65th Annual New Mexico Water Conference Poster Abstracts and Presented Posters

Ordered From Earliest to Latest Submission

*****Denotes Poster is Not Available in the Following Section*

1) Evaluation of Heavy Metal Adsorption onto Microplastics

Presenter: Jasmine Anne Quiambao, Civil Engineering, UNM, jannequiambao@unm.edu
Co-authors: Jorge Gonzalez-Estrella (Civil & Environmental Engineering, OSU), Kerry Howe (Civil Engineering, UNM)

This project evaluates the association of microplastics and heavy metals in freshwater systems. Microplastics are ubiquitous across aquatic environments. However, the studies on occurrences of microplastics in marine ecosystems are well-established compared to freshwater. Microplastics are defined as synthetic polymers with a diameter of <5mm. Microplastics with a diameter of <150 µm are of particular concern given their small size and their potential to be ingested. Microplastics could enter freshwater systems by recreational activities, solid waste dumping, wastewater treatment effluents, or other sources. The interaction of microplastics with other contaminants could enhance toxicity and threaten human health and the environment. Freshwater systems in New Mexico near abandoned mine sites have concentrations of heavy metals above the EPA maximum contaminant levels. This project aims to assess the adsorption of heavy metals onto microplastics in contaminated freshwater systems.

This research is divided into two main tasks: (1) detection and characterization of microplastics in freshwater systems containing elevated concentrations of heavy metals; and (2) evaluation of heavy metal adsorption onto microplastics in laboratory experiments. Water samples from Tingley Beach, the Rio Grande, and Laguna Pueblo, NM were collected and analyzed for this research. This project provides information about the occurrence of microplastics in freshwater systems in New Mexico and the potential adsorption of heavy metals onto them. The accumulation of heavy metals and microplastics in aquatic ecosystems may increase the potential toxicity to various living organisms. **(Pg. 141)**

2) Understanding Water Contamination by Household Chemicals: A Guide to Stop Polluting Taos Water

Presenter: Peggy De'Scoville, UNM-Taos, pde@unm.edu

A case study on common household chemicals with adverse effects on the water ecosystem. Chemicals discussed include bleach and chlorine, per- and polyfluoroalkyl substances (PFAS), polytetrafluoroethylene, benzophenone, triclosan, and synthetic musks. Each chemical is described, along with its effect on the environment, human health, and where to find it. The intention is to inform the reader and empower action.

This case-study was the assignment of Dr. Brooke Zanetell, FORS-2120-800. **(Pg. 142)**

3) Juvenile Drift of an Invasive Crayfish in the Pecos River, New Mexico

Presenter: Sara A. Ricklefs, Biology, ENMU, ara.ricklefs@enmu.edu
Co-author: Jesse E. Filbrun (Biology, ENMU)

Invasive crayfish disrupt ecosystem functions by competing and hybridizing with native species, altering physical habitats, and impacting water quality. In 2019 and 2020, we collected drifting juvenile crayfish in the Pecos River as part of our long-term Drifting Egg and Larval Fish Survey (DELFS). While downstream drift is a well-documented dispersal mechanism for early life stages of many marine and aquatic crustaceans, this behavior has not been reported for crayfish. Our study fulfilled two key objectives: 1) identify the drifting juvenile crayfish to species level using DNA barcoding and 2) report the timing and extent of drifting behavior relative to environmental variation. We collected 98 juvenile crayfish in 2019 and 59 juvenile crayfish in 2020. We confirmed that drift occurred at night from April through June. Collections occurred in relatively clear (5–64 NTU), warm water (15–23°C), and at low flows (41–152 cfs). We randomly selected 24 specimens from each field season for species-level identifications using the barcoding region of the cytochrome c oxidase I (COI) gene. We identified nearly all drifting juveniles as virile crayfish (*Faxonius virilis*). Collections of this invasive species have been recorded throughout the Rio Grande, but not in the middle Pecos River. Documenting this dispersal mechanism of an invasive crayfish species will be a valuable contribution to our understanding of crayfish invasion ecology. We believe educating the public on best practices to prevent further crayfish translocations within New Mexico should be a priority of watershed managers. **(Pg. 143)**

