were consumed in well geo-stimulation (or hydraulic fracturing) process and the remaining were used for drilling, cement mixing and maintenance water of brine dilution. From 2008 to 2014, the annual total industrial water uses for Bakken shale oil development accounted for 0.5% to 10% of state-wide total consumptive water use. The percentage increased from 3.0% to 40% within Bakken oil production region (Dunn, McKenzie, Mountrail, and Williams). The increased population of temporary oilfield service workers contributed additional domestic water use, which was about 15% of annual industrial water use for the shale oil development in the Bakken. On average the freshwater sources for Bakken development were equally split between groundwater sources and surface water sources. Despite in a semi-arid region, the impact of Bakken development on regional water supply was limited because the water in the Bakken was actively managed and the region received on average over 20% more precipitation than normal during 2008-2014. The average annual 7-day low flows in nine small to medium sized streams in the region actually increased since the development. Out of the fifteen glaciofluvial aquifers under study, twelve have seen average water level increasing or unchanged and the average water level for the remaining three aquifers has decreased compared to 2000-2007. We are in the process of modifying the agent-based model which was developed to simulate water depot based water allocation system in western North Dakota.

Umma Rashid: Injectable Nanoparticle-based Permeable Reactive Barriers for Groundwater Contaminant Remediation



A novel polymer was used to coat nanoscale zero-valent iron (NZVI) particles to increase their sticking coefficient in the aquifer materials. Two dimensional (2-D) transport study was done to examine the dispersion and transport of bare and polymer-coated NZVI (CNZVI) in porous media under steady state conditions. The results from the 2-D transport study were used to determine if coated NZVI particles could be the potential candidates for creating injectable permeable reactive barriers (PRBs) in the subsurface; experiments were done at different flow velocities and different aquifer porosities. Nitrate (NO_3^--N) was selected as test contaminants to evaluate bare and coated NZVI particles' removal efficiencies. Shelf-life study was also conducted for the coated NZVI. Many batches of CNZVI were prepared and stored in a cabinet at room temperature. NO_3^--N degradation studies were conducted at predetermined time interval over a 4-month period. Octenyl succinic anhydride (OSA) modified tapioca starch was used to coat NZVI particles to increase their sticking coefficient in the aquifer materials. The polymer has successfully increased the colloidal stability of NZVI in water. After 2 hours 70% of polymer coated NZVI particles remained suspended whereas only 10% of bare NZVI particles remained suspended. The 2-D transport study showed that, even at highest velocity (150 ft/d), the coated NZVI particles did not move in porous media (made of sand) as surface modification has increased the sticking coefficient of NZVI particles in the aquifer material. The nitrate treatability studies showed that, at low concentration (20 mg/L NO_3^- - N) CNZVI exhibited less removal efficiency (71%) compared to the bare NZVI (99%). However, at high concentration (40 mg/L and 60 mg/L of NO_3^- - N) both bare NZVI and CNZVI showed similar removal efficiency (69% for 40 mg/L and 54% for 60 mg/L). The CNZVI particles need to have long shelf-life to be commercially viable (storage and transportability requirements). The shelf-life study showed that the NO_3^- - N degradation rate remained more or less unchanged for 4 months. PRB study showed that bare NZVI removed nitrate until 11 days and after that the removal was zero. After doing mass balance for NZVI and nitrate it was found that only 20.6% of the NZVI was utilized to remove nitrate.

2016 — 2017 NDWRRI Fellowship Research Highlights

Ursinio Puga: Comparative Ultraviolet Disinfection Study for Wastewater Applications for the City of Fargo, North Dakota

