Kansas Water Resources Institute
Kansas State University Research and Extension

Annual Technical Report
2019

Products

Peer Reviewed:

Gaskill, J.A., Harris, T.D., North, R.L. 2020. Phytoplankton Community Response to Changes in Light: Can Glacial Rock Flour be used to Control Cyanobacterial Blooms? *Frontiers in Environmental Science* 8:180-201. https://www.frontiersin.org/article/10.3389/fenvs.2020.540607

Gowravaram, S., Chao, H., Molthan, A., Zhao, T., Tian*, P., Flanagan, H., Schultz, L., Bell, J., 2020. Spectral reflectance estimation of UAS multispectral imagery using satellite cross-calibration method. *American Society for Photogrammetry and Remote Sensing*, in review.

UAS monitoring of streambank erosion in incised channels. In prep. To be submitted to *Midcontinent Geoscience,* Spring 2021.

An assessment of the effectiveness of streambank stabilization projects on the Cottonwood
River via UAS monitoring. In prep. To be submitted to *Geomorphology*, Summer 2021.

Bigham, K. 2020. Streambank stabilization design, research and monitoring: the current state and future needs. *Transactions of the ASABE* 63(2): 351-387. Doi: 10.13031/trans.13647.

Dickson, K., Marston, L., & Dzombak, D. (2020). Editorial Perspectives: The need for a comprehensive, centralized inventory of interbasin water transfers. *Journal of Environmental Science: Water Research and Technology*, 6, 420-422. Doi: 10.1039/D0EW90005B.

Marston, L. T., Lamsal, G., Ancona, Z. H., Caldwell, P., Richter, B. D., Ruddell, B. L., Rushforth, R. R. & Davis, K. F. (2020). Reducing water scarcity by improving water productivity in the United States. *Environmental Research Letters*, 15(9), 094033. https://doi.org/10.1088/1748-9326/ab9d39

Konar, M., & Marston, L**.** (2020). The Water Footprint of the United States. *Water*, 12(11), 3286. https://doi.org/10.3390/w12113286

A.Y. Sheshukov, Gao, J., K.R. Douglas-Mankin, H. Yen. (2021) Observed Data Source used for Bias Correction Introduces Variability and Uncertainty to Downscaled Climate Projections for Hydrologic Modeling. *Transactions of the ASABE*. 64(1). https://doi.org/10.13031/trans.14061.

Book and Book Chapters

Moorberg, C., editor. 2019. Soil and Water Conservation: An Annotated Bibliography. New Prairie Press, Manhattan, KS.

Moorberg, C., A. Aubert, E. Brevik, I. Euler, T. Gillespie, B. Hogan, M. Owens, and D. Stich. 2019a. Conservation Practices for Shorelines, Streams, and Wetlands. Soil and Water Conservation: An Annotated Bibliography. New Prairie Press, Manhattan, KS

Moorberg, C., A. Aubert, M. Brungardt, E. Carver, K. Fross, T. Gillespie, S. Indorante, A. Lester, M. Owens, E. Purvis, L. Starr, D. Stich, C. Sutterby, M. Tynon, and A. Williams. 2019b. Conservation Agencies. Soil and Water Conservation: An Annotated Bibliography. New Prairie Press, Manhattan, KS

Oral or Poster Presentations:

Harris, T.D. 2020. Nutrient ratios impact phytoplankton community structure and metabolite occurrence. Kansas Biological Survey Ecology Seminar. 11-Sep.

Harris, T.D. 2020. Non-substitutable and substitutable resource ratio theory in phytoplankton ecology: Testing theory at large-scales. Wichita State University Biological Sciences Seminar. 31-Aug (Invited)

Harris, T.D. 2020. Nutrient ratios impact phytoplankton community structure and metabolite occurrence. Kansas Biological Survey Ecology Seminar. 11-Sep
Harris, T.D. 2020. Non-substitutable and substitutable resource ratio theory in phytoplankton ecology: Testing theory at large-scales. Wichita State University Biological Sciences Seminar. 31-Aug (Invited)

Gaskill, J.A., Harris, T.D., deNoyelles, F., Burgin, A., Shields, A., Baker, S., Webb, L., Klepikow, R., Mash, H., North, R. L. 2020. Can glacial rock flour be used to control cyanobacterial blooms? Kansas Harmful Algal Bloom Conference. Topeka, KS, USA. 22 Jan. (Invited)

North, R.L. 2020. Missouri reservoirs: are they toxic? Presented at the Big Muddy Speaker Series, Online Webinar.

