Oklahoma Water Resources Research Institute
Division of Agricultural Sciences and Natural Resources

Annual Technical Report
2018

General Information

Products

Reports
i. Conserving Agricultural Water Resources in Oklahoma using Smart Technologies
ii. Evaluating the potential of Sentinel-2 and Landsat images for mapping open surface water body areas and water quality in Oklahoma
iii. Control of Problematic Halanaerobiales that Limit the Reuse of Hydraulic Fracturing Fluids
iv. Developing seasonal streamflow forecasts to inform surface water management in Oklahoma

Journal articles
i. Masasi, Blessing; Saleh Taghvaeian; Randy Boman; Sumon Datta, 2019, Impacts of Irrigation Termination Date on Cotton Yield and Irrigation Requirement, Agriculture, 9(2), 39.
ii. Datta, Sumon; Saleh Taghvaeian; Tyson E. Ochsner; Daniel Moriasi; Prasanna Gowda; Jean L. Steiner, 2018, Performance Assessment of Five Different Soil Moisture Sensors under Irrigated Field Conditions in Oklahoma, Sensors, 18(11), 3786.

Presentations
i. Zou, Z. & X. Xiao. 2018. “Divergent trends in surface water area”. Poster presentation at 2018 GIS Day at the University of Oklahoma, Norman, OK.
ii. Wyatt, B.M., T.E. Ochsner, and E.S. Krueger. 2019. Improving seasonal streamflow forecasts by incorporating soil moisture data. SSSA International Soils Meeting. San Diego, CA.

iii. Wyatt, B.M., T.E. Ochsner, E.S. Kreuger, and E.T. Jones. 2019. Improving seasonal streamflow forecasts by incorporating soil moisture data. National Soil Moisture Network annual meeting. Manhattan, KS.

iv. Wyatt, B.M., T.E. Ochsner, E.S. Kreuger, and E.T. Jones. 2019. Improving seasonal streamflow forecasts by incorporating soil moisture data. Oklahoma State University Plant and Soil Sciences Department Research Symposium. Stillwater, OK.

v. Wyatt, B.M., T.E. Ochsner, E.S. Kreuger, and E.T. Jones. 2019. Improving seasonal streamflow forecasts by incorporating soil moisture data. Oklahoma Clean Lakes and Watersheds Association Annual Meeting. Stillwater, OK.

vi. Wyatt, B.M., T.E. Ochsner, E.S. Kreuger, and E.T. Jones. 2019. Improving seasonal streamflow forecasts by incorporating soil moisture data. Oklahoma State University Plant and Soil Sciences Department Seminar. Stillwater, OK.

vii. Wyatt, B.M., T.E. Ochsner, E.S. Krueger, and E. Jones. 2018. Improving seasonal streamflow forecasts by incorporating soil moisture data. National Institutes for Water Resources Regional Symposium. Lincoln, NE.

viii. Wyatt, B.M., T.E. Ochsner, E.S. Krueger, and E. Jones. 2018. Improving seasonal streamflow forecasts by incorporating soil moisture data. Marena, Oklahoma In-Situ Sensor Testbed (MOISST) annual meeting. Lincoln, NE.

ix. Wyatt, B.M., T.E. Ochsner, E.S. Krueger, and E. Jones. 2018. Improving seasonal streamflow forecasts to inform surface water management in Oklahoma by incorporating soil moisture data. Oklahoma State University Plant and Soil Sciences Department Research Symposium. Stillwater, OK.

x. Wagner K, Eck C, Chapagain B, and Joshi), 2019. Oklahoma’s Perspectives on Water Issues and Implications to Water Education Programs. UCOWR/NIWR Annual Water Resources Conference, June 11-13, 2019. Snowbird, Utah.

xi. Mansaray A, Stoodley S, Wagner K, Dzialowski A, and Harris T, 2019. Remote Sensing of Harmful Algal Blooms in the Southern Great Plains. UCOWR/NIWR Annual Water Resources Conference, June 11-13, 2019. Snowbird, Utah.