4) Coupling Winter Anoxia and Stream Metabolism within a New Mexico Montane Grassland Stream*

Presenter: Justin Nichols, Civil Engineering, UNM, justin76@unm.edu
Co-authors: Aashish Sanjay Khandelwal (Civil Engineering, UNM), Betsy Summers (Energy, Pacific Northwest National Laboratory), Peter Regier (Energy, Pacific Northwest National Laboratory), Ricardo González-Pinzón (Civil Engineering, UNM)

Historical studies have demonstrated drastic changes in a stream's biogeochemistry during seasonal ice- and snow-cover, such as observed winter dissolved oxygen (DO) depletion to hypoxic concentrations. Due to the logistical constraints of sampling DO in ice- and snow-covered streams, the sampling frequency is often sparse, which has led to multiple hypothesized DO depletion drivers. By utilizing aquatic semi-continuous sensors within the East Fork Jemez River, we observed prolonged winter DO depletion to anoxic concentrations, less than 0.2 ppm, for 57 days. By combining our aquatic data with meteorological data, we were able to find a strong temporal correlation between DO depletion

and snow depth with daily average DO declining by 8.6 ppm during five days of snow accumulation of 694.7 mm. Spectrograms indicated that diurnal cycling continued under ice-cover for both water temperature and DO, but cycling ceased during periods of prolonged snow cover. Principle component analysis verified a negative relationship between DO and snow depth, while DO recovery was correlated to increased stage attributed to spring snowmelt. The coupling between snow cover and DO depletion suggests that snow cover blocks solar radiation from reaching benthic autotrophic communities, thus stopping gross primary production (GPP) from occurring. DO rebounds when spring snowmelt scours enough ice and snow from the water column to revitalize reaeration and promote GPP by allowing solar radiation to reach the stream's benthos. Thus, our novel data demonstrates coupling between winter surface water quality, meteorological conditions, and stream metabolism.

5) Improving Fertigation Applications in a Flood-Irrigated Pecan Orchard*

Presenter: Esmaiil Mokarighahroodi, Plant and Environmental Science, NMSU, emokari@nmsu.edu

New Mexico is the largest producer of pecan in the USA with 43.8 million kilograms of in-shell nuts produced in 2019. The objective of this study is to investigate the soil nitrogen (N) distribution and root N uptake in a flood-irrigated pecan orchard located at the New Mexico State University Plant Science Research Center (PSRC). To measure soil N, loose soil samples were collected 5 times in three different distances (under canopy, dripline, and outside of dripline) from a tree trunk in six different depths. To determine the amount N in the pecan tree, plant samples including branch, leaf, stem, and nuts were collected 5 times. Results showed that considerable amounts of N were leached below rooting zone (approximately 60 cm) for all different distances in all months. As more root N uptake happens within rooting zone, N below the rooting zone can leach and contaminate the groundwater resources. No specific patterns were observed among soil N concentrations in different distances from the tree trunk for each month. Also, findings showed the NO_3 uptake increased sharply in the early growing season and declined gradually to the end of the growing season. The maximum NO_3 uptake occurred in May which was around 144 PPM. The results showed there was no increase in root NO_3 uptake after the peak root NO_3 uptake while two more fertigation applications were applied. Thus, findings showed that N fertilizer applications should be managed properly and should be applied any time before May.

Keywords: Nitrogen application; Nitrogen leaching; Root nitrogen uptake; Soil nitrogen

6) Recovery of Rare Earth Elements and Potable Water from Produced Water*

Presenter: Lin Chen, Civil Engineering, NMSU, chenlin@nmsu.edu
Co-authors: Frank Ramos (Geological Sciences, NMSU), Pei Xu (Civil Engineering, NMSU)

