# 2019
# WESTERN SOUTH DAKOTA HYDROLOGY CONFERENCE

## Program and Abstracts

---

**April 11, 2019**
**Rushmore Plaza Civic Center**
**Rapid City, South Dakota**

**With optional field seminars/trips**
**April 12, 2019**

# TABLE OF CONTENTS

# 2019 Western South Dakota Hydrology Conference

This program and abstracts book has been produced in conjunction with the 2019 Western South Dakota Hydrology Conference (17th annual), held at the Rushmore Plaza Civic Center on April 11, 2019. The purpose of this book is to provide summaries of the presentations made during the meeting.

The purpose of the 2019 Western South Dakota Hydrology Conference is to bring together researchers from Federal, State, University, local government, and private organizations and provide a forum to discuss topics dealing with hydrology in western South Dakota. This meeting provides an opportunity for hydrologists, geologists, engineers, scientists, geographers, students, and other interested individuals to meet and exchange ideas, discuss mutual problems, and summarize results of studies. The meeting consists of four technical sessions, several keynote speakers, the John T. Loucks Distinguished Lecture, and a poster session. The topics of the technical sessions include invited speakers; underground water; water management; water modeling; climate and ecosystems; dams and geomorphology; and hydrology potpourri. This year's conference is also hosting a session held in conjunction with the Great Plains Tribal Water Alliance meeting.

## ACKNOWLEDGMENTS

Many people have contributed to this meeting. The presenters are thanked for their contributions. The moderators are thanked for their help in streamlining the technical sessions, as well as the students and volunteers that helped with presentations and lights. The invited speakers, Tim Cowman, Shannon Minerich, Jaret Heise, and David Montgomery, are thanked for their time and perspectives. Registration help by Misty Mandas and Tony Anable (USGS) is greatly appreciated.

The organizing agencies are thanked for support: National Weather Service, RESPEC, South Dakota Department of Environment and Natural Resources, South Dakota School of Mines and Technology, U.S. Geological Survey, and West Dakota Water Development District. The West Dakota Water Development District is thanked for sponsoring the John T. Loucks Distinguished Lecture. RESPEC is thanked for being the Executive Sponsor. The many vendors are thanked for their support of the conference. HDR Engineering and Mid Continent Testing Labs is thanked for sponsoring the breaks. The chairpersons for this meeting were Melissa Smith (National Weather Service), Lacy Pomarleau (RESPEC), Joanne Noyes (South Dakota Department of Environment and Natural Resources), Scott Kenner (South Dakota School of Mines and Technology), Liangping Li (South Dakota School of Mines and Technology), J. Foster Sawyer (South Dakota School of Mines and Technology), Daniel Soeder (South Dakota School of Mines and Technology), Galen Hoogestraat (U.S. Geological Survey), Joyce Williamson (U.S. Geological Survey), and Janet Carter (U.S. Geological Survey).

# PROUD SPONSOR OF THE 2019 WESTERN SOUTH DAKOTA HYDROLOGY CONFERENCE

## VISIT US AT OUR BOOTH!

## BY THE NUMBERS...

**1969**
RESPEC WAS FOUNDED BY 5 SDSM&T PROFESSORS IN 1969

**300+**
OVER 300 EMPLOYEES IN OVER 20 OFFICES IN THE US AND CANADA

**$40M**
IN ANNUAL REVENUE

**100%**
EMPLOYEE OWNED

## WATER AND ENVIRONMENT SOLUTIONS

// Agricultural Water Management
// Flood Control & Management
// Geospatial Software & Analysis
// Groundwater Modeling & Analysis
// Integrated Watershed Planning & Management
// Lake, River, & Stream Restoration
// Water Quality Assessment
// Water Rights & Supply
// Wetland Delineation, Design, & Monitoring
// Mine Reclamation
// Transportation Drainage
// Urban Stormwater

## RESPEC CONFERENCE PRESENTATIONS

**10:50-11:10 A.M.**
The RESPEC Irrigation Management Assistant (IMA)
*Presented by Koby Dobler and Jared Oswald*

**1:30-1:50 P.M.**
The Big-Sioux River Flood Information System
*Presented by Jason Love, Seth Kenner, and Peter Rausch*

**RESPEC.COM**

# 2019 WESTERN SOUTH DAKOTA HYDROLOGY CONFERENCE PROGRAM

| | | |
|---|---|---|
| **7:00 – 8:00 a.m.** | **REGISTRATION** | |
| **8:00 – 10:00 a.m.** | **Plenary Session 1 in Alpine and Ponderosa Rooms – Invited Speakers (2.0 PDH)**<br>**Moderator – Joyce Williamson**, U.S. Geological Survey | |
| 8:00 – 8:10 a.m. | Welcome and general announcements | **Joyce Williamson**, U.S. Geological Survey |
| 8:10 – 8:50 a.m. | Impacts of Sedimentation on Missouri River Reservoirs and Free-Flowing Segments | **Tim Cowman,** State Geologist, SD DENR Geological Survey |
| 8:50 – 9:20 a.m. | An Overview of South Dakota's Integrated Report | **Shannon Minerich**, SD DENR Surface Water Quality program |
| 9:20 – 10:00 a.m. | Opportunities at the Sanford Underground Research Facility | **Jaret Heise,** Sanford Underground Research Facility |
| **10:00 – 10:30 a.m.** | **REFRESHMENT BREAK in Rushmore G – Sponsored by HDR Engineering** | |
| **10:30 a.m.–12:00 p.m.** | **Concurrent Session 2A in Alpine Room – Underground Water (1.5 PDH)**<br>**Moderator – Foster Sawyer**, SDSMT | **Concurrent Session 2P in Ponderosa Room – Water Management (1.5 PDH)**<br>**Moderator – Greg Delzer**, USGS |
| 10:30 – 10:50 a.m. | Dewatering and Water Quality at Sanford Laboratory – **Bryce Pietzyk** Underground Infrastructure Director (Sanford Laboratory) and **John Scheetz**, Environmental Manager (Sanford Laboratory) | Development of the West Dakota Water Development District's Future Use Permit for Water from the Missouri River – **Kurt Katzenstein, Scott Kenner, Arden Davis, Mark Anderson, Regan Wess, Haley Noteboom,** and **Kaleb Hedman,** South Dakota School of Mines & Technology |
| 10:50 – 11:10 a.m. | Fracking and Stray Gas in Groundwater: It's Complicated – **Daniel Soeder**, Energy Resources Initiative, South Dakota School of Mines & Technology | The RESPEC Irrigation Management Assistant (IMA): a web-based, mobile-friendly, irrigation-scheduling application that reduces the environmental impact of irrigation while reaping multiple benefits – **Koby Dobler** and **Jared Oswald**, RESPEC |
| 11:10 – 11:30 a.m. | Aquifer Testing Results for a Well Completed in the Madison Aquifer near Hot Springs, SD – **Mitch Kannenberg** and **Mike Plante**, WSP USA, Inc. | A Decision Support Tool to Support Rangeland and Riparian Health Management in the Little Missouri Headwaters – **Corissa Busse**, The Nature Conservancy |
| 11:30 – 12:00 p.m. | Applying a Jewel Cave model of Speleogenesis to Wind Cave – **Michael Wiles**, Jewel Cave National Monument | Conservation of Irrigation Water Through the Use of Compost as A Soil Amendment – **Jerry Wright**, South Dakota School of Mines and Technology |
| **12:00 – 1:30 p.m.** | **LUNCH in Rushmore F Room (1.0 PDH) –** with accompanying presentations<br>**John T. Loucks Distinguished Lecture** –<br>"Growing a Revolution: Bringing Our Soil Back to Life" by **David Montgomery**, University of Washington | |

| **1:30 – 3:10 p.m.** | **Concurrent Session 3A in Alpine Room – Water Modeling (1.5 PDH)**<br>**Moderator – Scott Kenner**, SDSMT | **Concurrent Session 3P in Ponderosa Room – Climate and Ecosystems (1.5 PDH)**<br>**Moderator – Melissa Smith**, National Weather Service | **Concurrent Session 3H in Rushmore H Room – Great Plains Tribal Water Alliance meeting (1.5 PDH)**<br>**Moderator – Doug Crow Ghost**, SRST |
|---|---|---|---|
| 1:30 – 1:50 p.m. | The Big Sioux River Flood Information System: A one-stop web platform to access real-time stream conditions, flood forecasts, visualizations, inundation maps and flood-related data – **Jason Love**, **Seth Kenner**, and **Peter Rausch**, RESPEC | Integrated Watershed Management in the Kootenai River, Montana: A fisheries and food web perspective – **Lisa Kunza** and **Kurt Chowanski**, South Dakota School of Mines & Technology | Session introduction: Climate Adaptation in Native American Communities – **Doug Crow Ghost**, Standing Rock Sioux Tribe |
| 1:50 – 2:10 p.m. | | Impacts of 21st Century Climate Change on Great Plains Extreme Events, Agriculture and other Climate-Related Hazards – **Bill Capehart** and **Heidi Sieverding**, South Dakota School of Mines & Technology | Climate Impacts to Native American Lands – **Imtiaz Rangwala**, Climate Science Lead, North Central Climate Adaptation Science Center (NCCASC) |
| 2:10 – 2:30 p.m. | Deerfield, Pactola and Rapid Creek Systems Analysis Modeling – **Rosemary Squillace, David Waterman, and Scott Kenner**, South Dakota School of Mines & Technology | An Investigation into Anomalously Wet and Dry Years across Western South Dakota – **Keith Sherburn**, National Weather Service | |
| 2:30 – 2:50 p.m. | Water-Balance Modeling of Selected Lakes for Evaluating Viability as Long-Term Fisheries in Kidder, Logan, and Stutsman Counties, North Dakota – **Bob Lundgren**, U.S. Geological Survey | Evaluation of USGS LCMAP Data Products to Assess Forest Condition in Western South Dakota – **Patrick Kozak**, **Heidi Sieverding**, and **James Stone**, South Dakota School of Mines & Technology | Opportunities and Actions for Climate Adaptation – **Stefan Tangen**, GPTWA and NCCASC, **Logan Gayton**, GPTWA/Louis Berger Intern, and **Chance Knutson**, GPTWA/Louis Berger Intern |
| 2:50 – 3:10 p.m. | Well Placement Design Using Extremal Optimization for Aberdeen, SD – **Fleford Redoloza** and **Liangping Li**, South Dakota School of Mines & Technology | Tree Cover and Topography Affect River Ecosystem Metabolism in the Black Hills, South Dakota – **Kurt Chowanski** and **Lisa Kunza**, South Dakota School of Mines & Technology | |
| **3:10–3:30 p.m.** | **REFRESHMENT BREAK in Rushmore G – Sponsored by Mid Continent Testing Labs** | | |
| **3:30 – 5:00 p.m.** | **Concurrent Session 4A in Alpine Room – Hydrology Potpourri (1.5 PDH)**<br>**Moderator – Daniel Soeder,**<br>Energy Resources Initiative, SDSMT | **Concurrent Session 4P in Ponderosa Room – Dams and Geomorphology (1.5 PDH)**<br>**Moderator – Joanne Noyes**, SD DENR | **Concurrent Session 4H in Rushmore H Room – Great Plains Tribal Water Alliance meeting (1.5 PDH)**<br>**Moderator – Doug Crow Ghost**, SRST |
| 3:30 – 3:50 p.m. | Nutrients, Pesticides, and Selenium in Agricultural Tile Discharges into Public Wetlands, Madison Wetland Management District, South Dakota – **Matt Schwarz**, U.S. Fish and Wildlife Service | Evaluating Geomorphic Characteristics of Remotely Classified River Systems in the US Great Basin – **John Costello** and **Scott Kenner**, South Dakota School of Mines & Technology | Drought Adaptation Planning – **James Rattling Leaf, Sr**., Co-PI for the NCCASC Program and **Syed Huq**, Director, Water Resources for Rosebud Sioux Tribe |
| 3:50 – 4:10 p.m. | Aquaponics: A Water Resources Project<br>**Kelsey Murray**, Environmental Engineering Program Director, Western Dakota Tech | Geology of Dam Spillways – **Perry Rahn,** Department of Geology & Geological Engineering, South Dakota School of Mines & Technology | Climate Adaptation Workshop – **Stefan Tangen**, GPTWA and NCCASC, **James Rattling Leaf, Sr**., Co-PI for the NCCASC Program, and **Imtiaz Rangwala**, Climate Science Lead, NCCASC |
| 4:10 – 4:30 p.m. | Using Green Stormwater Infrastructure to Create Urban Biodiversity Corridors – **Heidi Sieverding, Andrea Vargas Castano,** and **James Stone,** SDSMT, **Henning Nottebrock and Charles Fenster**, South Dakota State University | Emergency Response Monitoring for Oroville Spillway – **Kayla Ranney, Jaime Lubeck, and Daniel Osmun**, HDR, and **Olivia Virgadamo**, California Department of Water Resources | |
| 4:30 – 4:50 p.m. | Site-scale integrated Decision Support Tool (i-DST) for Stormwater Management – **Ali Shojaeizadeh** and **Mengistu Geza**, South Dakota School of Mines and Technology | Little Missouri River Initiatve: Cooperative streamflow and water chemistry data collection between the North and South Units of Theodore Roosevelt National Park – **Bryce Klasen,** North Dakota State Water Commission | |
| **4:50 – 5:00 p.m.** | Poster session lightning talks – 1 minute for each poster presenter – in **Alpine Room** | | |