North, R.L. 2020. Are green water bodies toxic water bodies? Presented at the Population, Education, and Health Seminar Series, University of Missouri-Columbia, Missouri, USA.

Yun, J.H., Gaskill, J.A., Baker, S., Webb, L., Klepikow, R., Mash, H., North, R.L., Harris, T.D. 2020. Influence of nitrogen form on phytoplankton community composition and cyanotoxin production in nitrogen- and phosphorus- deficient outdoor mesocosms. ASLO/SFS 2020 Joint Meeting, Madison, Wisconsin, USA. (Cancelled due to COVID-19).

Gaskill, J.A., Harris, T., North, R.L. 2019. Phytoplankton response to changes in light: can glacial rock flour be used to control cyanobacterial blooms? Poster presented at the Global Lake Environmental Observatory Network (GLEON) Meeting, Ontario, Canada.

Gaskill, J.A.,, Harris, T., North, R.L. 2019. Phytoplankton response to changes in light:

can glacial rock flour be used to control cyanobacterial blooms? Poster presented at the Great Plains Limnology conference, Ames, Iowa, USA.

Gaskill, J.A., Harris, T.D., deNoyelles, J., Burgin, A., Shields, A., Baker, S., Webb, L., Klepikow, R., North, R. L.. 2019. Using a novel geoengineering technique for harmful algal bloom mitigation. Presented at (i) Missouri Life Sciences Week 15-20 Apr. & (ii) School of Natural Resources research day 10-May. Columbia, MO, USA. (poster)

Gaskill, J.A., Harris, T.D., deNoyelles, J., Burgin, A., Shields, A., Baker, S., Webb, L., Klepikow, R., Mash, H., North, R. L. 2019. Exploring phytoplankton response to changes in light and nutrients in mesocosm tanks: Can glacial rock flour be used to control cyanobacterial blooms? Association for the Sciences of Limnology and Oceanography Conference. San Juan, Puerto Rico. 25 Feb.

Harris, T.D., Gaskill, J.A., deNoyelles, J., Burgin, A., Shields, A.R., Baker, S. Webb, L. Klepikow, R., Mash, H., North, R.L. 2018. Large-scale harmful algal bloom experiments at the University of Kansas Field Station. Governor's Conference on the Future of Water in Kansas, Manhattan, KS, USA. November 14 th .

Gaskill, J.A., Harris, T.D., deNoyelles, J., Burgin, A., Shields, A., Baker, S., Webb, L., Klepikow, R., Mash, H., North, R. L. 2018. Can glacial rock flour be used to reduce algal biomass in large-scale mesocosms? Great Plains Limnology Conference. Lawrence, KS, USA. Oct. 6 th . (poster)

Overstreet, E.V., Harris, T.D., Kelly, M.C., deNoyelles, J., Burgin, A.J. 2018. How do nitrogen form and ratio affect nitrogen fixation rates in experimental mesocosms? Great Plains Limnology Conference. Lawrence, KS, USA. Oct. 6 th . (poster)

Layzell, A.L., 2020. Assessing the effectiveness of streambank stabilization projects. Environmental Protection Agency Region 7 Nonpoint Source Virtual Annual Meeting, July 16.

Layzell, A.L., 2020. Streambank stabilization research in Kansas. Kansas Water Office Webinar, August 25.

Gowravaram*, S. 2020. Radiometric Correction of Digital UAS Multispectral Imagery Using Free and Open Satellite Surface Reflectance Images. 100th American Meteorological Society Annual Meeting, Special Symposium on Meteorological Observations and Instrumentation, January 11-16.