Produced water (PW) is the largest waste stream generated during oil and gas production. Recovery of potable-quality water and valuable metals such as rare earth elements (REEs) from PW could play a key role in reducing volumes of PW for disposal and mitigating the risks of conventional disposal processes. In PW, REEs such as lanthanum (La), neodymium (Nd), and europium (Eu), have been detected. However, present treatment technologies for PW is energy- intensive and high cost. Therefore, it is imperative to develop innovative low-cost and energy efficient technologies for clean water recovery and vital element recovery. Energy-efficient treatment of PW for clean water generation and for recovery of REEs provides an environmentally responsible and economically attractive solution to addressing the challenges of water scarcity, reducing the cost of PW disposal, and producing strategic elemental commodities. In this study, we developed an energy efficient and low-cost process for REEs recovery and production of clean potable water. Single slope, single basin solar stills (SSSS) are used for both generating of clean water and concentrating REEs for subsequent recovery. Multi-stage extraction of REEs using CYANEX572 extractant and ion exchange columns for separation of REEs can be applied. Results show that solar evaporation using SSSS can achieve 12.8-14.9% clean water recovery. Removal efficiencies of all metals in the distillate was higher than 96%, while the highest removal efficiency of 99.99% was achieved for Na, Mg, P, Ca, V, Mn, Fe, Ni, Se, and Sr. Recovery of Eu, La, and Nd are 88.7%, 21.1%, and 81.6%, respectively; recovery efficiency of REEs increased with increasing extraction reaction time during the baseline tests.

7) Flow Connectivity and Sediment Transport Modeling in Flashy Ephemeral Channel Networks

Presenter: Sandra Glasgo, Earth and Environmental Science, NMT, sandra.glasgo@student.nmt.edu
Co-authors: Daniel Cadol (Earth and Environmental Science, NMT), Madeline Richards (Ben Gurion University of the Negev) Jonathan Laronne (Ben Gurion University of the Negev), Kyle Stark (Ben Gurion University of the Negev)

In large river systems such as the Rio Grande, sediment influx and water delivery from ephemeral streams is difficult to quantify and track. Yet is has major management implications to such diverse issues as reservoir sedimentation, sediment plugs and avulsions, flooding, and additions to streamflow. In the Arroyo de los Piños, one such ephemeral system, we have been monitoring discharge at 18 different points for two years in an effort to quantify water and sediment delivery from the ephemeral channels. The data collected in the past, present, and future will allow for a better understanding of how the network connects across a range of precipitation intensities and magnitudes, and how these interactions control water and sediment delivery to the watershed outlet. Initial data support the prevailing understanding that the primary controls on local runoff generation are rainfall intensity, lithology, and sub-basin size.

To investigate how these flow events influence sediment discharge, future work will focus on building open channel flow models with sediment transport capability. First, we will focus on the outlet reach, where discharge and bedload data collected primarily during the 2018 monsoon season will be used to evaluate the quality of the sediment transport modules within the Army Corp of Engineers models HEC-RAS 1D/2D and ADH. If successful, we will then be able to model sediment transport in other reaches upstream in the channel network. Combined with our flow connectivity data, this would enable an unprecedented quantification of sediment transport connectivity within ephemeral fluvial systems. **(Pg. 144)**

8) Patch Mosaic Paradigms in Algae Turf Scrubber Substrate*

Presenter: Bert Siville, Plant and Environmental Sciences, NMSU, bsiville@nmsu.edu
Co-authors: Jessica Castro (Plant and Environmental Sciences, NMSU), Michaela Buenemann (Geological Sciences, NMSU), Wiebke J. Boeing (Fish, Wildlife & Conservation Ecology, NMSU)

Algae turf scrubbers (ATS) are increasingly utilized to grow benthic macroalgae on substrate to remediate aquatic ecosystems and wastewater while simultaneously growing beneficial biomass. Efficient estimation of algal biomass growth and composition are essential for economic management and may be achievable through spectral evaluation. ATS substrates across treatments were imaged and then digitized using ENVI visual analysis software, R studio statistical analysis software, and ArcGIS. Fragstats was then used to generate landscape, class and patch metric analysis. Analysis of correlations provided evidence of a negative correlation in percent land cover between two pairs of "class types." Spectral analyses were efficient at distinguishing among different health states of alga *Oscillatoria*.