| | |
|---|---|
| **5:00 – 6:30 p.m.** | **EVENING SOCIAL and POSTER SESSION (with complimentary refreshments) in Rushmore G**<br>**Sponsored by Energy Laboratories**<br>**POSTER CONTEST WINNERS ANNOUNCED AT 6:00 PM** |
| | Removal of Heavy Metals from Urban Stormwater using Biochar and Nanoscale Zerovalent Iron Modified Biochar – **Md Sazadul Hasan**, **Mengistu Geza**, and **Raul Vasquez**, South Dakota School of Mines & Technology |
| | Potential Influence of Climate Change on Stream Temperature in Regulated and Unregulated Streams in the Black Hills – **Lucas Graunke, Lisa Kunza** and **William Capehart**, South Dakota School of Mines & Technology |
| | Sensitivity Analysis of Frequency Storm Parameters in HEC-HMS – **Angelinah Rasoeu** and **Suzette Burckhard**, South Dakota State University |
| | Aqua 3.0 – **Gabe Maruani, Cody Runge, Cameron Ault, Bryan Mitchell, and Kelsey Murray**, Western Dakota Tech |
| | Hydrological Models for Rainfall-Runoff in Arid Regions: A Literature Review – **Ali Alsubeai** and **Suzette Burckhard**, South Dakota State University |
| | Characterizing Rangeland Salinization in Northwest South Dakota – **Patrick Kozak, Lisa Kunza, Kurt Chowanski,** and **Dan Heglund**, South Dakota School of Mines & Technology |
| | Investigation into Needs and Future Use of Missouri River Water for Western Pennington County, South Dakota – **Kaleb Hedman, Haley Noteboom**, and **Regan Wess**, South Dakota School of Mines and Technology |
| | ParFlow Model of Pine Ridge Reservation in South Dakota – **Lilly Jones**, South Dakota School of Mines and Technology |
| | Estimation of Best Treatment Conditions of Sugarbeet Wastewater Treatment using Response Surface Methodology – **Swati Sharma** and **Halis Simsek**, North Dakota State University |
| | White Clay Creek Rehabilitation Assessment – **Chance Knutson, Michael Mansfield,** and **Sophie Brogdon**, South Dakota School of Mines and Technology |
| | Electrochemical Impedance Spectroscopy as a tool for Monitoring the Microbial Contaminants – **Navanietha Krishnaraj Rathinam**, **David Salem,** and **Rajesh K. Sani**, BuG ReMeDEE consortium and South Dakota School of Mines and Technology |

## Optional Field Seminars/Trips – Friday, April 12, 2019
## (PRE-REGISTRATION REQUIRED)

| Times | Field Seminar/Trip |
|---|---|
| 8:00 a.m. – 4:00 p.m. | **Geology and Hydrology of the Northern Black Hills.** The field trip will discuss the sequence of Precambrian to Cretaceous age formations and major aquifer units in the northern Black Hills. Stops will be made at significant exposures of sedimentary, igneous and metamorphic rocks as time allows. (6.0 PDH) |
| 8:00 – 11:00 a.m | **The Past, Present, and Future: Progress Towards Better Stormwater Management in Rapid City.** Field trip highlighting the changes in Rapid City stormwater management over the last century from older conveyance and end-of-pipe solutions to modern multifunctional and upgradient solutions. (3.0 PDH) |
| 9:00 – 11:00 a.m. | **Overview and Details of Pactola Dam.** The field trip will discuss this U.S. Bureau of Reclamation facility that is operated and maintained by the City of Rapid City. The dam is located in a complex series of metamorphic rocks, it was constructed in 1952-56, and modified in 1987. (2.0 PDH) |

**THURSDAY, APRIL 11, 2019**
**SESSION 1**
**8:00 – 10:00 A.M.**

## INVITED SPEAKERS
**(ALPINE/PONDEROSA ROOMS)**

# IMPACTS OF SEDIMENTATION ON MISSOURI RIVER RESERVOIRS AND FREE-FLOWING SEGMENTS

**Tim Cowman**
South Dakota Department of Environment and Natural Resources
Geological Survey Program
tim.cowman@usd.edu

The introduction of dams and reservoirs on the main stem Missouri River in the mid-nineteenth century has resulted in large amounts of sediment deposition in the reservoirs. The Lake Sharpe, Lake Francis Case, and Lewis and Clark Lake reservoirs have all been impacted by sediment accumulation. The headwaters area of Lewis and Clark Lake has been described as the “poster child” for sedimentation issues on large rivers of the United States. Resources that are currently being impacted or may be impacted in the future by sediment accumulation include infrastructure, such as roads and bridges, recreation areas, flow regulation, water supply intakes, hydropower generation, and reservoir storage capacity.

Free-flowing segments of the river downstream of dams are also impacted. As most of the sediment is captured in the reservoirs, the free-flowing river strives to regain its sediment balance through bed and bank erosion. The erosion impacts can be seen at distances of tens of miles downstream from the dams. Near Yankton, South Dakota, bed erosion has exceeded 11 feet since Gavins Point Dam was closed off in 1955. Near Vermillion, South Dakota, some 30 miles downstream from Gavins Point Dam, bed erosion has lowered water tables and resulted in disappearing wetlands and backwaters on the floodplain adjacent to the river.

Sediment management on the Missouri River is vital to sustaining the resources of this large river system. Attempts are being made on a local level to reduce sediment inflow to the river. Larger regional efforts are being evaluated by both government and non-government organizations to make a significant reduction in the sedimentation problem on the Missouri River.

## AN OVERVIEW OF SOUTH DAKOTA'S INTEGRATED REPORT

**Shannon Minerich**
South Dakota Department of Environment and Natural Resources
Surface Water Quality Program
Shannon.Minerich@state.sd.us

South Dakota DENR prepares a biennial report called the Integrated Report. This report is required under Sections 303(d) and 305(b) of the Clean Water Act. The report identifies waters that are not meeting water quality standards for their designated beneficial uses and serves as the driver in TMDL development. This presentation will discuss the background of the Integrated Report, data collection and assessment, limitations and complications, and data information repositories.

## OPPORTUNITIES AT THE SANFORD UNDERGROUND RESEARCH FACILITY

**Jaret Heise**
Sanford Underground Research Facility
jheise@sanfordlab.org

Building on rich legacies in both mining and transformational science, the Sanford Underground Research Facility (SURF) has been operating for over 10 years as the nation's underground laboratory to advance compelling multidisciplinary research. A brief overview of the facility and the science program will be presented. SURF's unique characteristics present a number of scientific opportunities, and applications from new experiments and groups are welcome.

**THURSDAY, APRIL 11, 2019**
**SESSION 2A**
**10:30 A.M. – 12:00 P.M.**

**UNDERGROUND WATER**
**(ALPINE ROOM)**

# DEWATERING AND WATER QUALITY AT SANFORD LABORATORY- AN UPDATE

**Bryce Pietzyk**
Underground Infrastructure Director (Sanford Laboratory)
bpietzyk@sanfordlab.org

**John Scheetz**
Environmental Manager (Sanford Laboratory)
jscheetz@sanfordlab.org

The Sanford Underground Research Facility (formerly the Homestake Mine) hosts various science experiments deep underground. Data indicates that an average of 690-750 gpm of water flows into the underground openings from various surface and underground sources. This water typically finds its way to a saturated water level, or pool. This pool level is currently 5603 feet below the surface and 753-feet below the 4850-foot level, which is the deepest active science level. Inflowing groundwater is intercepted and pumped to the surface or diverted to the pool. The goal is to avoid having water inflows impact people and science.

Intercepted water is typically cooler and contains less contaminates than water from the pool due to less interaction with the warm wall-rock. The intercepted water works in concert with the mixing of cool water from the Grizzly Gulch Tailing damn to facilitate water discharge and meet cold water stream standards. Water temperature and total dissolved solids are managed by process controls whereas the removal of ammonia, arsenic, and total suspended solids are accomplished through waste water treatment that includes filtering and biological removal of ammonia. The water treatment process continues to meet all permit requirements and stream standards, revealing that the dewatering of the underground is not adversely impacting surface waters.

