Office of Water Programs
The University of Wyoming

Annual Technical Report
2018

General Information

Products

1. DeStefano, Audra, Jiashi Yin, Theodore J. Kraus, Bruce A. Parkinson, and Katie Dongmei Li-Oakey, 2018. Elucidation of Titanium Dioxide Nucleation and Growth on a Polydopamine-Modified Nanoporous Polyvinylidene Fluoride Substrate via Low-Temperature Atomic Layer Deposition, ACS Omega, 3: 10493?10502, https://doi.org/10.1021/acsomega.8b00864. (Project 2017WY93B)
2. DeStefano, Audra, 2018. Study of Interfacial Phenomena Involving Mussel-Inspired Polymers, M.S. Thesis, Chemical Engineering, University of Wyoming, Spring. (Project 2017WY93B)
3. Hansen, Kristiana, Dannele Peck, Scott Miller, and Kaila Willis, 2019. Economic Assessment of Alternative Groundwater Management Strategies in Laramie County, Final Report, Project 50, Wyoming Water Research Program, University of Wyoming, 15 pgs, uwyo.edu/owp. (Institute Project #50)
4. Jacobson, A., et al. (2019) Evaluation of Natural Goethite on the Removal of Arsenate and Selenite from Water, Journal of Environmental Sciences, Vol. 76, No. 2, PP 131-141. (Project 2019WY97B)
5. Kerr, G., 2019. Water Research Program Annual Activities Report, University of Wyoming Office of Water Programs. (Project 2015WY90B)
6. Kuehl, V., J. Yin, P. H. H. Duong, B. Mastorovich, B. Newell, K. D. Li-Oakey, B. A. Parkinson, and J. O. Hoberg, 2018. A Highly-Ordered Nanoporous, Two-Dimensional Covalent Organic Framework with Modifiable Pores, and its Application in Water Purification and Ion Sieving, Journal of American Chemical Society (JACs), 140 (2018), 18200-18207 https://doi.org/10.1021/jacs.8b11482. (Project 2017WY93B)
7. Li-Oakey, Katie Dongmei, 2019. Produced Water Treatment with Smart Materials for Reuse in Energy Exploration, Final Project Report, Project 51, Wyoming Water Research Program, University of Wyoming, 11 pgs, uwyo.edu/owp. (Project 2017WY93BB)
8. Mazzetti, T, 2019: “Climatology of Favorable Conditions for Ground Based Cloud Seeding In the Wind River Range”. MS thesis, Defended successfully in April 2019. ProQuest -- https://search.proquest.com/pqdtlocal1005743/advanced?accountid=14793. (Project 2018WY95B)
9. Paige, Ginger B., Miller, Scott N., and Parsekian, Andrew D., 2018, Quantifying Return Flow in the Upper Wind River Basin, Final Report, October, https://uwyo.edu/wrp”. (Project 2015WY89B)
10. Willis, K. 2019. “Farm-Level Economic Assessment of Alternative Groundwater Management Strategies Over the Ogallala Aquifer in Southeastern Wyoming.” M.S. Thesis. University of Wyoming Department of Agricultural & Applied Economics. 104 pp. (Project 2015WY88B)
11. Willis, K. and K. Hansen. 2019. “Eastern Laramie County wrestles with water use today versus conserving for future.” Wyoming Livestock Roundup. April 2019. (Project 2015WY88B)
12. Willis, K., K. Hansen, D. Peck, S. Miller and V. Sharma (forthcoming). Farm-Level Economic Assessment of Alternative Groundwater Management Strategies over the High Plains Aquifer in Southeastern Wyoming. University of Wyoming 2019 Field Days Bulletin. (Project 2015WY88B)
13. Yin, S., P. Hoang-Hanh Duong, S. Tan, and Katie Dongmei Li-Oakey 2019. Two-dimensional Molybdenum Disulfide Based Membranes for Ionic Liquids Separation, Separation and Purification Technology, 226 (2019), 109-116 https://doi.org/10.1016/j.seppur.2019.05.090. (Project 2017WY93B)

Information Transfer Program

Office of Water Program interacts with various State and Federal groups. These included: 9 Wyoming Water Forums, 6 Wyoming Water Association Board meetings, co-sponsor of the annual Wyoming Water Association Conference, 3 Water Legislative committees, 7 Wyoming Water Development Commission/Select Water Committee meetings, 4 meetings as Advisor to the Wyoming Weather Modification Program, 2 National meetings, and 2 Water Program Planning Advisory Committee sessions. The WRP supports other technology and information transfer activities throughout the year. In order to facilitate dissemination of results of WRP funded research projects, and other closely related water research projects, information transfer includes support of peer publications and conference and meeting presentations for PIs and students of ongoing and completed WRP funded research projects and other closely related projects. Project activities included: four oral presentations by participants of Project 2017WY93B, one oral presentation by PhD student Praya Rath of Project 2018WY94B, eight oral presentations by participants of Project 2018WY95B, five oral presentations by participants of Project 2019WY96B, and five oral and two poster presentations by participants of Institute project #50. Project ideas and results were disseminated in two courses for

Project 2019WY97B. The OWP maintains a website posting the most recent request for proposals and project reports.