Information Transfer Program

OWRC utilizes its website (>9,500 visitors annually), bi-monthly Currents e-newsletter (1,100 recipients), biweekly News & Notices (~80 OSU Water faculty recipients), Facebook (343 followers), Twitter (658 followers), and YouTube (402 subscribers), to distribute relevant and timely information on water research findings, funding opportunities, and upcoming events. The OWRC Director delivered 12 presentations to over 472 attendees on Oklahoma water issues, research needs, and opportunities. The OWRC Director also updated Oklahoma's Congressional delegation on OWRC activities in February 2019.

The OWRC's 24-member Water Research Advisory Board met semi-annually in FY18 to discuss water issues, research needs, and results of projects funded by the USGS 104b program. This provides a forum for informing the OWRC of issues and needs and disseminating research findings to water managers.
The OWRC and Oklahoma Water Resources Board co-hosted the Oklahoma Governor's Water Conference and Research Symposium, drawing >400 water professionals, to exchange ideas and information on water issues, policy, and research.

The OWRC and Oklahoma Cooperative Extension Service co-hosted the 2019 Oklahoma Irrigation Conference, providing the >80 participants with the latest research-based insights and information on irrigation management strategies.
Finally, the OWRC co-sponsored and helped plan the 2019 Oklahoma Clean Lakes and Watersheds Association Conference and 2018 NIWR Regional Symposium, Water Resources of the US Great Plains Region: Status and Future. The OWRC Director, along with the 8 other NIWR Directors in the region shared their unique challenges and discussed common issues such as water contamination, irrigation management, water use, reuse, climate change impacts, and others.

Student Support

Seven total students were supported including five PhD students and two undergraduates.

Notable Achievements and Awards

Dr. Saleh Taghvaeian received the 2019 Early Career Award for Extension/Outreach/Engagement from the Universities Council on Water Research.

Projects

Conserving Agricultural Water Resources in Oklahoma using Smart Technologies

Project Type: Annual Base Grant **Project ID:** 2018OK341B

Project Impact: This study assessed the performance of five commercially available soil water sensors under soils with varying salinity and clay content in Oklahoma and investigated use of sensor-reported values in irrigation management. Two sites were selected for performance assessment, one with lower salinity and lower clay content located in central Oklahoma and the other in southwest Oklahoma with higher salinity and higher clay content. To evaluate the performance of the selected sensors, volumetric water content readings were compared with reference volumetric water content values. The results showed similar fluctuations in volumetric water content across all sensors at both study sites. All sensors responded to most irrigation and precipitation events except when the amount of water received was not large enough to reach sensor installation depth. Sensors generally performed better at the lower salinity and lower clay content site than at the higher salinity and higher clay content site. This study contributes to the existing knowledge on sensor-based irrigation scheduling through quantifying the accuracies of five widely-used soil moisture sensors as impacted by soil texture and salinity. The results highlighted the wide range of accuracies that exist among soil moisture sensors and methods for determining soil moisture thresholds. Such a wide range creates major challenges in utilizing soil moisture sensors for irrigation scheduling applications. As new sensors are developed, similar studies need to be conducted under variable field conditions to evaluate the performance of the new sensors and provide guidelines on how they can be used for irrigation scheduling purposes.

Control of Problematic Halanaerobiales that Limit the Reuse of Hydraulic Fracturing Fluids