9) Quantifying Patterns of Drifting Fish Eggs and Larvae in the Middle Pecos River

Presenter: Jesse E. Filbrun, Biology, ENMU, jesse.filbrun@enmu.edu
Co-authors: Richard M. Raymondi (Biology, ENMU), Sara A. Ricklefs (Biology, ENMU)

Native fishes of the American Southwest are increasingly imperiled by habitat fragmentation from dam construction and intense regional drying. To monitor fish assemblage responses to environmental change, we recently established a long-term Drifting Egg and Larval Fish Survey (DELFS) in the Pecos River near Fort Sumner, New Mexico. Herein, we present survey results for April through August 2020. Fish eggs and larvae were collected using 500 µm drift nets equipped with flow meters. Larvae were also collected using quatrefoil light traps. We surveyed the river on 15 occasions, during which we collected 105 samples. We sorted 4,385 fish eggs and 10,184 fish larvae from our samples. Most eggs and larvae were collected in drift nets shortly after sunset. Total densities of drifting eggs and larvae decreased dramatically after a two-week reservoir block release (sustained at 1260 cfs) during June, but rapidly increased within days after returning to base flows (about 57 cfs). Although we have yet to complete larval identifications, the general successional pattern we observed in 2019 and 2020 consisted of early pulses of several species of minnows, then river carpsucker, and lastly channel and flathead catfishes. Currently, we are working to identify fish eggs and cryptic larvae using the barcoding region of the cytochrome *c* oxidase I (COI) mitochondrial gene. Our goal for this study is to provide water release recommendations to Pecos River managers that reduce extinction risk of native fishes in the face of rapid climate change and other habitat disturbances. **(Pg. 145)**

10) The Environmental Legacy of Uranium Mining and Milling in New Mexico

Presenter: Bruce Thomson, Civil Engineering, UNM, bthomson@unm.edu

Between 1951 and 1989, the Grants mining district of northwestern New Mexico produced more uranium than any other district in the United States. Almost 250 mines were located in New Mexico consisting of both open pit and underground mines. Open pit mines, especially the large Jackpile-Paguate mine on the eastern flank of Mt. Taylor, left a large area of open pits and exposed strata that remains largely un-remediated and it is now a Superfund site. Dewatering of underground mines had a large impact on regional aquifers. Eight mills processed uranium ore at one time or another in the state by leaching with a strong acid (seven mills in NM) or alkaline solution (one mill), and then recovering the dissolved U from solution. The tailings were disposed of as a slurry in unlined tailings piles. Tailings wastewater was of very poor quality characterized by either low pH (acid leach mills) or high pH (alkaline leach mill), high total dissolved solids, and high concentrations of metals and radionuclides. Most mills were located in remote locations, have been remediated, and therefore present little threat to human health or the environment, but two of the mill sites have been declared Superfund sites. Though no mining or milling has occurred for nearly 20 years, it is important to understand the legacy of uranium production to develop effective remediation strategies and minimize risks to health and the environment if production resumes in the future.

Note: This poster is largely based on a chapter in the forthcoming New Mexico Geological Society Guidebook, 71st Field Conference, Geology of the Mount Taylor Area, 2020 published by the New Mexico Bureau of Geologic and Mineral Resources, New Mexico Institute for Mining and Technology. **(Pg. 146)**

11) Developing an Effective Monitoring Strategy Using Photogrammetry and 3D Mapping to Measure the Impact of a Plug and Spread Composite Treatment in a Degraded Alluvial Fan in the Semi-Arid Grasslands of the Southwest

Presenter: Meagen Larson, Forestry, NMHU, mlarson2@live.nmhu.edu
Co-authors: Blanca Céspedes (Forestry, NMHU), Julie Tsatsaros (Forestry, NMHU), Craig Conley (NMHU; USFS, Rocky Mountain Research Station), Sara Amina Sena (Hermit's Peak Watershed Alliance)