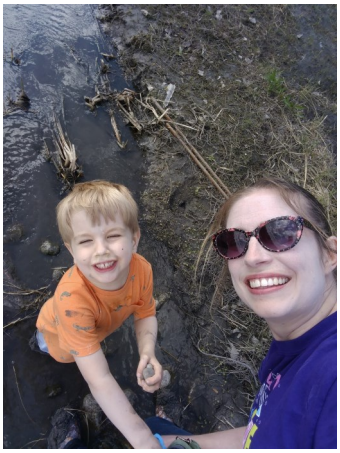
Although UV disinfection is a proven technology, its application in wastewater treatment is relatively new in North Dakota and throughout the Midwest. Additionally, past research indicates that there is a need to develop on-site studies to effectively design a full-scale UV disinfection system for a particular plant depending on its flow and water quality characteristics. The management of the Fargo wastewater treatment plant (WWTP) decided to perform on-site studies to determine the UV disinfection efficiency under different flow conditions, potential seasonal water quality changes, and quartz sleeve fouling prior to start implementing this technology in a full-scale basis. It was decided that the best way to perform on-site studies was through a pilot study. Fargo's WWTP management proposed a 7-month pilot study (April 1st through October 31st 2016) to match the current Fargo's WWTP disinfection season. The pilot was carried out by North Dakota State University researchers with collaboration with the scientists and wastewater experts from the City of Fargo, engineers from Apex Engineering Group, and representatives from UV system manufacturers. The specific objectives of the study are as follows: 1) To evaluate the impact of effluent water quality change on UV Transmittance (UVT); 2) To evaluate the impact of UVT changes on UV disinfection of *Escherichia coli*; 3) To evaluate the fouling tendency of quartz sleeves; and 4) To evaluate the impacts of fouling and flow rate variations on UV disinfection of *E. coli*. Instead of using the commonly accepted first-order kinetic model, a second-order kinetic model was successfully applied to explain the experimental results obtained with the CB apparatus. By using the second-order model we were able to quantify the impact of UVT on *E. coli* inactivation and to properly explain the impact of initial *E. coli* concentration on its inactivation rates. Reduction of UV intensity due to fouling of the quartz sleeves was a major concern during the UV system operation. Results of the pilot system showed that fouling was caused mostly by precipitation of metal salts and the impact of fouling on UV intensity reduction was successfully explained by the application of the Beer-Lambert law. *E. coli* inactivation in the pilot reactor was found to be dependent on influent UVT, flow rate, and UV intensity. The first-order plug flow model was used to interpret the pilot study results. No significant seasonal water quality changes that may affect the UV system operation were identified. However, water quality changes due to storm events could cause short term adverse impact on the UV system performance.

Meet Our Faculty

Dr. Amitava Chatterjee is an Associate Professor in the Department of Soil Science at the North Dakota State University. His research is focused on determining the nutrient availability and losses under different crop rotation, tillage and sub-surface drainage management practices. Besides analyses of soil, water and greenhouse gases, he extensively applies stable-isotope, drone-based remote sensing, and metagenomics tools to determine spatiotemporal shifts in nutrient dynamics.

He teaches undergraduate course in soil fertility. Dr. Chatterjee has published fifty peer-reviewed manuscripts and advised nine master and four doctoral students. He serves as an associate editor of Agronomy Journal. Prior to NDSU, he worked as postdoctoral research associate at the Ohio State University, University of California-Riverside, and Washington State University. Dr. Chatterjee received his doctoral and master degrees in Soil Science from University of Wyoming in 2007 and Konkan Agricultural University in 2002, respectively. He earned his bachelor's degree in Agriculture in 2000 from Visva Bharati University.

Dr. Stephanie Day is an Assistant Professor in the Department of Geosciences at North Dakota State University. She earned her BS from the University of Nebraska Lincoln in 2006 and her PhD from the University of Minnesota in 2012 where she worked with Dr. Karen Gran and Dr. Chris Paola.



Dr. Day's research focuses on the intersection of human and natural systems. She works to understand how people alter their environment and how the environment responds over various timescales. In addition, Dr. Day specializes in using Lidar, aerial photographs, and terrestrial laser scanning to track changing landscapes. Her research results have been published in scientific journals and presented at national and international conferences. Dr. Day's teaching focuses on geographic information system and remote sensing courses.

Dr. Day is a member of the American Geophysical Union, Geological Society of America, Association of Women Geoscientists.

Dr. Taufique Mahmood is an Assistant Professor in the Harold Hamm School of Geology and Geological Engineering (HHGGE) at the University of North Dakota. He holds a Ph.D. in Geological Sciences (Hydrology) from Arizona State University (2012) and an M.S. in Engineering Science from the University of Mississippi (2006). Prior to joining at UND, Taufique was a post-doctoral fellow at the University of Saskatchewan.

