your water
OUR FOCUS

The Kansas Water Resources Institute (KWRI) develops and supports research on high-priority water resource problems as defined by the Kansas state water plan. KWRI is designed to facilitate effective communication between water resources professionals and to foster the dissemination and application of research results.

The projects we fund represent key issues affecting Kansas water quality and water resources. These projects have diverse and wide-ranging subjects, including studies on the efficacy of new irrigation technologies, studies on river morphology, drought assessment tools, or water quality assessments.

This newsletter issue focuses on current KWRI projects. If you would like additional information about any project, please contact us at KWRI for more information or email the project leader directly.

KWRI
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FY2020

ACHIEVEMENTS AND PRODUCTS

FY2020

KWRI is committed to fostering excellence in research, at all levels. To that end, we are proud to support faculty and student research at different Kansas universities. KWRI is also a major sponsor of the largest conference on water and water-related research in the state of Kansas.

STUDENT MENTORING PROGRAM

In the summer of 2020, KCARE/KWRI hosted and mentored an undergraduate research student. The student participated in K-State's Summer Undergraduate Multicultural Research Fellowship program. This program supports undergraduate students from 1890 Land-Grant Institutions and Historically Black Colleges and Universities in a summer-long research experience to introduce multicultural students to the possibilities of Graduate research. KCARE/KWRI's student is a junior at Florida A&M University studying bio and ag engineering. His summer research focused on literature review and in-field assessments of the effectiveness of aeration, barley straw bale implementation, and sand filtration to mitigate harmful algae blooms.

PUBLICATIONS

4 Peer reviewed articles
1 Open file report
1 Dissertation

WEB-BASED PRODUCTS

Dataset: *soilwater.ksu.edu*
Hydrological network: *konzapulse.org*
Web app: *Kansas Mesonet Soil Moisture Explorer App*

CONFERENCES

12 Conference presentations
8 Invited talks
4 PI Poster presentations

STUDENT SUPPORT

16 Undergraduate students
11 Graduate students
1 Postdoctoral researcher

MAPPING AND MODELING OF INTERBASIN WATER TRANSFERS WITHIN THE UNITED STATES

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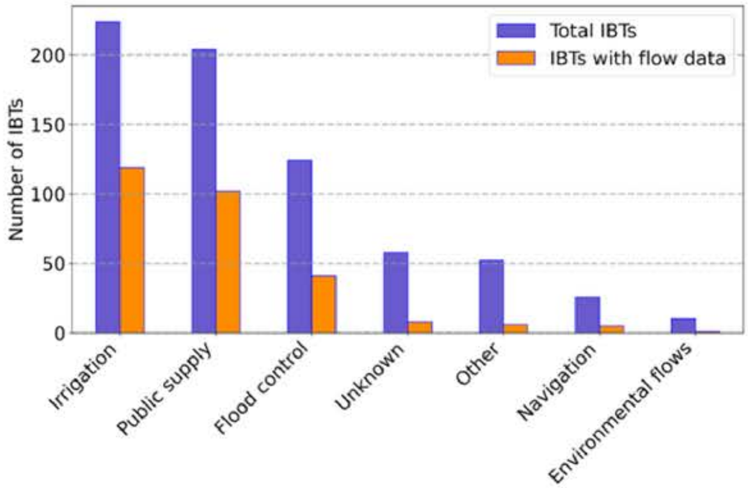

Figure 1. Primary purpose of interbasin water transfers in the United States.

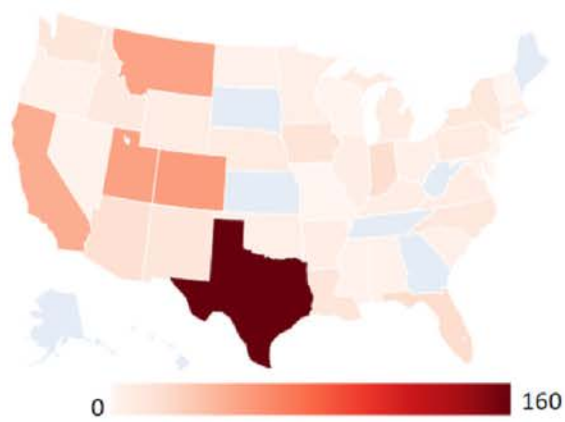

Figure 2. Spatial distribution of interbasin water transfers by state.