# FRACKING AND STRAY GAS IN GROUNDWATER: IT'S COMPLICATED

**Daniel J. Soeder**
Energy Resources Initiative, South Dakota School of Mines & Technology
dan.soeder@sdsmt.edu

Hydraulic fracturing is required for the production of shale gas and tight oil, which have become major new reserves of fossil energy in North America. Although fracking was invented in 1947 and is not new, the large-scale application of this technology has raised questions about potential impacts to the environment. The National Ground Water Association has identified two primary risks to shallow drinking water aquifers: 1) stray gas that appears to be associated with shale wells, and 2) chemical contamination from surface spills. Although stray methane gas in groundwater is non-toxic to humans, it poses an explosion hazard in confined spaces.

Stray gas has been statistically linked to shale gas wells, but without explanations as to why it may be associated more frequently with shale wells than conventional wells. Few laboratory and field investigations of stray gas origins and migration have been done. A methane injection test at the Borden site in Ontario in 2017 found that the movement of stray gas through aquifers is complex. Despite the extensive characterization of the Borden aquifer from decades of field studies, and detailed predictions of gas migration paths from numerical models, during the actual injection the methane did not go where expected, and it persisted in the aquifer much longer than anticipated. The Canadian study concluded that controls on stray gas migration in aquifers are subtle and complicated.

Stray gas can have both biologic and geologic origins. A methane detector modified for field use is undergoing testing to monitor stray gas in the headspace of a drinking water well near an active gas field in Harding County, SD. Results are expected to help establish baselines and show possible impacts. Understanding background levels in aquifers is a critical first step to assessing the potential inputs of stray gas to groundwater from gas wells.

# AQUIFER TESTING RESULTS FOR A WELL COMPLETED IN THE MADISON AQUIFER NEAR HOT SPRINGS, SD

**Mitch Kannenberg**
Project Manager, WSP USA Inc.
Mitch.Kannenberg@wsp.com

**Mike Plante**
Hydrogeologist, WSP USA Inc.
Mike.Plante@wsp.com

Aquifer testing was conducted to determine aquifer characteristics of the Madison aquifer at a well owned by the Southern Black Hills Water System (Casey well). The Madison aquifer is a karst aquifer formed within the Madison (Pahasapa) Limestone.

The step-rate test was conducted in the Fall of 2016, at rates of 100 gallons per minute (gpm), 150 gpm, and 270 gpm. Water levels were monitored in the Casey well (pumping well) and in two observation wells located approximately 2,800 feet and 12,300 feet from the pumping well. The maximum drawdown measured during the step-rate test was 2.82 ft. No change in the water levels in the two observation wells attributable to the Casey well pumping was measured.

In July 2017, SBHWS installed a Madison aquifer observation well (MW-1) 129 feet west of the Casey well. A constant-rate test was conducted in October 2017 at the rate of 267 gpm for 95 hours. Water levels were monitored in four wells (including the Casey well) and in a flooded passageway of Wind Cave called Calcite Lake. The maximum drawdown measured in the Casey well was 2.4 feet, which corresponds to a specific capacity of approximately 111 gpm/ft.

Drawdown directly attributable to pumping from the Casey well was only observed in the Casey well. The water levels in all four wells were influenced by changes in barometric pressure, as were the water levels in Calcite Lake.

Based on the results of the aquifer testing, the transmissivity of the Madison aquifer at the Casey well is estimated to range from approximately 30,000 feet squared per day (ft2/day) to nearly 100,000 ft2/day. The presentation will include the results of the aquifer testing and a description of the site hydrogeologic conceptual model.

# APPLYING A JEWEL CAVE MODEL OF SPELEOGENESIS TO WIND CAVE

**Michael E. Wiles**
Jewel Cave National Monument
mike_wiles@nps.gov

Jewel Cave has over 200 miles (322 km) of mapped passages and Wind Cave has more than 149 miles (240 km). They are the third- and sixth-longest caves in the world, respectively. Previous work shows an intimate relationship between Jewel Cave and the present-day geologic structure, contacts, topography, and broader landscape features. This presentation documents the same relationships existing at Wind Cave.

Both caves are located almost exclusively beneath the present-day Minnelusa cap, and are within 250 feet of the top of the Pahasapa limestone. The limestone at Wind Cave is thinner and represents a compressed stratigraphic section; so cave passages extend into dolomitic sandstone that comprises the base of the Pahasapa. At each location, cave passages are distributed on either side of a prominent canyon, located in the bottom of a plunging syncline.

Over 15,000 orthoquartzite clasts have been mapped across the western and southern flanks of the Black Hills. They cross-cut sedimentary rocks from the Deadwood Sandstone through the upper Lakota Formation, and are found above and inside both caves. Based on observations at Jewel Cave, the clasts appear to have been deposited on a planar erosional surface prior to an uplift occurring less than 15 Ma, and before the dissolution of cave passages. Minnelusa fill material began entering the caves at that time. At Wind Cave, this “neofill” also contains minerals derived from the Precambrian core, an indication that it was already exposed prior to cave development.

As different as the two caves appear, both seem to have formed at the same time by essentially the same processes. The variations are mostly the result of the different elevation and thickness of the Pahasapa, degree of folding, and the presence of exposed Precambrian rocks in the Wind Cave drainage area. Both caves are geologically recent in origin.

**THURSDAY, APRIL 11, 2019**
**SESSION 2P**
**10:30 A.M. – 12:00 P.M.**

**WATER MANAGEMENT**
**(PONDEROSA ROOM)**

# DEVELOPMENT OF THE WEST DAKOTA WATER DEVELOPMENT DISTRICT'S FUTURE USE PERMIT FOR WATER FROM THE MISSOURI RIVER

**Kurt W. Katzenstein**
South Dakota School of Mines and Technology
kurt.katzenstein@sdsmt.edu

**Scott J. Kenner**
**Arden D. Davis**
**Mark T. Anderson**
**Regan Wess**
**Haley Noteboom**
**Kaleb Hedman**
South Dakota School of Mines and Technology

This project examines potential uses and requirements for retention of the West Dakota Water Development District's allotment of Missouri River water designated by Future Use Water Permit No. 1443-2. The permit is reviewed by the South Dakota Water Management Board every seven years to determine whether a reasonable need exists for the reserved water. Under this future use permit, which was issued in 1976, a total of 10,000 acre-feet per year of water remains in reserve. The research will examine questions pertaining to potential uses, transport of the water, commitments, and related factors. The goals are: 1) To develop a clear understanding of current and projected water demands for Pennington County and the eastern Black Hills near Rapid City, 2) Documentation of current water supplies, including surface water and groundwater sources, and 3) Development of options for use of Missouri River water rights, including transmission through piping networks, alignment of pipeline routes, collaboration with other entities, storage, treatment, pumping stations, and associated costs.

# THE RESPEC IRRIGATION MANAGEMENT ASSISTANT (IMA): A WEB-BASED, MOBILE-FRIENDLY, IRRIGATION-SCHEDULING APPLICATION THAT REDUCES THE ENVIRONMENTAL IMPACT OF IRRIGATION WHILE REAPING MULTIPLE BENEFITS.

**Koby L. Dobler**
RESPEC
Koby.Dobler@respec.com

**Jared K. Oswald**
RESPEC
Jared.Oswald@respec.com

Across the American agricultural landscape, groundwater use is approaching or already exceeds sustainable levels in many areas. One of these areas is Little Rock Creek in Benton and Morrison Counties in Minnesota. The state has determined that this cold-water trout stream is impaired because of decreased stream flows and the resulting increase in temperature, low dissolved oxygen levels, and high levels of nitrates. A Total Maximum Daily Load study determined that the impairment is primarily caused by increased groundwater use, partly from crop irrigation.

One solution to the problem lies in better management of agricultural irrigation. RESPEC's Irrigation Management Assistant (IMA) is a web-based, mobile-friendly, irrigation-scheduling application that automates agricultural irrigation scheduling. IMA provides producers with recommendations for irrigation timing and volumes on a daily basis while providing the status of the impaired resource throughout the growing season.

IMA can extract external data such as the National Centers for Environmental Prediction Stage IV rainfall data by using the National Oceanic and Atmospheric Administration's Weather Climate Toolkit. Real-time weather and stream-monitoring data are also imported into IMA, as well as groundwater and soil-moisture sensor data. The use of IMA demonstrates that producers can reduce the environmental impact of irrigation while reaping multiple benefits (such as increased yield and reduced irrigation input costs) by using proven conservation practices and making calculated decisions on when and how much to irrigate based on individualized field factors.

# A DECISION SUPPORT TOOL TO SUPPORT RANGELAND AND RIPARIAN HEALTH MANAGEMENT IN THE LITTLE MISSOURI HEADWATERS

**Corissa Busse**
The Nature Conservancy
corissa.busse@tnc.org

Riparian areas are among the most critical habitats within the Northern Great Plains, providing essential habitat for a wide range of grassland birds and wildlife. Riparian areas are also essential for the success of ranchers that depend on them for water and forage for livestock, especially during dry periods. The Nature Conservancy has convened partners and experts working within the landscape of the Little Missouri and adjacent headwaters to provide input on conservation and restoration needs and priorities. We compiled spatial data and information regarding landscape characteristics and condition; conducted analysis and modeling designed to inform collaborative management; and developed an online web mapping tool intended to assist partners in targeting conservation measures to provide the most benefit utilizing limited resources. This presentation will describe the development of the tool and demonstrate potential uses for collaborative conservation planning. The tool is free and available to the public for use.

# CONSERVATION OF IRRIGATION WATER THROUGH THE USE OF COMPOST AS A SOIL AMENDMENT

**Jerry Wright**
South Dakota School of Mines and Technology
jerome.wright@mines.sdsmt.edu

Conservation of irrigation water is a vital avenue to better management of water resources as 37% of the total water used in the United States is for irrigation. Organic matter increases soil porosity, infiltration, and water availability. If the soil is able to absorb needed water and retain it better, the demands for additional irrigation application will be reduced, resulting in significant water conservation. In this research project the fields were located on a one-acre plot, with both the control field and the field receiving compost being the same size. The design was to simulate a large production field versus a small research plot. The large test fields were important in simulating real conditions. All other factors, amount of machinery work conducted, seed and fertilizer application rates, weather exposure and wind direction created standardization between plots with and without compost. Volume of water applied by rainfall and irrigation was recorded in detail and compared to soil water content. All conditions, with the exception of compost applied, were held the same. Therefore, a valid comparison will be available to determine if water can be conserved by amending irrigated soils with compost. Analysis of the water content, water applied, amendment differences, with other conditions kept the same, provided the basis of analysis. The project monitored water content differences in three soil structures with varying amounts of organic matter. The modeling software Hydrus was utilized to evaluate its potential in estimating water needs and potential of saving water when organics are increased in an irrigated soil. The organic content of the test soils was the compost produced by the City of Rapid City at their solid waste facility. Hydrus software was used to model water flow in soils with results compared to actual results from with soils that have compost amendment and soils that have not been amended with compost. Evaluation of the value of water to a community was conducted to determine the feasibility of municipal or regional water utility financial support for compost incorporation into agricultural operations that are irrigated. The increased use of compost, providing significant potential for water savings in irrigated fields, provides a significant and beneficial use for the compost produced from solid waste. Use of compost provides a utilization that makes composting an extremely beneficial tool in reducing solid waste being buried in a landfill.

