Water Resources Research Institute MSC 3167
New Mexico State University

Annual Technical Report
2019

Products

Cadol, D., Parrish, G., Reuter, S., Newton, T., Phillips, F.M., Hendrickx, J.M.H. 2020. Estimating Soil Water Holding Capacity and Runoff in New Mexico to Improve Modeled Recharge Rates. WRRI Technical Completion Report No. 384. 33pp. https://nmwrri.nmsu.edu/wp-content/uploads/TR/tr384.pdf

Markovich, K.H., Condon, L.E., Carroll, K.C., Purtschert, R., Mcintosh, J.C.. 2020. A Mountain-Front Recharge Component Characterization Approach Combining Groundwater Age Distributions, Noble Gas Thermometry, and Fluid and Energy Transport Modeling. *Water Resources Research*. https://doi.org/10.1029/2020WR027743

Boyko, K., Fernald, A.G., Bawazir, A.S. 2020. Improving groundwater recharge estimates in alfalfa fields of New Mexico with actual evapotranspiration measurements. *Agricultural Water Management* (in press)

Raymondi, Rick. 2019–present (defending April 2021). *DNA barcoding fish eggs in the Pecos River, New Mexico*. Department of Biology, Eastern New Mexico University, Portales, NM. Master Thesis

Ricklefs, Sara. 2018–present (defending April 2021). *Identifying early life stages of fishes and crayfishes and their responses to environmental gradients*. Department of Biology, Eastern New Mexico University, Portales, NM. Master Thesis

Professional Presentations

Pearson, A., D. Rucker, C.-H. Tsai, E.H. Fuchs, and K.C. Carroll (2020) Electrical Resistivity Mapping of Rio Grande River-Groundwater Interactions. American Geophysical Union Fall Meeting, Fall Meet. Abstract.

Pearson, A., D. Rucker, C.-H. Tsai, E.H. Fuchs, and K.C. Carroll (2020) Electrical Resistivity Mapping of Rio Grande River-Groundwater Interactions. 65th Annual New Mexico Water Conference, October 27 - 29, 2020.

Raymondi, R.M., and J.E. Filbrun. 2021. DNA barcoding fish eggs in the Pecos River, NM. Student Research Conference in Biology (Virtual), Eastern New Mexico University, 11 March.

Ricklefs, S.A., and J.E. Filbrun. 2021. Impacts for invasion: investigating juvenile drift of crayfish in the Pecos River. Student Research Conference in Biology (Virtual), Eastern New Mexico University, 11 March.

Filbrun, J.E., R.M. Raymondi, and S.A. Ricklefs. 2021. *Densities, age, and growth rates of drifting fish larvae in the middle Pecos River*. 54th Joint Annual Meeting of the AZ and NM Chapters of the Wildlife Society and the AZ/NM Chapter of the American Fisheries Society (Virtual), 5 February.

Ricklefs, S.A., and J.E. Filbrun. 2021. *Juvenile drift of invasive crayfish (*Faxonius virilis*) in the Pecos River*. 54th Joint Annual Meeting of the AZ and NM Chapters of the Wildlife Society and the AZ/NM Chapter of the American Fisheries Society (Virtual), 5 February.

Filbrun, J.E., R.M. Raymondi, and S.A. Ricklefs. 2020. *Quantifying patterns of drifting fish eggs and larvae in the middle Pecos River*. 65th Annual New Mexico Water Conference (Virtual), 29 October.

Raymondi, R.M., and J.E. Filbrun. 2020. *Establishing methods to artificially spawn Pecos River minnows*. 65th Annual New Mexico Water Conference (Virtual), 28 October.

Ricklefs, S.A., and J.E. Filbrun. 2020. *Juvenile drift of an invasive crayfish in the Pecos River, NM*. 65th Annual New Mexico Water Conference (Virtual), 28 October.

Filbrun, J.E. 2020. *Surveying fish egg and larval drift in the Pecos River, New Mexico.* American Fisheries Society, 150th Annual Meeting (Virtual), 14–25 September.