Project Type: Annual Base Grant **Project ID:** 2018OK342B

Project Impact: Microbial activity, particularly that of sulfide producing microbes such as Halanaerobiales, has the potential to undermine the successful reuse of produced water (PW) from oil and gas production. The goal of this study was to assess approaches to restrict the growth and activity of this organism by altering environmental conditions, using bacteriophage lysis, and identifying possible targets to use inhibitors to interrupt critical metabolic pathways. The study found that adding sodium chloride to PW to reach salinity concentrations >25% NaCl could economically control Halanaerobiales proliferation and its ability to reduce thiosulfate to sulfide. Sulfide production was also significantly (but not completely) inhibited at 1M Mg2+ (24 g/L). When the two (NaCl and MgCl2) were used in combination, sulfide formation decreased 3-fold. This suggests that using PW evaporates containing multiple cations would have an equivalent impact on the growth and activity of microorganisms at lesser concentrations relative to pure NaCl. Next, this study found that induction of viral lysis for the control of problematic Halanaerobiales is not currently practical. Finally, genome interrogation of Halanaerobiales revealed this organism likely reduces thiosulfate via the rhodanese pathway. Biochemical studies of crystallized rhodanese from other organisms detected sufhydryl groups at the catalytic center of this enzyme. Previous research has found that oxidation of sulfhydryl groups to sulfenyl groups effectively inactivated the enzyme suggesting that common oxidizing chemicals (e.g., peroxide, perchlorate, nitrite) could potentially react with the sulfhydryl groups of this enzyme and limit sulfide formation in this organism. Further investigation is needed to confirm this.

Developing seasonal streamflow forecasts to inform surface water management in Oklahoma

Project Type: Annual Base Grant **Project ID:** 2018OK340B

Project Impact: This study evaluated potential improvements from including in situ soil moisture data in principle components regression (PCR) based streamflow forecasts in four rainfall-dominated watersheds in Oklahoma, Arizona and Georgia. A two-step PCR analysis was used to distinguish the presumably first-order control of antecedent precipitation on streamflow from the presumably second-order control of soil moisture. Baseline forecasts made using only antecedent precipitation data were only able to produce forecasts at the 0-month lead time in two of the four watersheds, and no forecasts could be made at longer lead times. The two 0-month baseline forecasts that

were made only explained 27% and 19% of seasonal streamflow variability and were classified as unsatisfactory based on performance criteria described by Moriasi et al. (2007). Conversely, inclusion of soil moisture data in the two-step forecasts led to forecasts being made in all watersheds at all lead times. These forecasts explained 35% - 87% of seasonal streamflow variability, with 0-month forecasts explaining an average of 78% of variability. Of forecasts made using soil moisture data, 88% were rated as satisfactory or better based on the Moriasi et al. (2007) performance criteria. Inclusion of soil moisture data in PCR forecasts improves forecast accuracy, particularly in years when baseline forecast error is high. Results represent the first evidence that the PCR method can produce accurate seasonal streamflow forecasts in rainfall-dominated regions and including soil moisture data in the PCR model increases forecast accuracy over forecasts made using antecedent precipitation data alone.

Evaluating the potential of Sentinel-2 and Landsat images for mapping open surface waterbody areas and water quality in Oklahoma

Project Type: Annual Base Grant **Project ID:** 2018OK343B

Project Impact: This study evaluated using satellite imagery to characterize surface waterbody area and chlorophyll concentrations in waterbodies across Oklahoma. A statewide 10-m resolution waterbody frequency map was successfully generated using 2018 Sentinel-2 imagery showing Oklahoma had ~820 km2 of seasonal waterbody area and ~2670 km2 of year-long waterbody area. This 10-m resolution map provided clearer water body boundaries while capturing small streams omitted in the 30-m map. Stepwise multiple regression analysis of chlorophyll-a data and Landsat imagery from 420 sampling sites was used to characterize chlorophyll concentrations across Oklahoma. Of these, only 165 successfully produced regression models. Performance of these 165 models varied substantially with 5% having R2 0.75. Further, the spectral bands selected by the models varied by site with the blue band being selected by 24 models, the green band by 31 models, the red band by 36 models, the near infrared band by 34 models, the shortwave infrared-1 band by 38 models, the brightness temperature band by 51 models, and the shortwave infrared-2 band by 21 models. The brightness temperature band was included in a third of all regression models indicating temperatures significance in algal bloom development and its potential for chlorophyll-a estimation. Thirty-four chlorophyll-a field measurements were included in analysis of Sentinel-2. Only the Red Edge-2 Band showed significant linear relationships with chlorophyll-a; however, model performance was poor (R2 = 0.313).