His group's research works have been searching the answers of few critical science questions in the cold and continental climate of Northern Great Plain (NGP), Rocky Mountain Range and High Mountain Asia (HMA) using field-based and remotely sensed observations and high-resolution physically-based modeling. My graduate students are currently investigating the mechanisms of hydrologic changes to recent wetting (2002-2018), lake area and wetland dynamics and nutrient export in a terminal lake basin (Devils Lake Basin). He also has research experiences in both agricultural (Northern Great Plain & Canadian Prairies) and mountainous landscapes (New Mexico and Arizona) at scales ranging from hillslope to large watershed. Further, he has dealt with the water and climate issues in the southern Rockies (northern New Mexico) and the Northern Prairies (~excess water system) in his recent publications. Highlights of his other research works include monitoring and assessment of beneficial management practices on agricultural hydrology and water quality, developing a conceptual model for nutrient transport, spatial controls on the watershed and hillslope scale hydrologic responses (northern New Mexico) and geologic mapping from remotely sensed imagery. Dr. Mahmood collaborates with Native American communities across North Dakota and has extensive experience of supervising the Native American graduate students and tribal college students (NATURE summer camps) at UND. Dr. Mahmood teaches Groundwater Monitoring and Remediation, Hydrogeology, Cold Region Hydrologic Modeling, Introduction to Geology and Water Sampling and Analyses courses in the HHGGE.

NDSU Students Volunteer at WEFTEC 2017

On September 30th, 2017, over 220 Water Environment Federation Technology and Exposition Conference (WEFTEC) attendee volunteers helped at the 10th Annual WEF Community Service Project on the grounds of Chicago's Manierre Elementary School. NDSU students who volunteered for the community service project included Ruchi Joshi (past NDWRRI Fellow), Marina Martin (past NDWRRI Fellow), Emily Von Hagen, Emily Fassbender, Heather Yelle, Ricardo Zamora and Kristofer Knutson. The annual WEF community service project was organized by the Water Environment Federation (WEF) Students and Young Professionals Committee (SYPC). The project served as an educational platform for the community to learn about water, environment, and green infrastructure. Volunteers spent the day constructing a bioswale with native plants to control stormwater runoff as well as a permeable outdoor classroom area with an area for stormwater retention underneath. A time lapse of the service project can be accessed at YouTube link.

NDSU student group volunteers at the WEF community service project, Chicago, IL.

NDSU WEFTEC Design Team

NDSU Won 4th Place in Environmental Design Competition at WEFTEC 2017

NDSU student design team presenting at WEFTEC design competition, Chicago, IL

North Dakota State University (NDSU) competed in the Student Design Competition at the 90th Annual Water Environment Federation Technical Exhibition and Conference (WEFTEC) in New Orleans, LA. The 16th annual competition was held on October 1st, 2017 and is open to all universities nationwide. WEFTEC student design competition hosts competitions in following 2 categories: wastewater design (e.g. hydraulics, capacity design, and upgrades to existing systems) and environmental design (e.g. contemporary engineering topics such as sustainability and water reuse).

The NDSU student chapter team, representing the North Dakota Water Environment Association, competed in wastewater design category and won the fourth place out of the 11 teams in that category. The team included Kris Knutson, Emily Von Hagen, Ricardo Zamora and Heather Yelle. The project, 'Bismarck Wastewater Treatment Plant Hydrogen Sulfide Odor and Corrosion Control' presented by the NDSU team was developed as a part of the Environmental Engineering Design (CE 499/696) class coordinated by Dr. Wei Lin (ND WRRI Faculty) in Spring 2017.

The competing teams submit a design report for review by the judges in advance. During the conference, the teams give an oral presentation of their design project followed by a Q & A session with the judges. The project presented by NDSU team was well received by a panel of judges comprising of professional engineers and consultants. The team was awarded fourth place in the competition along with certificates, and a monetary award of $750. The conference also provided opportunities for professional networking through career fairs, a great learning experience through an open exhibition hall, technical sessions and much more.