**THURSDAY, APRIL 11, 2019**
**LUNCHEON**
**12:00 – 1:30 P.M.**

## JOHN T. LOUCKS DISTINGUISHED LECTURE:
## DAVID R. MONTGOMERY
## UNIVERSITY OF WASHINGTON
**"GROWING A REVOLUTION: BRINGING OUR SOIL BACK TO LIFE"**
**(RUSHMORE F ROOM)**

**THURSDAY, APRIL 11, 2019**
**SESSION 3A**
**1:30 – 3:10 P.M.**

**WATER MODELING**
**(ALPINE ROOM)**

# THE BIG SIOUX RIVER FLOOD INFORMATION SYSTEM: A ONE-STOP WEB PLATFORM TO ACCESS REAL-TIME STREAM CONDITIONS, OD FORECASTS, VISUALIZATIONS, INUNDATION MAPS AND FLOOD-RELATED DATA

**Jason T. Love**
RESPEC
Jason.love@respec.com

**Seth J. Kenner**
RESPEC
Seth.Kenner@respec.com

**Peter P. Rausch**
RESPEC
Peter.rausch@respec.com

**Tim Cowman**
SDDENR/SDGS
Tim.Cowman@usd.edu

The Big Sioux River Basin in eastern South Dakota has experienced repeated flooding in recent years. In 2014, a major flood in the lower basin revealed shortcomings in understanding and predicting flood-event behavior. Available data and modeling at the time were not adequate for enabling state and local authorities to respond appropriately to the imminent flood event. Thankfully, the response to the 2014 event was overly conservative rather than inadequate, but the need for a comprehensive flood-mapping system and predictive model was realized. The State of South Dakota commissioned the development of the Big Sioux River Flood Information System in 2016.

The Big Sioux River Flood Information System is a two-part web platform. The first part is a public site with access to observed and forecasted stream conditions at over 50 locations throughout the Big Sioux River Basin and a library of 8,500 inundation maps that represent possible flood scenarios for five different communities. The second part is a site reserved for state and community officials and includes access to real-time flood inundation forecasts. The system's core is a basin-wide hydrologic model (HSPF) that is continuously fed with observed and forecasted meteorological data. When flood events are predicted, the hydrologic output is run through flood inundation models (HEC-RAS 5) for the five communities, then predicted inundation maps are loaded to the web platform. The Big Sioux River Flood Information System provides the public with an understanding of potential flood risks and gives Flood Response Teams accurate information that is needed to make appropriate decisions during flood events.

# DEERFIELD, PACTOLA AND RAPID CREEK SYSTEMS ANALYSIS MODELING

**Rosemary C. Squillace**
South Dakota School of Mines and Technology
rosemary.squillace@mines.sdsmt.edu

**David M. Waterman**
david.waterman@sdsmt.edu
South Dakota School of Mines and Technology

**Scott J. Kenner**
South Dakota School of Mines and Technology
scott.kenner@sdsmt.edu

The Rapid Creek water system consists of Rapid Creek and the Deerfield and Pactola reservoirs. The two reservoirs typically operate together in order to meet demands within the Rapid Creek Basin which includes Rapid City, Ellsworth Air Force Base, and Rapid Valley irrigation demands. Shifting of some irrigation water rights to Rapid City, growth of Rapid City and Pennington County, and significant climate variability make management of the Rapid Creek water system critical to current and future sustainability for the multiple water uses in the Rapid Creek basin. The current project aims to develop two advanced system models which will represent the Rapid Creek water system as a contiguous system from Deerfield to Pactola and down through the Rapid Valley user district to quantify functionality provided by the system. The two models that are being utilized are HEC-ResSim and HEC-ResPRM which were developed by the U.S. Army Corps of Engineers and are designed to be operated in tandem. This presentation will demonstrate the modeling platform along with the current representation of the Rapid Creek water system in the model with flows prescribed by a set of simple operating rules. In addition, the intended use of the model will be briefly described.

# WATER-BALANCE MODELING OF SELECTED LAKES FOR EVALUATING VIABILITY AS LONG-TERM FISHERIES IN KIDDER, LOGAN, AND STUTSMAN COUNTIES, NORTH DAKOTA

**Robert F. Lundgren**
U.S. Geological Survey, Dakota Water Science Center
rflundgr@usgs.gov

**Benjamin C. York**
byork@usgs.gov
**Nathan A. Stroh**
nstroh@usgs.gov
**Aldo (Skip) V. Vecchia**
avecchia@usgs.gov

Lakes in the central North Dakota Missouri Coteau region that were either dry or only sporadically held water before the 1930s have been rising since the early-1990s in response to an extended wet period. The lakes have remained full since the mid-1990s and have provided benefits to migratory waterfowl, fisheries, and wildlife. These water bodies are affected by small shifts in climate conditions that can impact lake levels. The North Dakota Game and Fish Department identified five lakes, that were essentially dry during the early 1990s, as candidates for sustaining long-term fisheries. After 1995, the lakes filled and are deep enough to sustain game fish. Before investing in permanent fisheries and associated infrastructure, fisheries biologists needed to know if the lake levels will remain high in coming decades.

A water-balance model was developed to determine the effects of precipitation, evapotranspiration, and groundwater interaction on lake volumes. The model used climate input data and lake volumes for the calibration period 1992–2016, during which historical lake volumes could be estimated using land surface elevation data and Landsat images. Long-term (1940–2018) climate input data were used to reconstruct historical lake volumes, and block-bootstrapping was used to simulate potential future climate data and lake volumes for 2017–2067. These were used to estimate the likelihood of lake volumes remaining consistent, increasing, or decreasing through 2067.

Sibley lake was the most likely to sustain a long-term fishery for a period longer than 50 years. The simulated lake volumes for Alkaline Lake, Big Mallard Marsh, and Remmick Lake indicated the lakes have an equal chance to fall below 75 percent of its 2016 volume by about 2030, 2067, and 2025, respectively. Results for Marvin Miller Lake the lake has an equal chance to fall below 75 percent of its 2016 volume by about 2025.

# WELL PLACEMENT DESIGN USING EXTREMAL OPTIMIZATION FOR ABERDEEN, SD

**Fleford Redoloza**
Department of Geology and Geological Engineering
South Dakota School of Mines and Technology
fleford.redoloza@mines.sdsmt.edu

**Liangping Li**
Department of Geology and Geological Engineering
South Dakota School of Mines and Technology
Liangping.Li@sdsmt.edu

The City of Aberdeen, South Dakota is planning to expand its current water supply. In preparation for future droughts and increasing demands for water, the city is reassessing its water resources and is planning the construction of new wells to help meet growing water demands. To help the city reassess its water resources, the U.S. Geological Survey (USGS), in cooperation with the City of Aberdeen, released a newer and more accurate groundwater flow model for a study area just north of Aberdeen. To determine where to install future source wells, this model will be coupled with an optimization algorithm to approximate the best well field configuration with constraints such as costs, distance, drawdown, and river depletion. Current methods for well placement optimization are based on popular heuristics such genetic algorithms, simulated annealing, differential evolution and so on. Majority of these algorithms rely on many evaluations of the groundwater model to evolve a wellfield solution. If the groundwater model is computationally intensive (e.g., the Aberdeen groundwater model), then the optimization algorithm requires much more time to converge to a solution. These algorithms also have issues with hyperparameter tuning, which can lead to even greater computational demands. To handle this computational bottleneck, this study proposes a modified version of the Extremal Optimization algorithm. Extremal Optimization is an algorithm inspired by the Bak-Sneppen model, which attempts to imitate the co-evolution of interacting species. Unlike genetic algorithms, which use a population of possible solutions, this algorithm uses a single solution; Extremal Optimization improves the solution by modifying the components that contribute the least to its overall performance. This study presents a modified version of the Extremal Optimization algorithm, termed EO-WPP, that can be used for well placement problems. During development, EO-WPP was applied to simple geometry problems and a simple synthetic model. After analysis of preliminary data, EO-WPP was applied to the Aberdeen groundwater model.

**THURSDAY, APRIL 11, 2019**
**SESSION 3P**
**1:30 – 3:10 P.M.**

**CLIMATE AND ECOSYSTEMS**
**(PONDEROSA ROOM)**

# INTEGRATED WATERSHED MANAGEMENT IN THE KOOTENAI RIVER, MT: A FISHERIES AND FOOD WEB PERSPECTIVE

**Lisa Kunza**
Department of Chemistry and Applied Biological Sciences
Program of Atmospheric and Environmental Sciences
South Dakota School of Mines and Technology
lisa.kunza@sdsmt.edu

**Kurt Chowanski**
Department of Chemistry and Applied Biological Sciences
South Dakota School of Mines and Technology, Rapid City, SD 57701
kurt.chowanski@sdsmt.edu

Recovery efforts have been established for the endangered Kootenai White Sturgeon in the Kootenai River US-Canada transboundary watershed. Many state, provincial, and federal agencies work closely with tribal, academic, and industry partners to coordinate the research and restoration efforts on the river. River management includes reaches with unregulated flow, regulated flow, nutrient addition, and habitat restoration. We characterized the response of gross primary production (GPP) and ecosystem respiration (ER) in each of the reaches which generally increased as we progressed downstream. As biofilm accumulated in this nutrient poor river, we observed an increase in GPP and ER in mid-summer that reduced in fall. The time period in which the elevated GPP and ER occurred differed among reaches. River management affects GPP and ER, thereby altering the timing and amount of autochthonous carbon inputs to the food web. Our work will contribute to the planning process for future restoration efforts within the Kootenai River to support the Kootenai White Sturgeon and other fisheries of concern.

# IMPACTS OF 21ST CENTURY CLIMATE CHANGE ON GREAT PLAINS EXTREME EVENTS, AGRICULTURE AND OTHER CLIMATE-RELATED HAZARDS

**Bill Capehart**
Atmospheric and Environmental Sciences
Civil and Environmental Engineering
South Dakota School of Mines and Technology
William.Capehart@sdsmt.edu

**Heidi Sieverding**
Civil and Environmental Engineering
South Dakota School of Mines and Technology
Heidi.Sieverding@sdsmt.edu

Climate projections for the Northern Great Plains show the coming century of increased warming and shifts in precipitation patterns. The combination of the two will greatly alter the "normal" climate conditions of the region ranging from increased return frequency of precipitation events heavy precipitation events, shifts in existing crop regimes, reductions in safe outdoor working days, and a gradual northward progression of pests and vectors into the Northern Plains.

Assessing the magnitude and probabilities of these changes cannot be done with just one model. Rather an ensemble of global climate models is typically used to determine the range of outcomes for a given future emissions storyline that results in a given possible outcome of global greenhouse warming. Results from these ensembles can be used to project the expected ranges of event thresholds, spread of possible event frequencies as well as provide indices that can be associated with economic risk and cost.