The degradation of alluvial fans in semi-arid grasslands of the Southwest is often the result of channel incision and has been shown to contribute to a loss of hydrologic connectivity between montane areas and lowland grassland areas. Anthropogenic activities including agriculture and human settlement have contributed to the degradation of fluvial systems through channel formation. Functionally intact alluvial fans are depositional areas that contain nutrient-rich, permeable soils that support forage and habitat suitable for livestock and wildlife as well as represent important recharge zones for groundwater and shallow aquifers. In this study, we examine the impact of a Plug and Spread composite restoration treatment in improving the hydrologic function of an alluvial fan system in northern New Mexico by restoring sheet flow to the alluvial fan floodplain. The response to

the restoration treatment will be evaluated using photogrammetry and 3D mapping to measure changes in sediment height and volume throughout the study site. Drone imagery is collected post restoration, both before and after the 2020 monsoon season (June-November 2020) and is being processed using Pix4D Mapper software. The software will create an accurate 3D model of the site through a generated orthoimage and digital elevation model in which sediment height and volume measurements can be taken. The goal of this study is to develop a replicable methodology for processing drone imagery using Pix4D Mapper as well as developing an effective monitoring strategy using these technologies to measure the impact of restoration treatments in precipitation-driven, semi-arid grassland ecosystems. **(Pg. 147)**

12) Isotopic Niche Overlap Among Freshwater Turtles in the Pecos River System, USA

Presenter: Thanchira Suriyamongkol, Biology, ENMU, thanchira.suriyamongkol@enmu.edu
Co-authors: Vinicius Ortega-Berno (Biology, ENMU), Laramie B. Mahan (Biology, ENMU), Ivana Mali (Biology, ENMU)

Aquatic turtles represent important biotic components of freshwater ecosystems. The Pecos River system is inhabited by six freshwater turtle species, including a widespread *Trachemys scripta* (Red-eared Slider) and a species of conservation concern *Pseudemys gorzugi* (Rio Grande Cooter). Here, we assessed isotopic niche widths and niche overlap of these two sympatric riverine turtles in the Pecos River tributaries, New Mexico, USA. In 2017 and 2019, we collected freshwater turtles using hoop net traps and snorkel methods. We used carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope analyses from three different tissue types: blood, nail, and carapace. We analyzed the data using the package SIBER in R. Our results showed niche partitioning among *P. gorzugi* populations, but little partitioning among sex classes within a population. At the sites where both species occur, we documented niche overlap, especially for $\delta^{15}N$ values. Stable isotopes showed similar ellipse area overlap (SEA_B) of *T. scripta* and *P. gorzugi* among populations (~20‰²), but little to no overlap of standard ellipse areas for small sample sizes (SEA_C). At the study sites where *P. gorzugi* co-occurred with *T. scripta*, it is likely that the species are competing for similar resources although *T. scripta* generally showed wider ranges for $\delta^{13}C$ and $\delta^{15}N$. Our study aids in understanding the ecology and natural history of *P. gorzugi*, one of the least studied freshwater turtles of USA. Moreover, this study provides insights to interspecific relations of *T. scripta*, one of the most invasive turtle species, in their native range. **(Pg. 148)**

13) Analysis of the Relationship Between Water, Oil and Gas in New Mexico: Past and Future Trends

Presenter: Bruce Thomson, Civil Engineering, UNM, bthomson@unm.edu
Co-authors: Janie Chermak (Economics, UNM), Katie Zemlick (NMOSE)

The relationship between oil & gas (O&G) production and water in NM is complicated. Large volumes of water are used for hydrofracturing (HF or fracking). The number of wells hydrofracked increased from 623 in 2015 to 1076 in 2019, while the volume of water used increased from 8,700 AF/yr to 40,000 AF/yr. Although this is a large volume, it constitutes less than 25% of groundwater withdrawn for agricultural use in Eddy and Lea counties in 2015 alone.

Far greater volumes of wastewater, or produced water (PW), result from O&G production. The volumes of PW increased by 20% between 2015 and 2019, from 115,000 to 160,000 AF/yr. More than 95% of PW is generated in southeastern NM. While the number of wells and O&G production continues to increase, the PW-to-oil ratio has steadily decreased from 10 bbls PW/bbl oil in 2008 to 3.1 bbls PW/bbl oil in 2019.

PW has an average salinity greater than three times that of seawater making re-use difficult. Roughly half of PW is used for secondary recovery of oil and the rest is disposed of by injection into salt-water disposal (SWD) wells. Some PW is used for HF, however, the amount is not known. No desalination of PW is done in NM and, due to its costs and complexity, large-scale desalination is not anticipated in the foreseeable future.