NDSU AWWA/WEF Student Chapter Team

NDSU Students Won 2017 Environmental Challenge

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NDSU AWWA/WEF Student Chapter Team (from Left to Right): Emily Fassbender, Jamal Ghauri, Josh Hammermeister, and Eric Miller (Judge)

A team of Civil and Environmental Engineering students, representing the NDSU AWWA/WEF Student Chapter, won the Environmental Challenge (EC) at the Conference on the Environment (COE) on November 8, 2017 at the Minneapolis Convention Center in Minneapolis, Minnesota. The NDSU team members are Jamal Ghauri, Josh Hammermeister, and Emily Fassbender. They won the 1st place of the competition and a $1,500 cash award.

The EC, sponsored by the Air & Waste Management Association – Upper Midwest Section (AWMA-UMS) and Central States Water Environment Association (CSWEA)-Minnesota Section, is an undergraduate student team competition to prepare and present an optimal solution to a complex "true-to-life" environmental problem. The EC seeks not only technical and scientific analyses, but solutions that are presented in conjunction with the development of appropriate regulatory approaches and resolutions of political and community issues, which require multidisciplinary approaches for success.

Recent Publications and Presentations by Institute Fellows and PIs

Journal Papers

Lin, Z., Lin, T., Lim, S.H., Hove, M.H., and Schuh, W.M. (2017) Impacts of Bakken Shale Oil Development on Regional Water Resources. *Journal of American Water Resources Association*, **54**(1), pp. 225-239.

Shabani, A., Zhang, X., and Ell, M. (2017) Modeling Water Quantity and Sulfate Concentrations in the Devils Lake Watershed Using Coupled SWAT and CE-QUAL-W2. *Journal of American Water Resources Association*, **53**(4), pp. 748-760.

Shanbhogue, S.S., Bezbaruah, A., Simsek, S., and Khan, E. (2017) Trichloroethene Removal by Separately Encapsulated and Co-encapsulated Bacterial Degraders and Nanoscale Zero-valent Iron. *International Biodeterioration and Biodegradation*, **125**, pp. 269-276.

Sun, J., Khan, E., Simsek, S., Ohm, J.B., and Simsek, H. (2017) Bioavailability of Dissolved Organic Nitrogen (DON) in Wastewaters from Animal Feedlots and Storage Lagoons. *Chemosphere*, **186**, pp. 695-701.

Sun, J. and Simsek, H. (2017) Bioavailability of Wastewater Derived Dissolved Organic Nitrogen to Green Microalgae *Selenastrum capricornutum*, *Chlamydomonas reinhardtii*, and *Chlorella vulgaris* with/without Presence of Bacteria. *Journal of Environmental Science*, **57**, pp. 346-355.

Tahmasebi, N., Zhang, J., and Chu, X. (2017) A New Depression -Dominated Delineation (D-cubed) Method for Improved Watershed Modeling. *Hydrological Processes*, **31**(19), pp. 3364–3378.

Torres, L., Yadav, O., and Khan, E. (2017) Perceived Risks of Produced Water Management and Naturally Occurring Radioactive Material Content in North Dakota. *Journal of Environmental Management*, **196**, pp. 56-62.

Torres, L., Yadav, O., and Khan, E. (2017) Holistic Risk Assessment of Surface Water Contamination due to Pb-210 in Oil Produced Water from the Bakken Shale. *Chemosphere*, **169**, pp. 627-635.

Conference Proceedings

Hong, S., Ratpukdi, T., Sivaguru, J., and Khan, E. (2017) Glutaraldehyde Removal from Produced Waters Using Visible Light Driven Photocatalysis. In Proceeding 90th Annual Water Environment Federation Technical Exposition and Conference, Chicago, IL.

Niaghi, A.R., Jia, X., and Scherer, T.F. (2017) Impact of Accurate Evapotranspiration Estimates on DRAINMOD Simulation in North Dakota. In Proceeding of ASABE Annual International Meeting, Spokane, WA. Paper No. 1701500.

Niaghi, A.R., and Jia, X. (2017) Determination of Grass Evapotranspiration Rates and Crop Coefficients Using Eddy Covariance Method in Eastern North Dakota. In Proceeding of World Environmental and Water Resources Congress, American Society of Civil Engineers, Reston, VA.