In finishing up the first phase of this research project, a beta version of the national inventory of interbasin water transfers (IBTs) has been created, including data on the average annual water transfer rates, the purpose of the transfer, the origin (source) location, the destination for the transfer, as well as other pertinent information, particularly as it relates to infrastructure characteristics. A relational database structure that is used for our data collection and storage efforts has also been created. A detailed set of data standards has been created to standardize the diverse data provided to the research and ensure consistency across everyone on the team of researchers. A data collection survey was created to ensure that data collection efforts are replicable and remain consistent across states. A complete digital mapping of interbasin water transfers was also created that can be easily related to our tabular database.

The study has revealed over 700 IBTs between HUC 4 basins in the United States. (**Figure 1**) Of these 700 IBTs, more than 70% are for either irrigation, public water supply, or flood control. Average annual flow data has been collected for nearly 300 of these IBTs, and time series flow data for over 150 of these projects. IBTs are found throughout the United States but are most prevalent in the western United States. (**Figure 2**)

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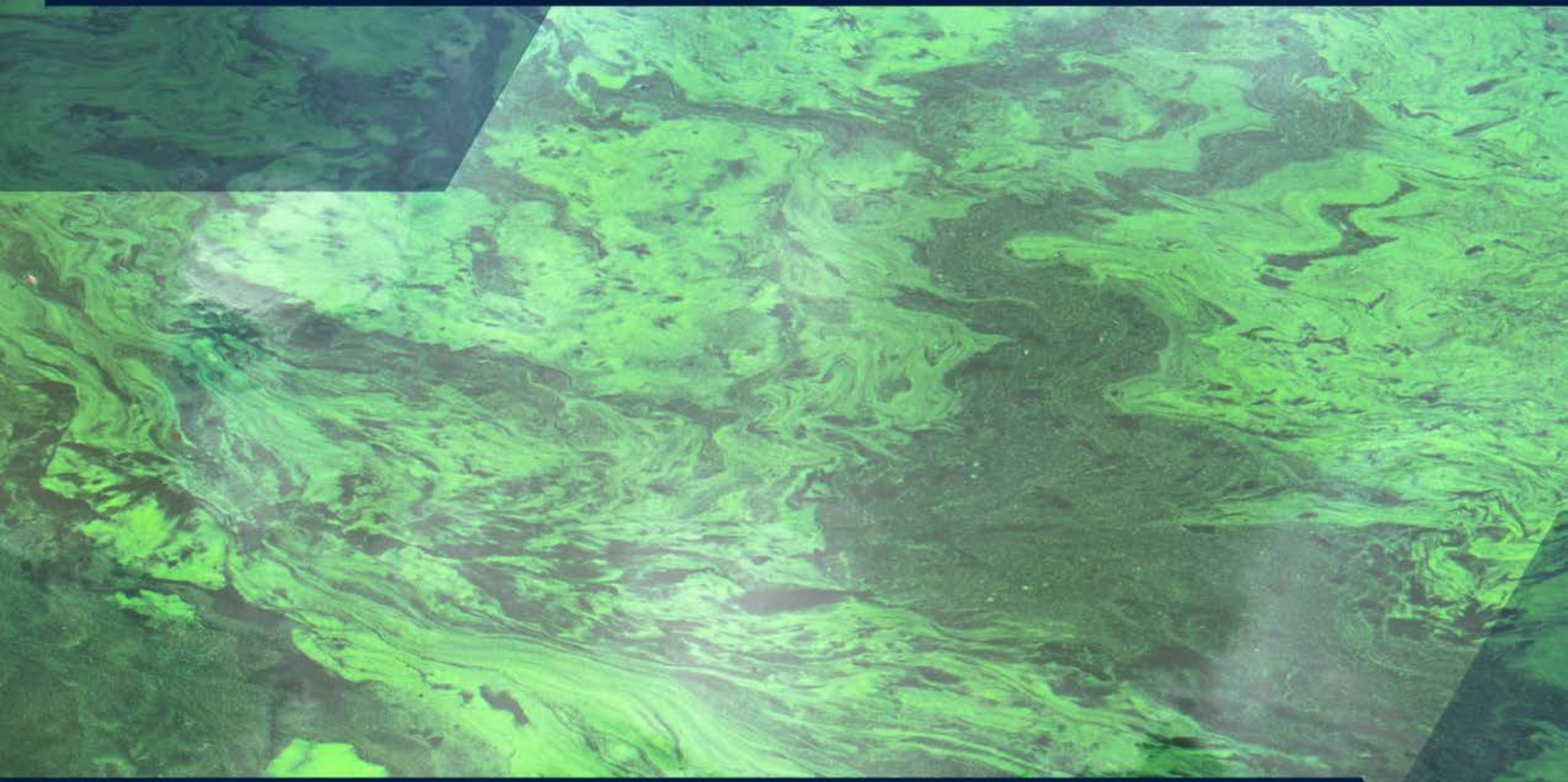