We will present results of the statistically-downscaled Localized Constructed Analogs (LOCA) for both moderate- and high-warming scenarios to show the potential outcomes of pending climate change on the Northern Great Plains, how the probability of notable past events will change in the future, and how the changes in climate will shift critical agricultural and other weather-dependent resources and infrastructure.

# AN INVESTIGATION INTO ANOMALOUSLY WET AND DRY YEARS ACROSS WESTERN SOUTH DAKOTA

**Keith D. Sherburn**
National Weather Service
keith.sherburn@noaa.gov

For western South Dakota, 2018 was characterized by near-record precipitation over the Black Hills and comparatively near-average precipitation across the plains. This presentation explores the unique attributes of 2018's spring and summer precipitation pattern, which led to the removal of moderate to extreme drought across portions of the Black Hills and western South Dakota plains but provided only modest improvement closer to the Missouri River. General large-scale setups for prior years that exhibited a similar spatial precipitation pattern are compared to those for years that were uniformly above or below average across all of western South Dakota. Additionally, the relationship of precipitation anomalies across western South Dakota and global teleconnections is explored, which reveals potential utility of the Madden-Julian Oscillation and other parameters in seasonal forecasting across the Northern Plains.

This presentation will also address the relative importance of antecedent moisture content over the Black Hills and plains in contributing the resulting precipitation anomalies of the spring and summer. Generally, a dry late winter through mid-spring is associated with below average annual precipitation across the Black Hills and western South Dakota plains. However, some years—such as 2015—had a top five lowest precipitation total from January through April yet closed the year with a top five highest annual accumulated precipitation. These anomalous years are explored in detail to reveal the factors contributing to their dramatic reversal of precipitation anomalies from the beginning to end of the wet season. The ultimate goal of this work is to improve our knowledge of patterns that support anomalously wet springs and summers across western South Dakota, which will aid in seasonal forecasting initiatives for the Northern Plains.

# EVALUATION OF USGS LCMAP DATA PRODUCTS TO ASSESS FOREST CONDITION IN WESTERN SOUTH DAKOTA

**Patrick K. Kozak**
Department of Atmospheric and Environmental Sciences
South Dakota School of Mines and Technology
Patrick.Kozak@mines.sdsmt.edu

**Heidi Sieverding**
Department of Civil and Environmental Engineering
South Dakota School of Mines and Technology
Heidi.Sieverding@sdsmt.edu

**James J. Stone**
Department of Civil and Environmental Engineering
South Dakota School of Mines and Technology
james.stone@sdsmt.edu

The United States Geological Survey Land Change Monitoring, Assessment, and Projection (LCMAP) science initiative was developed to provide a uniform and timely land use, land change, and land cover type and condition dataset across the conterminous US based on the Landsat “analysis-ready” data (ARD) archive. LCMAP is being implemented at the USGS Earth Resources Observation and Science (EROS) Center and is expected to be released for general use in the summer of 2019 and updated annually. The LCMAP datasets are a significant step forward in land cover and land use change regional analysis when compared to existing data sources such as NLCD. There are ten LCMAP data products leveraging the continuous change detection and classification (CCDC) approach developed by Zhe Zhu (Texas Tech) and Curtis Woodcock (Boston University) from 1985 through 2017. The LCMAP data products have the potential to be used to track temporal and spatial changes in land condition land health, and landcover change. We evaluated the usability of the LCMAP data products to accurately map the extent of mountain pine bark beetle (*Dendroctonus ponderosae*) tree kills over the last three decades within the Black Hills, South Dakota. This analysis used LCMAP data products Change Day and Land Cover Change and spatially compared them to the USFS insect and disease detection annual surveys from 1996 to 2016. The results were compared for spatial accuracy including omission and commission areas of the LCMAP data products. While our analysis shows there are spatial, temporal, and spectral limitations to the LCMAP data products, these new data resources provide a potentially viable approach for annual forest health and other survey updates. This presentation will be an overview of the LCMAP data process and products and the application of LCMAP products for the detection of MPB infestation in the Black Hills of South Dakota.

# TREE COVER AND TOPOGRAPHY AFFECT RIVER ECOSYSTEM METABOLISM IN THE BLACK HILLS, SOUTH DAKOTA

**Kurt Chowanski**
Department of Chemistry and Applied Biological Sciences
South Dakota School of Mines and Technology
kurt.chowanski@sdsmt.edu

**Lisa Kunza**
Department of Chemistry and Applied Biological Sciences
Program of Atmospheric and Environmental Sciences
South Dakota School of Mines and Technology
lisa.kunza@sdsmt.edu

River food webs are largely supported by in-situ primary production of algae and aquatic plants; however, gross primary production (GPP) and ecosystem respiration (ER) are rarely evaluated in the context of light limitations resulting from topography and or tree canopy cover. We estimated daily GPP and ER and measured water temperature during the 2018 growing season for 11 reaches in Rapid Creek, Castle Creek, Whitewood Creek, and Spearfish Creek. We characterized response of GPP, ER, and water temperature to tree cover and solar insolation estimates that account for physical relief. GPP and ER varied between creeks and reaches ranging from 0 - 12.3 g O2 m-2 d-1 for GPP and 0 - -8.4 g O2 m-2 d-1 for ER, and were lowest in Castle Creek (0.36 ± 0.04 GPP and -2.21 ± 0.05 ER, g O2 m-2 d-1, mean ± standard error), and highest in 1 Whitewood Creek reach (7.3 ± 0.5, -5.0 ± 0.2) with abundant aquatic plant cover. Change in heat energy of the water increased with light and decreasing tree cover. The timing of increasing GPP, ER, and water temperatures followed a seasonal pattern with low spring time values, elevated values in mid-summer, and decreasing values in late summer and fall. Temporal characteristics, such as timing of increase and duration of elevated values, for GPP and ER differed among reaches following changes in solar insolation, which varied with sun angle and reach topography. This suggest that topography and tree cover affect GPP, ER, and water temperatures, thereby altering the timing and amount of autochthonous carbon inputs to the food web. For creeks where summer water temperatures exceed desirable thresholds for fisheries, such as Rapid Creek, large scale habitat modification, such as planting shade trees, may limit downstream temperature increases; however, impacts to ecosystem metabolism should be considered.

**THURSDAY, APRIL 11, 2019**
**SESSIONS 3H AND 4H**
**3:30 – 4:50 P.M.**

**GREAT PLAINS TRIBAL WATER ALLIANCE MEETING**
**(RUSHMORE H ROOM)**

## CLIMATE IMPACTS TO NATIVE AMERICAN LANDS

**Imtiaz Rangwala**
Climate Science Lead, North Central Climate Adaptation Science Center

This presentation will discuss the climate impacts to Native American communities across the North Central Region (North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, and Montana). Climate change is creating new challenges and exacerbating existing ones across communities in the region. Dr. Rangwala will focus his presentation on the most pressing impacts including drought, wildfire, flooding, and extreme weather. He will draw on a case study from his work at Wind River Reservation where he partnered with the Tribal Water Engineers Office and several other agencies to develop a drought adaptation tool and prepare for future drought impacts.

## OPPORTUNITIES AND ACTIONS FOR CLIMATE ADAPTATION

**Stefan Tangen**
Tribal Resilience Liaison, Great Plains Tribal Water Alliance
North Central Climate Adaptation Science Center
stefan.g.tangen@gmail.com

**Logan Gayton**
South Dakota School of Mines and Technology
Louis Berger
LGayton@louisberger.com

**Chance Knutson**
South Dakota School of Mines and Technology
Louis Berger
CKnutson@louisberger.com

Presenters will discuss the various ways to address climate change in Tribal communities including funding opportunities and processes for dealing with climate impacts. They will draw from case studies of successful Native American/Alaska Native communities adapting to climate change. In this presentation they will cover community engagement workshops, vulnerability assessments, and climate adaptation planning.

## DROUGHT ADAPTATION PLANNING

**James Rattling Leaf, Sr.**
North Central Climate Adaptation Science Center Program
jamesrl413@gmail.com

**Syed Huq**
Director, Water Resources for Rosebud Sioux Tribe
shuq@sicangu.com

In this presentation James will highlight drought adaptation projects in numerous communities throughout the region as part of his work with the National Integrated Drought Information System (NIDIS) and the High Plains Regional Climate Center (HPRCC). James will discuss how to begin a drought project, best practices in this work, and his experience working with various agencies (state, federal, and non-profit).

In the final portion of this presentation Syed will discuss his experience developing climate adaptation tools for Rosebud Sioux Tribe including a climate dashboard and guidebook. Dr. Huq will discuss his experience over the past 30 years at Rosebud Sioux Tribe dealing with drought and managing water resources for over 20,000 Tribal members and thousands of non-Tribal members.

## CLIMATE ADAPTATION WORKSHOP

**Stefan Tangen**
Tribal Resilience Liaison, Great Plains Tribal Water Alliance
North Central Climate Adaptation Science Center
stefan.g.tangen@gmail.com

**James Rattling Leaf, Sr.**
North Central Climate Adaptation Science Center Program
jamesrl413@gmail.com

**Imtiaz Rangwala**
Climate Science Lead, North Central Climate Adaptation Science Center

This session will be an interactive workshop to focus on the process of planning for climate change for each attendee. Time will be allocated to work individually and in small groups to develop a draft plan for addressing climate impacts. In their draft plan attendees will decide for their community how to start a plan, who to include, a practical timeline, and preparing for barriers they might expect to see in the adaptation process. At the end attendees will have an opportunity to bounce ideas off the group to learn from each other and gather feedback.

## THURSDAY, APRIL 11, 2019
## SESSION 4A
## 3:30 – 4:50 P.M.

## HYDROLOGY POTPOURRI
## (ALPINE ROOM)

# NUTRIENTS, PESTICIDES AND SELENIUM IN AGRICULTURAL TILE DISCHARGES INTO PUBLIC WETLANDS, MADISON WETLAND MANAGEMENT DISTRICT, SOUTH DAKOTA

**Matthew S. Schwarz**
U.S. Fish and Wildlife Service, South Dakota Ecological Services Field Office
matt_schwarz@fws.gov

**Drew R. Davis**
University of South Dakota, Department of Biology

**Jacob L. Kerby**
University of South Dakota, Department of Biology

There are approximately 4.4 million acres of wetlands in the Prairie Pothole Region of the Dakotas that provide essential habitat for wildlife, improve water quality, and provide flood control benefits. However, these wetlands are increasingly receiving discharges from agricultural tile drainage. We measured pollutants in tile effluent and evaluated water quality and habitat degradation at Waterfowl Production Areas managed by the U.S. Fish and Wildlife Service. Eighteen wetland sites were periodically sampled from 2011–2015. These sites were divided into three site categories: 1) “Tile Wetland” for wetland sites that directly receive tile outfall discharges but may also receive surface runoff of agricultural chemicals, 2) “Surface Wetland” for wetland sites that receive surface runoff of agricultural chemicals but have no known tile discharge inputs, and 3) “Reference Wetland” for wetland sites that are well buffered from agricultural chemicals in surface runoff and receive no direct tile outfall discharges. Concentrations of nutrients, pesticides and selenium in tile effluent exceeded water quality benchmarks for the protection of aquatic life. There were also differences in pollutant concentrations between wetland site categories, with Tile Wetlands having higher concentrations of select pesticides, chlorophyll-a, and selenium than Reference Wetlands. Tile Wetlands also exhibited selenium bioaccumulation in wetland biota (plants, aquatic invertebrates, and duck eggs) and had overall lower South Dakota Wetland Rapid Assessment Protocol scores. We recommend actions to reduce agricultural pollutant discharges into public wetlands.