Sharma, S., Can, O.T., Hammed, A.M., Nawarathna, D., and Simsek, H. (2017) Organic Pollutant Removal from Edible Oil Process Wastewater Using Electrocoagulation. In Proceeding of the 4th International Conference on Sustainable Agriculture and Environment, Solo City, Indonesia.

Tahmasebi Nasab, M., Grimm, K., Wang, N., and Chu, X. (2017) Scale Analysis for Depression-Dominated Areas: How Does Threshold Resolution Represent a Surface? In Proceeding of World Environmental and Water Resources Congress, American Society of Civil Engineers, Reston, VA, 164-174.

Conference/Seminar Presentations

Acharya U., Chatterjee, A., and Daigh, A.L.M. (2017) Can We Increase Yield with Adopting Tile Drainage in Fargo Clay Soil? 2017 ASA, CSSA, and SSSA International Annual Meetings, October 22-25, 2017, Tampa, Florida. (Poster presentation)

Grimm, K. and Chu,, X. (2017) Modeling of Spatio-temporal Variations in Hydrologic Connectivity and Contributing Areas. ND EPSCoR/IDeA 2017 State Conference, April 12, 2017, Fargo, ND. (Poster presentation)

Hong, S., Ratpukdi, T., Sivaguru, J., and Khan, E. (2017) Glutaraldehyde Removal from Produced Waters Using Visible Light Driven Photocatalysis. The 90th Annual Water Environment Federation Technical Exposition and Conference, September 30-October 4, 2017, Chicago, IL.

Recent Publications and Presentations by Institute Fellows and PIs

Niaghi, A.R., Jia, X., and Scherer, T.F. (2017) Impact of Accurate Evapotranspiration Estimates on DRAINMOD Simulation in North Dakota. ASABE Annual International Meeting, July 16-19, 2017, Spokane, WA.

Niaghi, A.R. and Jia, X. (2017) Determination of Grass Evapotranspiration Rates and Crop Coefficients Using Eddy Covariance Method in Eastern North Dakota. ASCE World Environmental & Water Resources Congress Annual Meeting, May 21-25, 2017, Sacramento, CA.

Phillips, Z.R. and Day, S. (2017) Explaining the Possible Geomorphic Implications of the Spatial Distribution of Meander-cutoffs for the Red River of the North. Geological Society of America Annual Conference, October 22-25, 2017, Seattle WA.

Phillips, Z.R. and Day, S. (2017) Is Your Meandering River Stable? Methods for Determining Controls of Historic River Meandering, 2017 Upper Midwest Stream Restoration Symposium, February 26-March 1, 2017, La Crosse, WI.

Shabani, A. and Zhang, X. (2017) Examining the Impact of Devils Lake Outlet on the Flood Risk of the Sheyenne River. American Geophysical Union Conference, December 11-15, 2017 New Orleans, LA.

Shabani, A. and Zhang, X. (2017) Estimated Water Surface Temperature Using Landsat 8 TIR Bands Using Split Window Algorithm. Great Plains/Rocky Mountains American Association of Geographers Conference, October 13-14, 2017, Grand Forks, ND.

Shabani, A. and Zhang, X. (2017) Estimated Water Surface Temperature Using Landsat 8 TIR Bands Using Split Window Algorithm. NDGIS User Conference, September 19-20, 2017, Bismarck, ND.

Sharma, S., Can, O.T., Hammed, A.M., Nawarathna, D., and Simsek, H. (2017) Organic Pollutant Removal from Edible Oil Process Wastewater Using Electrocoagulation. The 4th International Conference on Sustainable Agriculture and Environment, August 10-12, 2017, Solo City, Indonesia.

Tahmasebi Nasab, M., Grimm, K., Wang, N., and Chu, X. (2017) Scale Analysis for Depression-Dominated Areas: How Does Threshold Resolution Represent a Surface? ASCE World Environmental & Water Resources Congress Annual Meeting, May 21-25, 2017, Sacramento, CA.

Tahmasebi Nasab, M., Chu, X., and Singh, V. (2017) Depressions as Gatekeepers: How Do Depressions Control Hydrologic Modeling? ASCE World Environmental & Water Resources Congress Annual Meeting, May 21-25, 2017, Sacramento, CA.