INTEGRATED DATA SCIENCE

Mechanistic modeling framework to predict cyanoHABS in contrasting freshwater systems

The overall goal of this project is to develop a flexible modeling framework for predicting cyanoHAB events, as well as to provide insight to drivers of toxic blooms. Many freshwater systems across the nation are stressed by the economic and ecological impacts of repeated cyanoHAB events; thus accomplishing this objective is expected to advance HAB management responses. Toward achieving this goal, primary findings in this first year stem from observational monitoring data collected from Marion Reservoir after establishing in-situ monitoring sites. The lake experienced cyanobacteria blooms beginning in May 2021, which produced detectable amounts of the toxin Microcystin at concentrations up to an order of magnitude higher than WHO guidelines for drinking water and approaching WHO guidelines for recreational waters. Multiple, bloom peaks were detected between May and August; preliminary analysis indicated correlation between high water surface temperatures and stable water column (e.g., low wind) but more thorough analysis of multi-dimensional data with fuzzy and other data-based/machine learning methods is needed. Continued monitoring through the late fall and winter will provide insight to environmental conditions leading up to anticipated bloom season in the coming project year. USGS project partners at the New York data science center have continued collecting in-situ water quality and phytoplankton community data for selected lakes in the Finger Lakes Region. Framework for analyzing and modeling data from these two distinct lake systems (Marion Reservoir and Skaneateles of the Finger Lakes) was developed and will be applied and refined in the coming project year.

BENTHIC CYNAOBACTERIAL MATS

A potential cource of harmful and nuisance compounds to Kansas streams

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Samples were taken approximately every week for three months from nine benthic algae locations and analyzed for cyanotoxin concentration as well as taste-and-odor compounds. The nine sites are distributed across a land use gradient, posing the question: “does land use impact the occurrence and intensity of toxic and nuisance compounds that emanate from benthic algal mats?”. Preliminary findings show that microcystin and geosmin are ubiquitous in the Johnson County area; every sample has contained measurable quantities of the two substances. So far, there does not appear to be a clear trend between toxin concentration and urban land use. Instead, all land uses show elevated microcystin and geosmin concentrations. Analysis will also be performed on genomic and taxonomic data of the mats, and there may be information there that provides some explanation as to the genes and communities responsible for elevated toxin and nuisance compound concentrations. The impact of this project will be an improved understanding in where toxic and nuisance compounds originate so that water resources can be preserved and drinking water supplies can be protected.

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Improving irrigation water use efficiency using novel root sensors

Irrigation scheduling assumes a soil depth of 1.5 m for water storage and availability, and assumes roots explore this entire soil volume. However, corn seedlings do not reach 1.5 m of rooting depth until later vegetative growth stages. Thus, irrigation during early vegetative growth could theoretically be reduced based on current rooting depth. It was hypothesized that an automated minirhizotron camera system could monitor rooting depth and be used to adjust irrigation scheduling. An inexpensive, automated minirhizotron camera system was developed. This experiment was conducted during the 2020 and 2021 corn growing seasons at the North Central Experiment Field near Scandia, Kansas. Irrigation water availability at this location is limited by the irrigation district during the early growing season. In addition, the camera system can observe rooting depth to a maximum depth of 1 m. Thus, the time in which irrigation scheduling can be modified is bounded by water availability and rooting depth.

In 2020 mechanical problems were experienced with the first iteration of camera designs during this critical time period, and were not able to capture root images prior to the corn plants reaching a rooting depth of 1 m. In 2021 the irrigation system was broken during this critical time period, though rooting images were acquired. As a result, planned irrigation treatments were not imposed. Going forward historical records of corn planting dates and irrigation water availability will be explored to determine if early-season irrigation can be adjusted in this region of Kansas.