# AQUAPONICS: A WATER RESOURCES PROJECT

**Kelsey E. Murray**
Program Director, Environmental Engineering Program
Western Dakota Tech
Kelsey.Murray@wdt.edu

**Bryan Mitchell**
Program Director, Electrical Trades
Western Dakota Tech

In 2018, the National Science Foundation (NSF) and the American Association of Community Colleges (AACC) awarded the team from Western Dakota Technical Institute (WDT) in Rapid City, SD first place in the fourth annual Community College Innovation Challenge (CCIC). The winning project, entitled "Electrical Automation to Solve World Hunger," used an aquaponics system as a tool for both the technical training of Electrical Trades and Environmental Engineering professionals as well as the broader goal of and solving the local, regional, and national problem of food insecurity.

Aquaponics is a synergistic food production platform that combines techniques in aquaculture and hydroponics to simultaneously raise edible plants and fish. As a forward-looking technology, aquaponics responds to the current sustainability challenges of the 21st century, including limited arable land, constrained freshwater supplies, soil degradation, and soil nutrient depletion, by minimizing water use and negative environmental impacts. It uses biomimicry of ecosystem processes, including nutrient and water cycling, that occur naturally in lakes and rivers. In aquaponics, there are multi-trophic levels within a recirculating system. Ammonia-rich wastewater from the fish is cycled from the tank through a grow bed which serves as a biologic filter for nitrogen transformations by nitrifying bacteria. Plants utilize the converted nitrates for growth, and in turn provide water filtering services for the system. This recycling eliminates the need for mineral fertilizers that can be harmful to the environment. By creating a symbiosis among plants, fish, and microorganisms, water and nutrient reuse is maximized, and environmental impacts are minimized.

Aquaponics gaining attention as a potential solution to sustainable food production. The project started by building an integrated aquaponics prototype, and its successors Aqua 2.0 and 3.0, where Programmable Logic Control (PLC) and environmental monitoring systems were designed, tested, and implemented to build mini-ecosystems that could maintain and generate organic fish and produce with minimal user involvement. The next stages of the project are community level testing. Our continuing work will have direct and positive impacts on our local problems associated with food deserts and food insecurity while upholding the values of energy neutrality and sustainability.

# USING GREEN STORMWATER INFRASTRUCTURE TO CREATE URBAN BIODIVERSITY CORRIDORS

**Heidi Sieverding**
Department of Civil and Environmental Engineering
South Dakota School of Mines and Technology
Heidi.Sieverding@sdsmt.edu

**Andrea Vargas Castano**
Department of Civil and Environmental Engineering
South Dakota School of Mines and Technology
andrea.vargascastano@mines.sdsmt.edu

**Henning Nottebrock**
Department of Biology and Microbiology, Agricultural Experiment Station
South Dakota State University
henning.nottebrock@sdstate.edu

**Charles Fenster**
South Dakota State University
charles.fenster@sdstate.edu

**James J. Stone**
South Dakota School of Mines and Technology
james.stone@sdsmt.edu

Cities themselves present both the problems and solutions to sustainability challenges of an increasingly urbanized world. By removing vegetation and topsoil and creating impervious structures, urbanization damages natural biodiversity, hydrological processes, and ecosystem services provision. But urbanization can be designed to support and minimize impact to ecosystem services through landscaping and multi-purpose infrastructure, such as rain gardens. Well-planned green stormwater control infrastructure (e.g. rain gardens, green roofs, hellstrip gardens) can serve to meet regulatory mandates while restoring connectivity. Careful placement and design of green stormwater infrastructure can provide ecological niches and habitat corridors to larger natural areas. Pollinators have a functional role inside an ecosystem and can serve as biodiversity indicators. Two rain gardens and a semi-natural wetland area in Rapid City, SD were surveyed for pollinator habitat. Trait-based plant models were created to link urban pollinators, plant health, and water resources. Over 70 species of insects were identified within the stormwater structures. Soil moisture within the rain garden structures had a significant positive effect (LRT: $\chi^2_{1DF} = 41.48$, $p < 0.001$) on flower number. Pollinator habitat within engineered rain gardens was comparable or greater than natural wetland areas. Generalized results of these models can be used by city planners and engineers to increase the multi-functionality of green stormwater structures and create habitat connectivity.

# SITE-SCALE INTEGRATED DECISION SUPPORT TOOL (I-DST) FOR STORMWATER MANAGEMENT

**Ali Shojaeizadeh**
Department of Civil and Environmental Engineering
South Dakota School of Mines and Technology
ali.shojaeizadeh@mines.sdsmt.edu

**Mengistu Geza**
Department of Civil and Environmental Engineering
South Dakota School of Mines and Technology
stu.geza@sdsmt.edu

The objective of this research is to develop a site-scale integrated decision support tool (site-scale i-DST) for selection and sizing of Best Management Practices (BMPs). The tool has several component modules integrated into a single tool. The component modules include runoff estimation module, BMP selection, BMP sizing and cost module. Several of the more complex stormwater tools require expertise to build and operate. The site-scale i-DST is built on accessible platform (Microsoft Excel VBA) and can be operated with a minimum skillset. It is based on readily available data and provides a comparative analysis among various scenarios for BMP selection, sizing, cost, and performance. Site-scale i-DST is fully automated optimization tool that selects BMPs based on input data such as quality of stormwater, target water quality, and technical, environmental, social and economic criteria. It was demonstrated through scenario evaluation that the tool recommended cost effective BMPs. The tool is flexible allowing user interaction through a graphical user interface. In the BMP selection module, users can change criteria and weights, include or exclude BMP types from the selection process depending on site specific criteria. Users can apply the sizing module to size various types of BMPs including green roof system, infiltration-based and storage-based BMPs and run BMP sizing module, users can run several scenarios in short time. The tool also includes a hydrologic module for simulation of runoff on event and continuous basis and a cost module for analysis of life cycle cost of project. The site-scale i-DST is intended for designers, regulators and municipalities for quick analysis of scenarios involving the interaction of several factors.

**THURSDAY, APRIL 11, 2019**
**SESSION 4P**
**3:30 – 4:30 P.M.**

**DAMS AND GEOMORPHOLOGY**
**(PONDEROSA ROOM)**

# EVALUATING GEOMORPHIC CHARACTERISTICS OF REMOTELY CLASSIFIED RIVER SYSTEMS IN THE US GREAT BASIN

**John J. Costello**
South Dakota School of Mines and Technology
john.costello@mines.sdsmt.edu

**Scott J. Kenner**
South Dakota School of Mines and Technology
scott.kenner@sdsmt.edu

Rivers are often defined as linear, continuous structures that increase in size in the downstream direction, however, recent studies have questioned whether this concept adequately accounts for the discontinuities caused by natural variation and human influence. Alternatives to the River Continuum Concept (RCC), a downstream gradient, call for a discontinuum or patches. Functional Process Zones (FPZs) can be used to classify these patches. For this study, FPZs were classified and mapped along three rivers in the Great Basin (USA) using a GIS protocol and statistical grouping methods. River reaches within the resulting FPZs were sampled based on the modified EMAP protocol to test whether significant hydrogeomorphic differences existed across scales, including between FPZs, within a single watershed, and among watersheds in the Great Basin region. Cluster analysis was used to initially group FPZs using metric subsets (channel morphology, bank morphology, Substrate, fish cover, large woody debris, riparian, human influence, canopy density) of geomorphic characteristics measured in the field. Then using Principal Component Analysis (PCA) the number of variables in each subset were reduced to determine a smaller number of characteristics that best represent that subset. The strongest variables from each of the different subsets are used all together to determine if FPZs are similar or different from a geomorphic perspective. Our study reveals that FPZ type (upper wide, upper confined, lower wide, lower confined) can be grouped by hydrogeomorphic characteristics examined by PCA or Cluster analysis. When using specific metric subsets both the ideas of a continuum and patchiness can be supported.

# GEOLOGY OF DAM SPILLWAYS

**Perry H. Rahn**
Department of Geology & Geological Engineering
South Dakota School of Mines & Technology
perry.rahn@sdsmt.edu

Serious erosion occurred on the main spillway and the emergency spillway of the Oroville Dam, California, in February 2017. There was concern that the dam could fail, and 188,000 people who lived below the dam were evacuated. Erosion of both spillways was facilitated by poor quality bedrock that originating from a laterite paleosol developed on the meta-basalt bedrock.

A variety of geologic conditions exist at dam spillways in South Dakota. During the 1972 floods in the Black Hills two dams were overtopped and failed, one because the spillway got clogged, and the other because the spillway had inadequate freeboard. The spillway for Oahe Dam, on the Missouri River in South Dakota, has never been tested. It is underlain by fissile Cretaceous shale that could be eroded in the event of high discharge.

# EMERGENCY RESPONSE MONITORING FOR OROVILLE SPILLWAY

**Kayla J. Ranney**
HDR, Denver, CO
Kayla.Ranney@hdrinc.com

**Jaime C. Lubeck**
HDR, Sacramento, CA
Jaime.Lubeck@hdrinc.com

**Daniel W. Osmun**
HDR, Denver, CO
Daniel.Osmun@hdrinc.com

**Olivia M. Virgadamo**
California Department of Water Resources
Division of Operations and Maintenance
olivia.virgadamo@water.ca.gov

The Oroville spillway encountered increasing discharges in January and February 2017 due to growing rainfall and reservoir levels. These increased discharges lead to structural damages of the spillway and engagement of the emergency spillway. Beginning February 19, 2017, continuous emergency monitoring of the Oroville spillway was performed in a joint effort between DWR's Dam Safety Branch and HDR as part of the overall emergency response. Monitoring included visual assessments of site conditions and data collection at various frequencies performed by teams of inspectors and engineers. Continuous data analysis and reporting through documentation was also performed. Throughout the emergency monitoring period, it was important to monitor for any change to the spillway chute. Emergency situations like the unexpected damage that occurred to the spillway chute, combined with increased rainfall and reservoir levels, shows the need for dam safety engineers to have the ability to evaluate potential risks and respond quickly with recommendations for action to minimize the potential for further damage to the spillway. This presentation will provide a background of the hydrologic events leading to eventual spillway damage, the progression of emergency response monitoring, and the techniques and approaches taken throughout the duration of the emergency period. Additionally, lessons learned and procedures to consider in future emergency situations from the Oroville spillway incident will be discussed.