Student Support

Undergraduate = 6, Graduate MS = 5, Graduate PhD = 6, Post-Doc = 1

Notable Achievements and Awards

1. Thomas Mazzetti: Recipient of the 2018 North American Weather Modification Council student award, which supported his presentation at the WMA meeting. (Project 2018WY95B)
2. Nunzio Carducci: Poster presentation awarded second place at the Rocky Mountain Branch of the American Society of Microbiology meeting. (Project 2019WY96B)

Projects

Developing a Framework for Estimating Groundwater Connections to Wyoming Reservoirs

Project Type: Annual Base Grant **Project ID:** 2018WY94B

Project Impact: This project is well into the data collection phase at the end of its second year. In Summer 2018, 13 monitoring wells were drilled around the study site, producing over 300 ft of core. The core was logged with a GEOTEK Multi-Sensor Core logger, providing continuous physical measurements along the length of each core. Numerous sediment samples from these cores have been analyzed for porosity and hydraulic conductivity in our lab. Each of the wells has a logger that recorded water level measurements every 30 minutes over the last fiscal year, which will provide the key dataset for addressing groundwater connections with the reservoir. These data are supplemented and validated with manual water level measurements approximately every two months. A bathymetric survey was performed and is nearly processed into a final elevation model. As part of the supplemental USGS funding, we conducted nine seismic refraction surveys coincident with nine electrical resistivity tomography surveys. These datasets are being post-processed to constrain the three-dimensional hydrogeology of the site, including identifying geologic layers and the water table. This very active year of data collection has kept the project on the proposed timeline with the focus of the next year to integrate these data into a predictive numerical model framework. We continue to work with the State Engineers Office to supplement our data collection, and we anticipate working with them to publish the data we have recorded.

Economic Assessment of Alternative Groundwater Management Strategies in Laramie County

Project Type: Annual Base Grant **Project ID:** Institute Project #50

Project Impact: Economic modeling of alternative groundwater management strategies in eastern Laramie County, in the State of Wyoming reveals the existence of economic winners and losers, depending on how the aquifer behaves under individual farms or parts of a community. For farms already feeling the effects of aquifer depletion – maybe as reduced pumping capacity – the economic impacts of an allocation strategy are lower because their farming system is already well-adapted for limited water. In contrast, farms not yet feeling the effects of aquifer declines – those currently able to fully irrigate on all of their pivots – would experience larger economic impacts from an allocation strategy. Of course, the more hydrology varies within a community, the more difficult to choose one management strategy that benefits – or at least does not harm – all water users in a community. A buyout strategy could create economic and hydrologic benefits but a source of funding would be needed to support the program. Economic and hydrologic benefits of a buyout program also depend on whether pivots near those enrolled in the program are restricted to historical consumptive use. If there is no restriction, economic benefits to remaining pivots are higher, but hydrologic benefits are lower. Finally, a significant challenge for local water users is the lack of generally accepted hydrologic studies. Producer perceptions of future hydrology (as were used to inform the present study) may or may not match reality, but they may nonetheless be a good starting point for regional conversations regarding groundwater management.

Numerical Simulations of the Impact of Cloud Seeding in the Wind River Range on Precipitation, Snowpack, and Streamflow

Project Type: Annual Base Grant **Project ID:** 2018WY95B

Project Impact: Procedures for two separate high-resolution WRF simulations for seeding operations conducted over the WRR for the past 10 cold seasons, one with seeding and one without (control) were developed. This will allow us to quantify the impact of seeding on snowfall and snowpack evolution. This work is completed for 1 winter, but issues have been identified, and we are rerunning this using a different framework (single high-resolution domain). We find that the seeding impact is positive, and that 90% of the snowfall enhancement resulted from just over 10% of the cases, i.e. the AgI-induced yield is much higher in some winter storms than in others. We also have used our 30-year regional climate simulation, funded through a previous WRP grant, to characterize the natural

snowfall over the Wind River Range, and to identify conditions where the low-level flow is blocked and decoupled from a snow-producing layer aloft. We find that about 50% of the natural precipitation can be seeded over the Winds. Of that, 80% falls in unblocked conditions, and is seedable from the ground; the other 20% requires a seeding aircraft, since the AgI nuclei from the ground generators remain at low levels, unable to be lofted over the mountain. Airborne seeding expands the seeding window by 65% over the Winds. We currently are quantifying the seeding impact on snowfall totals for the blocked and unblocked flow cases.

Produced Water Treatment with Smart Materials for Reuse in Energy Exploration

Project Type: Annual Base Grant **Project ID:** 2017WY93B

Project Impact: In the past three years we have extensively studied how atomic layer deposition (ALD) can be used to modify polymeric membrane surfaces, with a focus on providing fundamental understanding of interfaces combining polydopamine (PDA) and nanoparticles. Specifically, the impact of PDA on nanoparticle nucleation and growth was systematically investigated with PDA being used to generate functional bonding sites for depositing titanium dioxide (TiO2) via atomic layer deposition (ALD) onto a nanoporous polymer substrate for ALD cycles of