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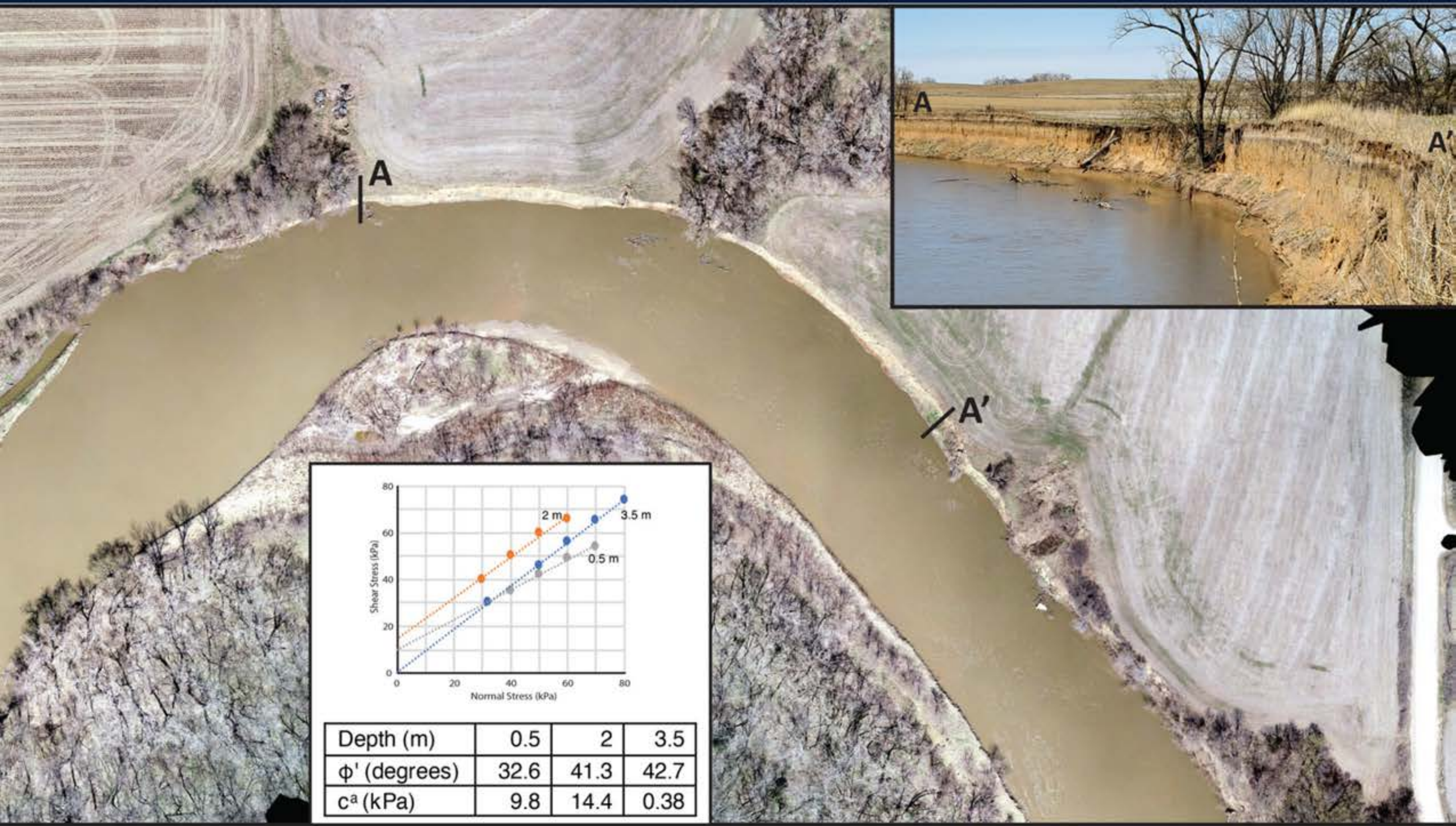

Depth (m)	0.5	2	3.5
ϕ' (degrees)	32.6	41.3	42.7
c^a (kPa)	9.8	14.4	0.38

Simulating the effects of reservoir management strategies on in-stream sediment load, streambank stability, and water quality

A model was developed that calculates a factor of safety for stream reaches. This model interfaces with the existing hydrological model of the Lower Republican River Basin. The model is currently being tested and validated and a sensitivity analysis will be conducted. Once complete, the model will be used to demonstrate the impact of different water management strategies on streambank stability in the basin.