Boyko, K., Bawazir, A. S, Fernald, A. *Estimating Groundwater Recharge in Alfalfa Fields the Mesilla Valley, New Mexico with Actual Evapotranspiration Measurements.* 64th Annual New Mexico Water Conference: Common Water, Sacred Water: Tribal perspectives on water issues in New Mexico. November 6-8, 2019, Hilton Santa Fe Buffalo Thunder Resort and Casino, Pojoaque, New Mexico. (Presented by Kevin Boyko). https://nmwaterconference.nmwrri.nmsu.edu/2020/posters/poster-abstracts/program.pdf (Abstract 36)

Information Transfer Program

The primary methods for information transfer are the institute's website, conferences, publications, and audio/visual presentations. The 64th Annual New Mexico Water Conference, *Common Water, Sacred Water: Tribal perspectives on water issues in New Mexico,* took place in Pojoaque, NM on November 7-8, 2019. Over 260 participants were in attendance, during which 44 posters were displayed, of which 32 were presented by students. The 65th Annual New Mexico Water Conference, *Meeting New Mexico's Pressing Water Needs: Challenges, Successes, and Opportunities*, took place online October 26-29, 2020. Over 530 participants were in attendance, and 52 posters were displayed during a virtual poster session, of which 43 were presented by students. During the reporting period, the institute coordinated eight workshops and/or conferences bringing together water resources practitioners working for state, federal, or local agencies, members of the general public, and academia.

The institute produces a monthly newsletter, "New Mexico Water *e*News." which reaches 2,155 recipients and keeps its recipients informed of institute activities, upcoming meetings, publications, and research projects.

The institute's online library catalog provides, 8,964 books and references, which can be searched through the NM WRRI website, reference room at https://nmwrri.nmsu.edu/reference-room/.

Publications include technical completion reports resulting from NM WRRI-sponsored projects, special in-house publications, and conference proceedings. The institute has published more than 400 technical and miscellaneous reports. The peer reviewed technical completion reports are directed toward water professionals working in disciplines related to the research projects.

Student Support

The annual base (104b) grant supported three undergraduates, two masters graduate students, and two doctoral students.

Coordination Grant awards supported four masters graduate students and one doctoral graduate student. The total number of students supported by the USGS annual base (104b) grant and required matching funds and other Coordination Grant awards was twelve.

Notable Achievements and Awards

Graduate research assistant Sarah Reuter was awarded a Grant-in-Aid from the New Mexico Geological Society to support her research.

The EOS magazine of the AGU just published an editorial on the paper, A Mountain-Front Recharge Component Characterization Approach Combining Groundwater Age Distributions, Noble Gas Thermometry, and Fluid and Energy Transport Modeling, which is another outreach and dissemination of research project results related to coordination grant, TAAP.

Kevin Boyko, master's degree student at New Mexico State University, supported by the TAAP coordination grant, graduated and is now employed by Los Alamos National Laboratories.

The expertise of the lab was used in collaboration with modeling researchers to received $75,000 in private funding through the New Mexico Produced Water Research Consortium to begin creating a hybrid system dynamics and agent-based model that incorporates the geospatial variability of produced water in Southeastern New Mexico

Student Internship Program

N/A

Geographic Information System For Water Resources Research Planning

Project Type: Annual Base Grant
Project ID: 2019NM187B

Project Impact:

During FY19, the NM WRRI GIS lab was successful in supporting water research needs of New Mexico by providing geospatial data and analysis, collaborating with state and federal agencies, supporting student professional development, researching water issues in New Mexico, and leveraging the capacity of the lab for funding opportunities. The lab supported the New Mexico Statewide Water Assessment by providing data analysis and by initiating the construction of a nearly completed web-mapping service. The lab participated in an advising role in the metadata working group for the ongoing state-led effort, the New Mexico Water Data Act. The lab also participated in the state-led New Mexico Geospatial Advisory Subcommittee on Unmanned Aerial Vehicles. Three student employees were trained and each was successful in obtaining full-time employment in natural resource jobs. Two additional graduate students were employed to work on GIS related water research. The lab supported a New Mexico Universities Produced Water Synthesis Project by contributing previously gained expertise in produced water management. This effort was recently leveraged for $75,000 in private funding through the New Mexico Produced Water Research Consortium to begin creating a hybrid system dynamics and agent-based model that incorporates the geospatial variability of produced water in Southeastern New Mexico. The lab continues to support the USDA AFRI CAP project entitled Diversifying the Water Portfolio for Agriculture in the Rio Grande Basin by processing satellite and aerial remote sensing data for improving measurements of evapotranspiration in the Mesilla Valley. The GIS lab collaborated on four funding proposal submissions.