Layzell, A.L., 2019. The use of Unmanned Aircraft Systems to assess streambank erosion and related engineering solutions. Governor's Conference on the Future of Water in Kansas, Wichita, KS. November 9-10.

Layzell, A.L., 2018. Streambank stabilization effectiveness in the Cottonwood/Neosho River Basin. Governor's Conference on the Future of Water in Kansas, Manhattan, KS. November 13-14.

Bigham, K. , Keane, T., Moore, T. 2020. Understanding channel erosion processes to inform streambank stabilization design. Poster presentation at the American Society of Agricultural and Biological Engineers Annual International Meeting (virtual), July 2020.

Are streambank stabilization systems reducing sediment supply and reservoir sedimentation? Bigham, K.[1] Oral presentation at the Kansas Governor's Water Conference, Wichita, KS, November 2019.

Evaluation of the reach-scale effects of streambank stabilization structures on the Cottonwood River, Kansas. Bigham, K., Burden, Maxwell, Moore, T.L., Keane, T., Kulesza, S., Sheshokov, A. Poster presentation at the Kansas Governor's Water Conference, Manhattan, KS, November 2018.

Islam, M.A., Y. Zhou, A.Y. Sheshukov (2020). Implementing process-based modeling framework for understanding cyanobacteria dynamics using various environmental factors. ASABE International Virtual Meeting. 7-10 July, 2020. ASABE Paper 1901426.

Islam, M.A., C. Weerasekara, Y. Zhou, A.Y. Sheshukov (2019). Ephemeral Gully Erosion Modeling and Surveying with Close-range Digital Photogrammetry. International ASABE Meeting. Boston, MA, 7-10 July, 2019. ASABE Paper 1901426. https://doi.org/10.13031/aim.201901426.

Marston, L., Mapping and modeling of interbasin water transfers within the United States, USGS Water-Use Open Forum, Cyberseminar, 29 July 2020.

Marston, L., Mapping and modeling of interbasin water transfers within the United States, AGU Hydrology Days, Colorado State University, Fort Collns, CO, 14 April 2020 (held virtually).

Moorberg, C.J. 2020. Open Textbooks and Soil Science Education. North Central National Cooperative Soil Survey Regional Conference. Columbia, MO.

Moorberg, C.J. 2020. Developing an open annotated bibliography to improve student engagement and combat rising textbook costs. ASA-CSSA-SSSA International Meeting. Phoenix, AZ

Moorberg, C.J. 2020. Annotated bibliographies and open textbooks in agriculture: A case study. NACTA Journals Abstracts. Vol. 26(1). p. 167.

Moorberg, C.J. 2020. Development and Use of an annotated bibliography as an open textbook for soil and water conservation. SWCS 75th International Annual Conference Abstract Book. p. 184.

Moorberg, C.J. 2020. Development of Soil and Water Conservation: An Annotated Bibliography. Kansas Natural Resources Conference. Manhattan, KS. 30-31 Jan. 2020.

Isaiah Euler. 2019. Riparian Buffer Strip Escapade. AGRON 405 – Internship in Agronomy Poster Showcase. September 12, 2019.

Daniel Stich. 2019. Still Buffering? AGRON 405 – Internship in Agronomy Poster Showcase. September 12, 2019.

Lucas Scott. 2018. Phosphorus Concentrations in Kansas Buffer Strips. AGRON 405 – Internship in Agronomy Poster Showcase. September 13, 2018.

Thesis:
Md Atiqul Islam. 2020. Cyanobacterial harmful algal bloom modeling in eutrophic water bodies, MS Thesis. Kansas State University. Manhattan, KS. 109 p. Available at https://hdl.handle.net/2097/40914.

Information Transfer Program

The KWRI maintains a website that is used to transfer project results, inform the public on water issues and contact scientists with grant opportunities. An annual newsletter is prepared and posted on the website. News and updates are also sent to followers via a Facebook page and a twitter account.

KWRI supported the Governor's Water Conference which is held each November. Approximately 600 people attend the conference including legislators, researchers, NGOs, small town representatives, landowners and farmers.