The geotechnical characteristics of streambanks were measured at five sites. Data are being used to develop the reservoir management model to simulate streambank stability. Aerial surveys were conducted with an unmanned aerial vehicle (drone) at five sites. Flight images were processed to generate DEMs of the streambanks. Future flight surveys will be conducted to quantify the volume of material eroded at each site.

Depth-resolved soil nutrient concentrations were measured at the five sites where bank erosion estimates were conducted. Soil samples were analyzed for total phosphorus, nitrate and ammonium. The data are being used along with the bank erosion estimates to determine the potential amount of phosphorus and nitrogen contributed by bank erosion.

Erin Seybold, PI erinseybold@ku.edu

Spatial variability and subsurface controls of groundwater recharge and nutrient mobilization in dry streams

The first project year focused on characterizing the historical streamflow intermittency regime of the Arkansas River at Larned, KS, understanding the drivers of flow intermittency, and the feedbacks that may determine whether the river remains in a wet/flowing vs. dry/not-flowing state. It was found that historical stream intermittency is characterized by alternating shifts between 'wet' (flowing) and 'dry' (no-flow) regimes spanning multiple years. Wet and dry regimes were associated with wetter and drier than average climate conditions at the annual time scale but were not as responsive to seasonal (three-month) climate conditions.

Multiple lines of evidence suggested that wet and dry regimes represent alternative stable states that are driven by ecohydrological feedbacks among stream-aquifer interactions, climate, vegetation, and pumping. This suggests that widespread observed shifts from perennial to non-perennial flow may be difficult to reverse. Work in project year 2 will focus on geophysical research that can constrain the subsurface structure which drives these feedbacks, and characterization of biogeochemical processes occurring during wet up and dry down events.

Andres Patrignani, PI andrespatrignani@ksu.edu

A new statewide system for tracking and forecasting drought

One of the primary outcomes of this project was the generation of a benchmark database of soil physical properties for the Kansas Mesonet environmental monitoring network. The database includes observations of soil physical and chemical properties at four soil depths at 40 locations across the state. This database can be used for improving drought monitoring, modeling of ground water recharge rates, and study carbon stocks across Kansas precipitation gradient.

The database adds value to the infrastructure of existing soil moisture sensors at each station of the Kansas Mesonet and helps to put in context the soil moisture readings from these sensors. The Kansas Mesonet and the Konza Pulse hydrological network are currently being used to validate a statewide gridded soil moisture product at 1-km spatial resolution.

Reza Barati, PI reza.barati@ku.edu

Experimental and modeling investigation of fluid-fluid and rock-fluid compatibility between Arbuckle and Lansing Kansas City formations with the purpose of produced water-exchange between the two formations to reduce both fresh water usage and water disposal problems

This work consisted of fundamental physical phenomena modeling, experimentation with real-world samples, and preliminary economic modeling to advance the use of low-salinity oil and gas wastewaters (produced water) for enhanced oil recovery in high-salinity oil-producing formations. First, an extended surface complexation model was developed to predict the zeta potential at calcium carbonate rock surfaces in different brine compositions. This model is critical to effectively predict the compatibility of the brine to enhance oil recovery and promote the beneficial reuse of produced waters.

Results indicate that the use of produced water creates a negative surface charge on carbonate rocks, which repels oil and enhances the oil recovery. Next, to assess the geochemical compatibility of the produced water, formation brine, and formation rock, real-world samples were mixed and assessed for precipitation and dissolution over a two-month period. No change in the geochemistry was observed indicating the produced water's compatibility with the formation brine and rock.

Last, to quantify limits to the beneficial reuse of produced waters, a preliminary economic model was constructed. Monte Carlo simulations were performed. Preliminary results have established a Pareto frontier that could help guide decision-making when assessing the reuse of produced water.

Governor's Conference on the Future of Water in Kansas

The eighth statewide Governor's Conference on the Future of Water in Kansas was held virtually on November 9-10, 2020. The ninth statewide Governor's Conference on the Future of Water in Kansas was held virtually on November 17-18, 2021. Both conferences were highly successful with over 600 people attending each year. Governor Laura Kelly fully supports this conference and has expressed her concern about preserving and protecting the future viability of water in Kansas.

Scientific presentations, panel discussions and invited presentations focused on various topics pertaining to water use and water resources. Scientific posters and graduate and undergraduate student posters were presented during the poster session. Two undergraduate and two graduate student posters were awarded a cash prize to encourage student participation. A water photo contest was held with the best photo being selected by vote from conference participants.

Information about this annual conference can be found at https://kwo.ks.gov.