Increase Soil Water for Desirable Plants through Invasive Plant Management

Project Type: Annual Base Grant
Project ID: 2018NM193B

Project Impact:
Research is ongoing, with an alternate site located and the soil moisture probe equipment delivered during the reporting period. A synopsis of the alternate site follows: Throughout the Hatch and Mesilla Valleys, vegetation loss in upland watersheds leads to floods that scour soils and transport sediment and the non-point source pollution (NPS) of E. coli bacterial. It has been determined that watershed restoration is a critical priority throughout the Hatch and Mesilla Valleys. Our team has collaboratively produced a two paired-subbasin watershed study in the Rincon Arroyo watershed to establish the approach, quantify the expected benefits, and define the extent of watershed restoration to achieve these benefits. The restoration approach is to install and monitor practices that slow and spread “flashy” flood flow, to both settle out bacterial and sediment transport, and support increased vegetation cover to increase infiltration further and decrease hydrologic energy, and address the below research questions:

1) If flow is spread onto the landscape using stormwater harvesting practices (one rock dams, stone lines, net-wire fencing, rock and brush weirs) will the soil moisture below the practice experience a significant increase when compared to a control with no interventions?
2) Will the slowing and spreading of flood flow in upland watersheds support revegetation to the extent that it reduces runoff?

3) Will the slowing and spreading of flood flow in upland watersheds support revegetation to the extent that it filters sediment and nutrients, particularly E. coli?

Adding snow physics to PyRANA to understand the impacts of climate change on diffuse recharge in New Mexico headwaters

Project Type: Annual Base Grant
Project ID: 2020NM328B

Project Impact:
Detailed snow physics is a critical component for PyRANA to conduct robust climate change scenario estimates in snow-dominated watersheds, like the ones recharging New Mexico streams and aquifers. This addition will enable many, unforeseen applications in the future. One immediate impact of adding these model physics will be to conduct assessments of 100-year duration climate change scenarios, by systematically varying precipitation and temperature based on climate models predictions for the Southwest.

This will allow state, county and large municipality level planners to understand changes in future baseflow. Also, by coupling relatively detailed model physics and snow physics together, we will be able to directly test the assumptions of stationarity of the current operational and scientific models used to understand run-off. Changing saturation levels in mountains have been posited as the reason for loss of accuracy of NRCS snowmelt predictions (D. Gutzler, pers. communication); this new model will be able to test this directly and be used in addition to increasingly invalid operational models.

Currently, the researcher is incorporating the new snow physics into the existing PyRANA model. Given prior work with a similar model improvement, Dr. Rinehart expects the model to significantly improve the spatial representation of snow-driven recharge in rugged terrains due to the detailed snow-pack physics and radiation budget.

Electrical Resistivity Mapping of Rio Grande River-Groundwater Interactions

Project Type: Annual Base Grant
Project ID: 2020NM329B

Project Impact:
Surface-groundwater interactions including connectivity remain a challenge to quantify, especially for ephemeral rivers such as the lower Rio Grande. This investigation used a noninvasive and spatially distributed geophysical method (i.e., time-lapse electrical resistivity) for mapping the water table below and adjacent to the Rio Grande River, which has been validated using groundwater table monitoring well data. Time-lapse monitoring of electrical resistivity (i.e., inversely related to electrical conductivity and also water saturation) before, during, and after the irrigation season has been used to characterize the transient and spatial connectivity of the water table with the base of the Rio Grande from disconnection, to connection, and back to disconnection. Results have shown resistivity impacts due to a coupling of both variations in water saturation and an aqueous electrical conductivity (i.e., salinity) difference between resident groundwater from the previous irrigation season and the infiltrating surface water. The relationships between bulk resistivity versus aqueous salinity and bulk resistivity versus water saturation have been developed using laboratory experiments to evaluate the time-lapse resistivity data and characterization of surface-groundwater connectivity. This type of spatiotemporal groundwater level assessment advances our disconnection process characterization capabilities, and will support the sustainable conjunctive use of surface water and groundwater especially for ephemeral systems.