Although there are many different aspects of the Oroville spillway incident, this presentation will focus on emergency response monitoring performed by DWR and HDR between February and May 2017.

# LITTLE MISSOURI RIVER INITIATVE: COOPERATIVE STREAMFLOW AND WATER CHEMISTRY DATA COLLECTION BETWEEN THE NORTH AND SOUTH UNITS OF THEODORE ROOSEVELT NATIONAL PARK

**Bryce A. Klasen**
Hydrologist, North Dakota State Water Commission
900 East Boulevard Avenue, Bismark, ND 58505
bklasen@nd.gov

The North Dakota State Water Commission (SWC), in cooperation with the United States Geological Survey (USGS) and the National Park Service, conducted a flow study of the Little Missouri River in the summer of 2018. The 109-mile stretch of river studied was located between Medora, North Dakota and the US Highway 85 bridge over the Little Missouri River, locally known as the Long X Bridge, located south of Watford City, North Dakota.

Data was collected at six (6) approximately equidistant sites and one tributary. Two existing USGS streamflow monitoring sites bracketed the study area. Five (5) SWC sites were located within the study area. Four of the sites were located on the mainstem of the Little Missouri River and one site on Beaver Creek, the largest tributary of the Little Missouri River within the study area. Streamflow measurements and water chemistry samples were collected during four simultaneous sampling events that occurred approximately six weeks apart, starting in June 2018 and ending in October 2018. Stage height data was collected in one-hour intervals at the SWC sites and transmited to a database at the SWC offices in Bismarck using satellite transmissions once per day. The stage height data was collected, stored and transmitted with custom-built units named PRESENS (Pushing REmote SENSors). The PRESENS units were designed and constructed by staff hydrologists and technicians at a considerably lower unit cost than units available on the market. The concept was to collect the streamflow data in real time, store the data on an on-board SD card and transmit the data in bursts to keep the transmission costs to a minimum.

The ability to remotely collect water resource data allowed the SWC and its partners to observe the river as water from precipitation events pulsed through the system. The PRESENS also allowed the SWC to make efficient use of staff's field time, while maximizing the amount of recorded data. This data will be used to make regulatory decisions regarding the beneficial use of water designed to protect the rights of senior appropriators and the public interest.

**THURSDAY, APRIL 11, 2019**
**POSTER SESSION AND EVENING SOCIAL**
**4:30 – 7:00 P.M.**

**(RUSHMORE G ROOM)**

# AQUA 3.0

**Gabe Maruani**
Western Dakota Tech
Gabriel.Maruani@stu.wdt.edu

**Cody Runge**
Western Dakota Tech
Cody.Runge@stu.wdt.edu

**Cameron Ault**
Western Dakota Tech
Cameron.Ault@stu.wdt.edu

**Bryan Mitchell**
Program Director, Electrical Trades

**Kelsey Murray**
Program Director, Environmental Engineering

Western Dakota Tech recently took first place in the National Science Foundation's 2018 Community Innovation Challenge. In this project, aquaponics, a combination of hydroponics and aquaculture, was integrated into the technical training of Electrical Trades and Environmental Engineering professionals with the overarching goal of solving world hunger. Since this award, our team at Western Dakota Tech has been working to build several additional units to allow for controlled comparison of differing parameters. Once assembled, the ecological conditions will be optimized, and the operating conditions will be described to optimally balance plant and fish growth. This data-driven component is necessary a.) to serve as a point of comparison for other small aquaponics operations, b.) to describe the inputs (energy, water, fish feed) and outputs (edible crops and fish) required to maintain the system, c.) and to reconcile the water quality and lighting parameters that affect the survival and growth of the plants, fish, and nitrifying bacteria in the system. Parameters that will be optimized include pH, alkalinity, dissolved oxygen, specific conductivity, ambient air and water temperature, total suspended solids, nitrogen transformations, phosphate and iron levels, weekly water demand, and photo-period. Energy-use optimization of water heaters, air blowers, box fans, sump pumps, and lights will be performed to remain as carbon neutral as possible. Rainfall collection methods will be examined to potentially eliminate the expected water needs. The student body in the Environmental Engineering, Electrical Trades, Computer-Aided Design, and Business departments are currently involved in "Aqua 3.0," a design competition that works to maximizes the output, while simultaneously minimizing input of the aquaponics units. The winning design will be built in the next stages of the project.

# ESTIMATION OF BEST TREATMENT CONDITIONS OF SUGARBEET WASTEWATER TREATMENT USING RESPONSE SURFACE METHODOLOGY.

**Swati Sharma**
North Dakota State University
Agricultural and Biosystems Engineering
s.sharma@ndsu.edu

**Halis Simsek**
North Dakota State University
Agricultural and Biosystems Engineering
halis.simsek@ndsu.edu

Processing and washing of sugarbeet for the production of sugar produces a large amount of wastewater that contains high concentration of chemical oxygen demand (COD) consisting mostly organic carbon compounds. In this study, electrooxidation (EO) was adopted to treat the primary effluent of the sugarbeet processing industry. The effects of pH, current density and operation time were investigated using Box-Behnken design (BBD), a response surface methodology (RSM) and a set of 15 experimental run were conducted for optimization of operating parameters. Quadratic regression models with estimated coefficients were developed to describe the removal of organic pollutants. The results showed that EO could remove total and soluble COD and total and dissolved organic carbon by 76%, 73%, 76% and 77% respectively at optimum conditions of pH 5.2, current density of 50.5 mA/cm2 and operation time of 364.5 min. The predicted values were in reasonable agreement with observed values.

# SENSITIVITY ANALYSIS OF FREQUENCY STORM PARAMETERS IN HEC-HMS

**Angelinah N. Rasoeu**
Department of Civil and Environmental Engineering
South Dakota State University
ntsieng.rasoeu@jacks.sdstate.edu

**Suzette Burckhard**
Department of Civil and Environmental Engineering
South Dakota State University
Suzette.Burckhard@sdstate.edu

Hydrologic models are widely used in managing, predicting or evaluating water resources. US Army Corps of Engineers Hydrology Engineering Center Hydrologic Modeling System (HEC-HMS) is a widely used model and its application is well documented. However, little is known about the choice of model parameters and their impact on the reproducibility of the results. The purpose of this study was to perform sensitive analysis to evaluate the effects of changing storm intensity position, control specification time interval, and maximum intensity duration on model output. HEC-HMS storm parameters for the Frequency Storm precipitation method were evaluated in the Indian Creek watershed in South Dakota. A storm of 1 inch depth and 2 year return period was used. The effect on peak discharge, time to peak, and runoff volume were evaluated by varying storm intensity duration and control specification time intervals for each maximum intensity position. The results show that the peak discharge increased with an increase in the storm center intensity position. Time to peak varied as intensity position increased. The peak discharge decreased with an increase in the control specification time interval for each maximum intensity duration while time to peak fluctuated with an increase in the control specification time interval for each maximum intensity duration. However, for the same control specification time interval, peak discharge remained relatively unchanged and time to peak remained constant. The 2 hour control time interval showed constant results for all intensity durations. The depth of runoff remained constant for all the experiments with 0.07(IN).

# HYDROLOGICAL MODELS FOR RAINFALL- RUNOFF IN ARID REGIONS: A LITERATURE REVIEW

**Ali M. Alsubeai**
Department of Civil and Environmental Engineering
South Dakota State University
Ali.Alsubeai@sdstate.edu

**Suzette Burckhard**
Department of Civil and Environmental Engineering
South Dakota State University
Suzette.Burckhard@sdstate.edu

Hydrological models were created to work with limited input parameters, so they are not necessarily valid unless they have been tested in different situations. The majority of models were created for humid regions which receive high amounts of precipitation compared to arid regions as well as other differences. For instant, vegetation cover is extensive in humid areas compared to arid areas. In addition, there are very intense rainfall events that occur during the year which causes runoff in both humid and arid regions. Moreover, soil characteristics affect infiltration rate such as variations in layer depths, and accessibility to be storage. The objective of this paper is to present results of a literature review and analyses of hydrological models used in arid regions. Furthermore, 13 models were reviewed in different countries, Saudi Arabia, China, Jordan, Tanzania, and Libya where the arid climate is prevalent. All of the models were developed for humid regions. Results will be presented for the models studied and typical modifications implemented to use the model in arid regions.

# WHITE CLAY CREEK REHABILITATION ASSESSMENT

**Chance C. Knutson**
South Dakota School of Mines and Technology
Chance.knutson@mines.sdsmt.edu

**Michael P. Mansfield**
South Dakota School of Mines and Technology
Michael.mansfield@mines.sdsmt.edu

**Sophie S. Brogdon**
South Dakota School of Mines and Technology
Sophie.brogdon@mines.sdsmt.edu

Agricultural and storm water run-off as well as waste water from obsolete treatment facilities contribute to poor water quality in rivers and streams on Tribal lands. White Clay Creek, located on the Pine Ridge Reservation near Pine Ridge South Dakota, experiences seasonal poor water quality from agricultural run-off as well as storm run-off and waste water overflow events occurring in the town of Pine Ridge. The objectives of this project are three-fold. 1) Perform a watershed analysis to quantify the amount of agricultural and storm water run-off entering White Clay Creek, 2) Investigate methods/practices to lessen the amount of run-off entering the creek, and 3) Identify and mitigate causes of waste water from treatment facilities from entering the Creek. The results for the project include preliminary designs for a water monitoring system, re-design of the Pine Ridge Lift Station, and riparian buffer zone. Relevant conclusions include the implementation of any of the preliminary designs will improve the water quality within the White Clay Creek Watershed.

# INVESTIGATION INTO NEEDS AND FUTURE USE OF MISSOURI RIVER WATER FOR WESTERN PENNINGTON COUNTY, SOUTH DAKOTA

**Kaleb Hedman**
South Dakota School of Mines and Technology
Kaleb.Hedman@mines.sdsmt.edu

**Haley Noteboom**
South Dakota School of Mines and Technology
Haley.Noteboom@mines.sdsmt.edu

**Regan Wess**
South Dakota School of Mines and Technology
regan.wess@mines.sdsmt.edu

This work involved: (1) Prediction of population growth and projected water demands for western Pennington County and the Black Hills area near Rapid City, (2) Documentation of locally available water supplies, including surface water and groundwater resources, and (3) Development of options for future use of Missouri River water rights. These future use permits include the West Dakota Water Development District's allotment of Missouri River water designated by Permit No. 1443-2, for 10,000 acre-feet per year, as well as the City of Rapid City's future use permits that total 66,000 acre-feet per year from the Missouri River. Development of options will consider transmission of water through new or existing piping networks, alignment of routes, coordination with public rights-of-way, collaboration with other entities, pumping stations, treatment, and associated factors.