Tahmasebi Nasab, M., Grimm, K., Wang, N., and Chu, X. (2017) Hydrologic Monitoring and Modeling for Quantifying Prairie Pothole Dynamics. ASCE World Environmental & Water Resources Congress Annual Meeting, May 21-25, 2017, Sacramento, CA.

Tahmasebi Nasab, M. and Chu, X. (2017) A New Physical-Based Gridded Model for Macro-Scale Hydrologic Modeling. ND EPSCoR/IDeA 2017 State Conference, April 12, 2017, Fargo, ND. (Poster presentation)

Van Hoy, D., Mahmood, T.H., and Jeannotte T. (2017) Hydrological Responses to Climate Change in the Mauvais Coulee Basin. ND EPSCoR/IDeA 2017 State Conference, April 12, 2017, Fargo, ND. (Poster presentation)

Van Hoy, D., Mahmood, T.H., Jeannotte T., and Todhunter, P. (2017) Impacts of Recent Climatic Wetting on Distributed Snow and Streamflow Responses in a Terminal Lake Basin. AGU Fall Meeting, New Orleans, LA. (Poster presentation)

Xiao, F. and Bosen, J. (2017) Surface and Subsurface Transport of Perfluoroalkyl Substances in Urban Runoff of a Typical North Dakota City. Society of Environmental Toxicology and Chemistry (SETAC) North America Annual Meeting, November 12-16, 2017, Minneapolis, MN.

Xiao, F., Bosen, J., and Bedane, A. (2017) Bioconversion of Poly-fluoroalkyl Substances in Earthworms. Society of Environmental Toxicology and Chemistry (SETAC) North America Annual Meeting, November 12-16, 2017, Minneapolis, MN.

Institute Publications

Technical Report No: ND17-01
Assessment of Molecularly Imprinted Polymers as Sustainable Phosphate Sorbents
Cody Ritt and Achintya Bezbaruah

Technical Report No: ND17-02
Effect of Glacial Isostatic Adjustment on Rivers and Drainage Basins in the Red River Valley, North Dakota and Minnesota, USA
Benjamin York and Philip J. Gerla

Institute publications can be accessed via the Institute website: http://www.ndsu.edu/wrri

Theses and Dissertations

Shoghli, Bahareh (2017) Modification Methods for Soil and Water Assessment Tool (SWAT) Performance in Simulating Runoff and Sediment of Watersheds in Cold Regions. Ph.D. Dissertation, Department of Civil Engineering, College of Engineering and Mines, University of North Dakota, Grand Forks, ND.

Hong, Soklida (2017) Glutaraldehyde Removal from Produced Water Using Photolysis and Photocatalysis. M.S. Thesis, Environmental and Conservation Sciences Program, College of Graduate and Interdisciplinary Studies, North Dakota State University, Fargo, ND.

Jackson, Courtney (2017) Assessment of Climate Change and Agricultural Land Use Change on Streamflow Input to Devils Lake: A Case Study of the Mauvais Coulee Sub-Basin. M.S. Thesis, Department of Geography and Geographic Information Science, College of Arts and Sciences, University of North Dakota, Grand Forks, ND.

Steinman, Alexis (2017) Assessment of Wetland Water Quality and Plant Species Composition Across the Rural, Peri-Urban, and Urban Gradient. M.S. Thesis, Natural Resources Management Program, College of Agriculture, Food Systems, and Natural Resources, North Dakota State University, Fargo, ND.

Ritt, Cody (2017) Assessment of Molecularly Imprinted Polymers as Sustainable Phosphate Sorbents. M.S. Thesis, Department of Civil and Environmental Engineering, College of Engineering, North Dakota State University, Fargo, ND.

York, Benjamin (2017) Effect of Glacial Isostatic Adjustment on Rivers and Drainage Basins in the Red River Valley, North Dakota and Minnesota, USA. M.S. Thesis, Harold Hamm School of Geology and Geological Engineering, College of Engineering and Mines, University of North Dakota, Grand Forks, ND.