Improving Water Use Efficiency Using Ground-based Microwave and Optical Scintillometer Measurements of Evapotranspiration of Pecan Orchards

Project Type: Annual Base Grant
Project ID: 2020NM330B

Project Impact:
The project is aimed at acquiring measurements of evapotranspiration (ET) using unique equipment that uses microwaves and scintillations to measure ET. This research uses the microwave scintillometer RPG 160 by RPG Radiometer Physics GmbH, Germany. The proposed research activities over pecan orchards has been rescheduled to resume in April 2021 due to the pandemic that started in February 2020, causing major delays. However, the microwave scintillometer has been operationally evaluated over at nearby site that belongs to NMSU in collaboration with the vendor to avoid any further delays. This allowed the research group to properly test and integrate its components. The research group of this project was able to collaborate with researchers from Jornada External Range to conduct this initial testing. This testing phase while was not planned it was required to identify all the needed miscellaneous units such as power supply, cables, as well as updating the software of the microwave system in collaboration with the vender and training a graduate student. The research group was able to obtain approval from NMSU to conduct the research during the pandemic. Collaboration with a pecan grower of the proposed site is in progress. As indicated by the grower this information of water use of pecan would be helpful in terms of water use management as well as energy use in case if energy is needed for pumping groundwater for irrigation.

Investigating the effects of reservoir water releases on spawning activities of fishes in the Pecos River

Project Type: Annual Base Grant
Project ID: 2020NM331B

Project Impact:
Pelagic spawning minnows that require long, continuous stream reaches with adequate flow to complete their life cycles are particularly threatened by the unnatural flow regimes of fragmented river systems. Accordingly, I am monitoring reproductive responses of middle Pecos River fish assemblages to long-term climate forcing and short-term reservoir releases. During March through August 2020, I surveyed adults, eggs, and larvae at a single site near Fort Sumner, New Mexico. I collected adults by backpack electrofishing and eggs and larvae using triplicate sets of 500 µm drift nets deployed for 30 min after sunset. I identified eggs and larvae to species level using diagnostic features and/or the COI DNA barcoding region. Sand Shiner were dominant in adult and egg surveys, with peak reproductive effort during April and May. Adult Red Shiner had the highest body condition during May through July, although eggs and larvae were absent from the drift nets. Pelagic-spawning Plains Minnow decreased sharply in relative abundance and body condition after the single two-week reservoir release in early June, although I never collected their eggs. By contrast, adult and egg densities of native pelagic-spawning Speckled Chub peaked after the release. Other notable observations include massive pulses of Common Carp and River Carpsucker larvae during April and July, respectively, and dramatic declines in all drifting eggs and larvae immediately after the reservoir release. Overall, my early results support global predictions of ecological “winners and losers,” species replacements, and community homogenization driven by intense habitat disturbances.

Transboundary Aquifer Assessment Program (TAAP): NM WRRI Effort

Project Type: Coordination Grant
Project ID: G17AC00441

Project Impact:
To better understand the Mesilla Basin priority transboundary aquifer, NM WRRI has addressed six major research efforts:

1) Geochemical and isotopic determination of deep groundwater as a source of discharge and salinity to the shallow groundwater and surface-water systems, Mesilla Basin, New Mexico, Texas, and Mexico. This research advanced understanding of deep groundwater in the Mesilla Basin aquifer to improve groundwater models and water management.

2) Remote sensing to develop evapotranspiration (ET) fluxes for the Mesilla Valley Aquifer. The project improved the ET model for enhanced water budget and aquifer assessment. Other efforts include collecting additional data, synchronizing satellite images, and obtaining ground measurements to accomplish remote sensing objectives and compare the modified models with measured data.

3) Estimation of Regional Groundwater Recharge from Non-Irrigated Land in the Mesilla Basin, New Mexico. The project produced a PyRANA model for the Mesilla Basin with 2000-2015 data, and extracted model results for the Rincon Arroyo watershed. Researchers analyzed PyRANA results over three additional watersheds gauged by EBID.

4) Alfalfa Recharge Estimation. This project estimated recharge of alfalfa fields by measuring ET and soil moisture in the semi-arid Mesilla Valley Aquifer.

5) Ethnographic Assessment of Agricultural Groundwater Use along the New Mexico/Chihuahua Border. This project established collaborative working relationships on both sides of the U.S/Mexico border in areas that draw from the Mesilla Bolson Aquifer.

6) Collaborate with USGS and Mexico. We held binational conferences, collaborated in joint research, and exchanged data with our partners at USGS and in Mexico.