Ted Harris was interviewed on NPR to discuss the funded study "Does nutrient form control harmful algal bloom (HAB) toxin release?" and collaborator North was interviewed on WROC (CBS affiliate in Rochester, NY) on mitigating harmful algal blooms. Both the University of Kansas and the University of Missouri produced media about the project or related projects within their media programs.

Data collected from the funded study "Assessing the effectiveness of streambank stabilization projects on the Cottonwood River using Unmanned Aircraft Systems (drones)" about development of KHawk UAS platforms were integrated into the Aerospace Instrumentation class (AE 430) taught by Dr. Chao (Spring 2019 and 2020). A total of 34 undergraduate students in 2019 and 47 undergraduate students in 2020 were lectured on GPS sensor accuracy. Students formed teams of 2 to conduct a lab on GPS data collection, processing, and error quantification.

AGRON 635 – Soil and Water Conservation Field Trip. A field trip was developed as a regular laboratory activity that trains AGRON 635 students how to assess streambank

stability and estimate rates of streambank erosion. This is now a regular laboratory activity in AGRON 635 – weather and river conditions permitting.

Student Support

Students supported by 104B and 104G grants were:
16 Bachelor of Science
6 Master of Science
1 PhD
1 Post-Doc

Notable Achievements and Awards

Governor's Water Conference Student Poster Award Winners:

Runner up Undergraduate ($125)
School: University of Kansas
Poster title: Designing And Implementing A Platform For Remotely Sensing High-Frequency Water Quality Data Across An Urbanization Gradient

Runner up Graduate ($125)
School: Kansas State University
Poster title: Conserving Kansas Communities Through Voluntary Group Efforts to Manage Ogallala Groundwater

1st Place Undergraduate ($250)
School: University of Kansas
Poster title: Sediment Source Assessment Along an Urban to Rural Transition Using Stable Isotopes and Geochemical Tracers

1st Place Graduate ($250)
School: University of Kansas
Poster title: Understanding how upgrading the Tomahawk Wastewater Treatment Facility affects Indian Creek sources of impairment, Indian Creek, KS

Determining If Riparian Buffer Strip Age Impacts Phosphorus Retention Potential

Project Type: Annual Base Grant
Project ID: 2019KS109B

Project Impact:

Twenty-four buffer strips along three river systems in northeast Kansas were evaluated, including eight along the Big Blue River, 10 along the Little Blue River, and six along the Republican River. Most buffer strips were implemented to stabilize previously eroding tracts of river banks. Forested buffer strips are preferred over grassed buffers for streambank stabilization in this region of Kansas. Thus, more forested buffer strips were available for investigation than grassed strips. The 24 sites included four grassed buffers along the Big Blue River and one along the Republican River. Three transects were set up at each site extending across the buffer strip from the streambank towards the crop field. A streambank stability assessment was performed at each transect. Five soil sampling points were established for each buffer strip, including one at the slope break, one at the field edge, one in the field, and two in the buffer strip between the slope break and field edge. Each sampling point was sampled for soil phosphorus samples at 0-15 cm, and 15-60 cm depths, and sampled for bulk density at the surface. Total and Mehlich III extractable phosphorus are currently being analyzed by the Kansas State University Soil Testing Lab. Soil phosphorus results, analysis, and an estimation of phosphorus export to streams via streambank erosion are forthcoming. The age (years since the buffer was established) was shown to be a significant factor in the streambank stability assessment score, with older buffer strips exhibiting less stability and higher rates of streambank erosion.