# PARFLOW MODEL OF PINE RIDGE RESERVATION IN SOUTH DAKOTA

**Lilly Jones**
South Dakota School of Mines and Technology
lilly.jones@mines.sdsmt.edu

Groundwater is the major source of drinking water on the Pine Ridge reservation in South Dakota. The U.S. Environmental Protection Agency requires groundwater vulnerability assessment for public wells per the Safe Drinking Water Act. Uranium and heavy metals have been identified in some reservation water samples. Source and extent of these contaminants is unknown. Uranium mining and weapons testing have both occurred in the region. Reservation residents continue to use impacted wells because few alternatives exist.

Aquifer modeling is the first step in producing a groundwater vulnerability assessment. Modeling integrates data about the aquifer system into a single framework that is used to simulate aquifer conditions and hypothetical or real stresses. This project will produce a ParFlow model of the Pine Ridge Reservation.

ParFlow is an integrated surface water/groundwater modeling package. Groundwater flow, overland flow, atmospheric, and plant processes are integrated into the framework. Saturated and variably saturated flow are solved in three dimensions with a fine vertical resolution for both confined and unconfined aquifers using the shallow water equations for overland flow implicitly coupled to the mixed form of the Richards' equation for subsurface flow. The equations are solved simultaneously over the entire model domain, simulating surface-water/groundwater interactions and intermittent streamflow. Of particular interest for this project is identification of numerous springs in the study area, with implications for the other ongoing hydrogeologic projects in the region.

# CHARACTERIZING RANGELAND SALINIZATION IN NORTHWEST SOUTH DAKOTA

**Patrick K. Kozak**
Department of Atmospheric and Environmental Sciences
South Dakota School of Mines and Technology
Patrick.Kozak@mines.sdsmt.edu

**Lisa Kunza**
Department of Chemistry and Applied Biological Sciences
South Dakota School of Mines and Technology
Lisa.kunza@sdsmt.edu

**Kurt Chowanski**
Department of Chemistry and Applied Biological Sciences
South Dakota School of Mines and Technology
Kurt.Chowanski@sdsmt.edu

**Dan Heglund**
Department of Chemistry and Applied Biological Sciences
South Dakota School of Mines and Technology
Dan.heglund@sdsmt.edu

Salinization of rangeland is a major concern for ranchers and other land managers. We examined baseline soil and water conditions in Butte and Harding Counties to identify areas of concern and provide direction for future research and management. With more than 12,000 identified impoundments in the study area, there is greater potential for increased concentration of natural occurring salts in the region. We selected impoundments and creek locations to collect both water and soil samples on public land and surrounding areas in Harding and Butte Counties. We measured electrical conductivity at 44 impoundments and 15 creeks in July and August 2018 to evaluate spatial variability in salinity. Initial analysis indicated spatial variability of conductivity in impoundments (28-7,720 µS $cm^{-1}$) and creeks (359-4865 µS $cm^{-1}$), and mean conductivity was lower in impoundments (829 µS $cm^{-1}$) than in creeks (1632 µS $cm^{-1}$) . As we create a regional baseline for rangeland salinity, we can start to make linkages with potential sources in both soils and surface water. Developing a temporal series of soil salinity maps from remotely sensed imagery (Landsat and National Agriculture Imagery Program), may help evaluate spatial and temporal distribution of saline soils and assess impacts of rangeland management across the region.

# ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY AS A TOOL FOR MONITORING THE MICROBIAL CONTAMINANTS

**Navanietha Krishnaraj Rathinam**
Department of Chemical and Biological Engineering and BuG ReMeDEE
South Dakota School of Mines and Technology
navanietha.rathinam@sdsmt.edu

**Rajesh K. Sani**
Department of Chemical and Biological Engineering and BuG ReMeDEE
South Dakota School of Mines and Technology
Rajesh.Sani@sdsmt.edu

With rapid increase in population and industrialization, the pollutants in the environments are increasing tremendously. Although many types of microorganisms offer benefits to mankind, pathogens and drug resistant microorganisms are threat to the environment. There are several sources of microbial contamination in the surface water bodies and ground water. There is an urging need to develop a facile strategy for monitoring the microbial contaminants. Conventional microbiology techniques are laborious, time consuming, and demands laboratory infrastructure. Herein, we report an electrochemical strategy for screening the microbial contaminants. Carbon felt electrode was used as the base material. Electrochemical Impedance Spectroscopy was performed in the three-electrode mode in the frequency range of 20 Hz to 10 m Hz with an AC amplitude of 10 mV. The results of the Nyquist plot showed the polarisation resistance increased with increase in biofilm formation whereas the solution resistance increased with increase in concentration of the cells in the electrolyte. This developed strategy could be a promising technology for wastewater treatment plants and public water systems.

# REMOVAL OF HEAVY METALS FROM URBAN STORMWATER USING BIOCHAR AND NANOSCALE ZEROVALENT IRON MODIFIED BIOCHAR

**Md Sazadul Hasan**
Civil and Environmental Engineering
South Dakota School of Mines and Technology
mdsazadul.hasan@mines.sdsmt.edu

**Mengistu Geza**
Civil and Environmental Engineering
South Dakota School of Mines and Technology
stu.geza@sdsmt.edu

**Raul Vasquez**
South Dakota School of Mines and Technology
raul.vasquez@mines.sdsmt.edu

Urbanization has degraded the quality of urban water resources, and effective stormwater treatment is necessary to lowered concentration of pollutants. Ideally, conventional Best Management Practices (BMPs) such as bioretention cells and infiltration basins should attenuate contaminants in stormwater. However, contaminants like heavy metals, pass through these systems. Three heavy metals (Cu, Cd, and Zn) were used to evaluate sorption capacity of biochar (BC) and biochar modified with nanoscale zerovalent iron (BC-nZVI). A synthetic stormwater solution accompanied by a single metal and a solution with all metals were used in batch experiments. Surface morphology and characteristics of BC and BC-nZVI were characterized using Scanning Electron Microscope (SEM), Fourier-Transform Infrared Spectroscopy (FTIR) and Brunauer–Emmett–Teller (BET) techniques elucidate the mechanism of metal removal. The experiment was conducted for the initial concentrations ranging from of 2.5 to 10 mg/L for Cu2+, 20 to 50 mg/L for Cd2+, and 30 to 60 mg/L for Zn2+. On average the removal efficiencies were higher for BC-nZVI compared to BC in all cases; average removal efficiencies for single metals were 97% vs. 96% for Cu2+, 93% vs. 71% for Cd2+, and 70% vs. 46% for Zn2+ respectively and for mixed metals were 99% vs. 97% for Cu2+, 25% vs. 19% for Cd2+, and 50 vs. 42% for Zn2+ respectively. Langmuir and Freundlich isotherm models; and Pseudo-first and second order kinetic isotherms were determined to understand the adsorption behavior and kinetics. Experimental data determined BC-nZVI had the higher maximum adsorption capacity (mg/g); with the order of Cu2+ (260.86) > Cd2+ (223.62) > Zn2+ (166.66) in single metal Langmuir adsorption isotherm. Higher metal removal by BC-nZVI is attributed to enhanced sorption due to chemical reduction, complexations, and cation exchange. The study demonstrated that BC-nZVI composite enhances removal of heavy metals in urban stormwater compared to biochar.

# POTENTIAL INFLUENCE OF CLIMATE CHANGE ON STREAM TEMPERATURE IN REGULATED AND UNREGULATED STREAMS IN THE BLACK HILLS

**Lucas G. Graunke**
South Dakota School of Mines and Technology
lucas.graunke@mines.sdsmt.edu

**Lisa Kunza**
Department of Chemistry and Applied Biological Sciences
South Dakota School of Mines and Technology
Lisa.kunza@sdsmt.edu

**William Capehart**
South Dakota School of Mines and Technology
William.Capehart@sdsmt.edu

Water resources in the Black Hills provide multiple recreational and economic benefits to the surrounding area. Biodiversity and water quality can be significantly affected by increases in stream temperature. Rapid Creek is a heavily regulated stream with headwaters in the central Black Hills and Spring Creek is a smaller unregulated stream that is 10 miles south of Rapid Creek. USGS gauge station stream temperature observations on Rapid Creek throughout the year range from -2.0º C to 29.5º C with a large increase in stream temperature in the immediate tailwaters of Pactola Dam with temperatures gradually increasing downstream as it converges with the Cheyenne River. Spring Creek also increases in stream temperatures as the creek descends from the higher elevations of the Black Hills to the surrounding plains, with observed USGS gauge station stream temperatures ranging from 0.0º C to 25.5º C annually. The goal of this project is to model stream temperature changes in response to projected climate change, and then discern if the modeled stream temperature changes are different or similar in the unregulated and regulated streams. Data from Global Climate Models (GCM) will be used in SWAT (Soil and Water Assessment Tool) to model stream temperatures. Two emission scenarios will be used, Representative Concentration Pathways (RCP) 4.5 and 8.5. Unregulated or regulated stream temperatures may be more resilient to climate change.

## FRIDAY, APRIL 12, 2019
## FIELD SEMINARS/TRIPS
## PRE-REGISTRATION REQUIRED

## FIELD TRIP #1: GEOLOGY AND HYDROLOGY OF THE NORTHERN BLACK HILLS

**Description:** The field trip will discuss the sequence of Precambrian to Cretaceous age formations and major aquifer units in the northern Black Hills. Stops will be made at significant exposures of sedimentary, igneous and metamorphic rocks as time allows.

**Leaders:** Mark Fahrenbach and Joanne Noyes (South Dakota DENR Geological Survey Program)

**Meeting time:** 8 A.M.

**Meeting location:** Civic Center parking lot (east side). Due to limited parking space and traffic concerns along the tour route, transportation will be provided via SDSMT vans. NO PERSONAL VEHICLES.

**Duration:** 8AM – 4PM (approx.). You should pack your own lunch. 6.0 PDH.

## FIELD TRIP #2: THE PAST, PRESENT, AND FUTURE: PROGRESS TOWARDS BETTER STORMWATER MANAGEMENT IN RAPID CITY

**Description**: Field trip highlighting the changes in Rapid City stormwater management over the last century from older conveyance and end-of-pipe solutions to modern multifunctional and upgradient solutions

**Leaders**: Jason Phillips and Heidi Sieverding, SDSM&T

**Meeting time**: 8 A.M.

**Meeting location**: Meadowbrook Golf Course Parking Lot (3625 Jackson Blvd)

**Duration**: 8 – 11 A.M. (3.0 PDH)

## FIELD TRIP #3: PACTOLA DAM OPERATIONS

**Description**: The field trip will include a tour of Pactola Dam and an overview of U.S. Bureau of Reclamation water operations related to Deerfield, Pactola, and the Rapid Creek system.

**Leaders**: Steve Schelske and Ginger Wessels (Bureau of Reclamation)

**Meeting and location:**

Pactola Dam visitor's center 9:00 A.M.

or

Canyon Lake boat ramp (west side) at 8:30 A.M. for carpool

**Duration**: 9 – 11 AM (3.0 PDH)