Recent USGS Reports

Runoff and water-quality characteristics of three Discovery Farms in North Dakota, 2008-16
Joel M. Galloway, Rochelle A. Nustad
2017, Scientific Investigations Report 2017-5124
https://doi.org/10.3133/sir20175124

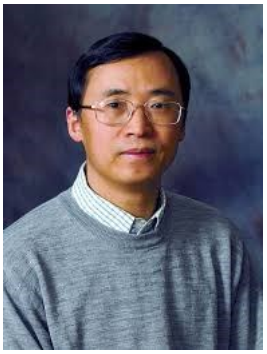
Potential effects of energy development on environmental resources of the Williston Basin in Montana, North Dakota, and South Dakota
Max Post van der Burg, Kevin C. Vining, Jill D. Frankforter, editor(s)
2017, Scientific Investigations Report 2017-5070
https://doi.org/10.3133/sir20175070

Maps and grids of hydrogeologic information created from standardized water-well drillers' records of the glaciated United States
E. Randall Bayless, Leslie D. Arihood, Howard W. Reeves, Benjamin J.S. Sperl, Sharon L. Qi, Valerie E. Stipe, Aubrey R. Bunch
2017, Scientific Investigations Report 2015-5105
https://doi.org/10.3133/sir20155105

Recent ND State Water Commission Publications

The 2017-2019 Strategic Plan
ND State Water Commission
2017
http://www.swc.nd.gov/info_edu/reports_and_publications/strategic_plans/pdfs/2017.pdf

6th NDWRRI Annual Distinguished Water Seminar



The annual 6th Distinguished Water Seminar sponsored by the Institute was held on January 23, 2017. The featured speaker was Dr. Ximing Cai, Colonel Harry F. and Frankie M. Lovell Endowed Professor in the Department of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign. Dr. Cai is a renowned research leader in integrated hydrologic-economic modeling for river basin management and water systems operations. His current research areas include coupled human-natural system analysis with an emphasis of human interferences in hydrological processes, water-energy-food system modeling especially in dry areas, and sustainable water resources management particularly in developing countries. He has authored or co-authored over 130 peer reviewed journal papers, 3 books and several monographs. He currently serves as Editor for Water Resources Research (Am. Geophysical Union, AGU, the flagship journal of water resources) and Editorial Board of other major water journals. He has obtained several awards including U.S. National Science Foundation Career Award and Best Paper Awards with Water International and J. of Water Resources Planning and Management. He has worked as consultant to the World Bank, United Nations and other international agencies. Professor Cai teaches undergraduate and graduate courses in civil engineering systems and engineering economics, environmental and water resources systems analysis, water resources engineering, surface water hydrology, and river basin management. Before joining the faculty of the University of Illinois in 2003, Professor Cai served as a Research Fellow at the International Food Policy Research Institute in Washington, D.C. He holds a B.S. in Water Resources Engineering (1990) and an M.S. in Hydrology and Water Resources (1994) from Tsinghua University, Beijing, and a Ph.D. in Environmental and Water Resources Engineering (1999) from the University of Texas at Austin.

Abstract: Water science has been shifting its focus over the past century to support water governance evolving from engineering development, demand management, water quality protection, and ecosystem restoration to building sustainable water systems. Meanwhile a gradual shift towards a holistic water management approach has already been evident in many countries and regions. The future of the world can be challenged by dramatic environmental change and increasing human population, which may stress the world's water resources at local to global scales and from single sector to multiple sectors (e.g., food-energy-water-environment nexus). In order to handle the complex and complicated water systems problems, technology innovation will be called upon to move us from segmented methods to seamless methods integrating all necessary components to solve real-world water problems, from physical to cyber-physical infrastructural support, and from human domination to human-nature harmony. Water has been playing a growing role to unify nature and humanity, and the target of water science in the 21st century must be ambitious to ensure that humans and our planet co-evolve sustainably. This talk will provide a historical review of water resources research and discuss the pressing research issues and directions for future studies, which call for a paradigm shift to deal with the challenges of sustainable water resources management.

Following the seminar, students and faculty had the opportunity to interact with Dr. Cai.

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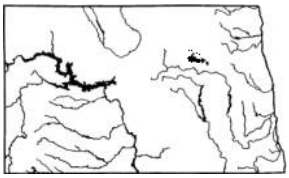

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North Dakota Water Resources Research Institute (NDWRRI)

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.