Evaluation Of The Geomorphological Adjustment Of A Meandering, Alluvial River Subject To Streambank Stabilization Structures

Project Type: Annual Base Grant
Project ID: 2019KS110B

Project Impact:

The primary objective of this study was to measure the short-term, reach-scale impacts of streambank stabilization projects (SBS) on a meandering, alluvial river that outlets into a federally-owned reservoir.
A 2D HEC-RAS model was developed to estimate boundary shear stresses exerted by streamflow prior to SBS construction. ADCP measurements will be repeated after SBS installation so that post-construction HEC-RAS models can also be calibrated.
Modeled shear stresses can be used to support interpretation of field observations. The cross sections that experienced the highest rates of bank losses are coincident with the region of high shear stress leading into the downstream-most meander bend.
Streamflow during the large event would have been in contact with upper bank materials, and thus shear stresses exerted by flowing water may have played a substantial role in the observed loss of upper-bank material.
An analysis of historical aerial imagery was performed to estimate relative changes in streambank position and geometry. While the results of this analysis are not directly comparable to channel cross sections measured in the field over the course of this study, they do align with observations of accelerated channel widening. Accelerated widening was evident through analysis of historical images. Thus, we conclude that historic images provide a window back to relative erosion bank erosion rates. Given patterns of observed bank erosion in the study cross sections we would advise against using changes in bank position obtained through historical images to quantify streambank erosion volumes.

Stochastic Forecasting Of Harmful Algae Blooms In Cheney Reservoir

Project Type: Annual Base Grant
Project ID: 2019KS111B

Project Impact:

The developed mechanistic modeling framework for cyanobacteria growth in well-mixed water bodies was capable of making short-term predictions of cyanobacteria concentrations. The factors of water temperature, irradiation, and phosphorous and nitrogen concentrations were used as driving environmental factors. The model performed better for short-term predictions than for long-term forecasting with 2-day time-step found to be beneficial. Performance of reduced models can be considered under nutrient-enriched eutrophic conditions. The analysis found that 15-day interval data monitoring can be sufficient for predictive purposes. The results were impacted by combined interactions of temperature, irradiance and nutrients. HAB occurrences can be negatively impacted by extended drought periods with warmer weather, stagnant water, nutrients influx, and sunlight. Implementation of conservation practices can reduce the amount of nutrients reaching streams and lakes, control cyanobacteria growth rate and limit the frequency of blooms.
We implemented an uncertainty quantification methodology based on the Fokker-Planck equation and developed a solution that represents HAB concentration at different times in the form of probabilistic density functions (PDF). PDF of cyanobacteria concentration quantifies the uncertainty and stochasticity of HAB dynamics in a lake system. Analysis based on this approach provides temporal snapshots of cyanobacteria concentration PDF to understand probabilistic risks in cyanobacteria propagation. A significant effect of uncertainty in initial concentration on resulting uncertainty in cyanobacteria concentration forecasting is observed from the analysis. This suggests that facilitating a continuous lake monitoring system with frequent updates to physical parameters can provide higher certainty in setting initial concentration and reduce uncertainty in cyanobacteria propagation.

Does Nutrient Form Control Harmful Algal Bloom (HAB) Toxin Release?

Project Type: Annual Base Grant
Project ID: 2019KS112B

Project Impact:

The project goal was to determine how different nutrient limitation (nitrogen –N and phosphorus-P) regimes and nutrient forms (N forms – NO 3 and NH 3) affect cyanobacteria populations and cyanotoxin (microcystin) concentrations in Kansas reservoirs. A large-scale tank experiment was used to determine the response of CyanoHABs and the cyanotoxin microcystin to differing macro-nutrient limitations and nitrogen forms. CyanoHAB response was variable between treatments but seemed to favor CyanoHAB taxa over other phytoplankton taxa in nitrogen-limited conditions. Median microcystin concentrations were substantially higher in treatments where nitrogen and phosphorus were added compared to treatments with nitrogen or phosphorus. Treatments where only phosphorus was added yielded CyanoHAB biovolume similar to other nitrogen limited treatments, but relatively little cyanotoxins. Our study shows a relatively strong link between nitrogen and nitrogen-rich cyanotoxins like microcystin.

Although the scope of the funded project by KWRI was to determine how nutrient type and form affected growth and toxicity of blooms, blooms created within tanks were also used to test CyanoHAB mitigation measures. For example, Gaskill tested if glacial rock flour additions were able to disrupt blooms via light limitation. Because multiple state and federal agencies have interest in understanding and mitigating CyanoHABs, the study funding also yielded collaborations with EPA ORD, EPA R7, and the University of Missouri limnology laboratory. Data collected as part of the collaborative team studying CyanoHABs at KUFS in large-scale tanks will be published as part of a journal article currently in preparation with team members.

Mapping And Modeling Of Interbasin Water Transfers Within The United States

Project Type: National Competitive Grant
Project ID: 2019KS015G

Project Impact:

We are currently finishing up the first phase of this research project. At the conclusion of phase 1, we will produce a beta version of our national inventory of interbasin water transfers (IBTs), 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. We have created a relational database structure that is used for our data collection and storage efforts. A detailed set of data standards has been created so to standardize the diverse data provided to us and ensure consistency across our team of researchers. We also created a data collection survey so to ensure our data collection efforts are replicable and remain consistent across states.

COVID-19 Impact on Research – Though we have made significant progress to date due to our detailed preparations, the ongoing pandemic has started to slow our efforts. As the pandemic and economic shutdowns began to take hold across the nation, state agency contacts – our key source of IBT data – have been increasingly unresponsive. We expect a low response rate, and in turn a slowing in data collection, to continue until state agencies resume normal work practices and their backlog of critical duties are complete. We have taken measures to help mitigate the impact of these unforeseen events, including redirecting student workers whose state contacts have been unresponsive to other states or placing them on other tasks, such as mapping IBTs. We have also slowed our spending of project funds so to ensure funds are available when we are able to ramp back up again.

Assessing the effectiveness of streambank stabilization projects on the Cottonwood River using Unmanned Aircraft Systems (drones)

Project Type: Annual Base Grant
Project ID: 2019KS113B

Project Impact:
This study has shown that UAS technology can be utilized as a cost-effective means to (1) obtain high-resolution spatial data, (2) monitor geomorphic change, and (3) specifically assess the effectiveness of streambank stabilization (SBS) projects. Results from two years of UAS monitoring, coupled with historical pre-construction assessment, indicate that SBS projects significantly reduce erosion locally at the stabilized site. Our assessment shows the importance of normalizing estimates of the volume of material eroded at each site to appropriately determine the effectiveness of SBS projects. However, quantification of sediment reduction and efficiency of SBS projects is only possible with accurate and representative baseline data. Pre-construction UAS monitoring, where possible, would provide a valuable baseline dataset. Such baseline data have been collected for proposed SBS sites C102 and C112, which are currently scheduled to be constructed in the spring of 2021. Future work will focus on continued post-construction monitoring of SBS sites, with a strong emphasis on proposed sites C102 and C112. Also, there is significant variability in terms of volumes eroded between individual sites that warrants further investigation. Finally, potential upstream and downstream effects of SBS projects remain to be assessed in order to thoroughly evaluate SBS effectiveness. Future work will seek to incorporate the KHawk v2 UAS platforms developed as part of this study. In particular, the KHawk Flamewheel UAS, modified to support LiDAR capability, will have great value for SBS monitoring as LiDAR can penetrate dense vegetation thereby overcoming one of the major limitations of photogrammetry-based UAS surveys.

2019 Governor’s Water Conference

Project Type: Annual Base Grant
Project ID: 2019KS108B

Project Impact:
The seventh statewide Kansas "Governor's Conference on the Future of Water in Kansas Conference" was held on November 6-8, 2019 in Wichita, Kansas. The conference was highly successful with 610 people registered and attending. Attending the conference was the Lt. Governor of Kansas, Lynn Rogers, and several state and national senators and representatives. The Governor fully supports this conference and has expressed her concern about the issue of preserving and protecting the future viability of water in Kansas. Forty-eight volunteer scientific, two panel discussions and five invited presentations were presented in plenary and concurrent sessions. One Faculty/Staff/Professional scientific posters, nine graduate student posters and six undergraduate posters were presented during the poster session. An undergraduate/graduate student poster award program was conducted to encourage student participation. The conference will be held again on November 9-10, 2020 in Wichita, Kansas. The conference website is located at:
https://kwo.ks.gov/news-events/governor's-water-conference#39;s-water-conference