Decisions on future management of water by the O&G industry are primarily driven by private economic considerations, demonstrating the need for improved understanding between water and O&G production. **(Pg. 149)**

14) Environmental Flow Analysis for Rio Grande Silvery Minnow Recruitment

Presenter: Michael D. Porter, U.S. Army Corps of Engineers, michael.d.porter@usace.army.mil
Co-author: Aubrey Harris (U.S. Army Corps of Engineers)

Rio Grande Silvery Minnow (*Hybognathus amarus*, Silvery Minnow) reproduction in response to spring runoff is the focus of an analysis to improve our understanding environmental flow requirements. Water management on the Rio Grande over the past 100 years has changed the hydrology and channel geomorphology. Determination of appropriate flow parameters supporting floodplain inundation provides important information for fish nursery habitat, including Silvery Minnows. Water management and drought have reduced the magnitude of the spring snowmelt hydrograph, while channelization and in-stream structures have reduced the connectivity between the river and the floodplain. The availability of inundated floodplain habitat can have important implications for Silvery Minnow reproduction, recruitment, and population viability.

The objective of this study to better understand annual Silvery Minnow spawning and production in response to environmental flow parameters. Metrics describing juvenile production and other population parameters were calculated from Silvery Minnow population monitoring data. A functional analysis approach with HEC-Ecosytem Functions Model and R statistical software is used to evaluate the relationships of seasonal hydrology (magnitude, duration), seasonal hydrology paired with hydraulic analyses (1-D and 2-D hydraulics on various scales, habitat suitability indices), and Silvery Minnow life history metrics (seasonal recruitment trends and population indices). This method supports adaptive management by identifying environmental flow parameters that benefit recruitment, which may inform water management strategies and restoration design criteria. **(Pg. 150)**

15) Establishing Methods to Artificially Spawn Pecos River Minnows

Presenter: Richard M. Raymondi, Biology, ENMU, richard.raymondi@enmu.edu
Co-author: Jesse E. Filbrun (Biology, ENMU)

The Pecos River provides critical ecosystem services and water to support agricultural activities and human population centers. Unfortunately, dam construction, water extraction, and intense regional warming increasingly fragment the river and threaten its native ichthyofauna. Current hydrological regimens are causing collapses of native pelagic-spawning minnows and replacement by invasive fishes. In 2020, we were awarded a NM WRRI Student Research Grant to investigate the effects of streamflow on growth and survival of larval pelagic-spawning minnows. The first step of this project was to establish methods to induce laboratory spawning and hatching of captive minnows. We collected adults in spawning condition of target species (*Cyprinella lutrensis, Hybognathus placitus, Macrhybopsis aestivalis, Notropis stramineus*) from the Pecos River using backpack electrofishers. Fish were transported to ENMU, acclimated in aerated aquaria, and maintained on high-protein diets. Males and females were anesthetized with MS-222 and checked for spawning readiness. Gravid females and ripe males were injected with Ovaprim®, a spawning agent used to induce reproduction, and placed in aquaria with different environmental variables to determine optimal conditions for spawning. In total, we performed 438 injections from June to August resulting in four spawning events: one *H. placitus* released eggs that were not fertilized, and *C. lutrensis* successfully spawned on three occasions. As native fish populations continue to decline, conservation aquaculture may be necessary for species preservation. Our results will fill critical gaps on the efficacy of Ovaprim® on pelagic-spawning minnows for future spawning trials. **(Pg. 151)**

16) Investigating Channel Infiltration and Groundwater Recharge in the Jornada Experimental Range Using Chloride Profile Analysis*

Presenter: Sarah Reuter, Earth and Environmental Science, NMT, sarah.reuter@student.nmt.edu
Co-authors: Daniel Cadol (Earth and Environmental Science, NMT), Talon Newton (NM Bureau of Mines and Geology, NMT) Fred M. Phillips (Earth and Environmental Science, NMT)

Determination of the rate and distribution of groundwater recharge is essential to understanding the water budget of New Mexico and to making informed water plans. A study in the Jornada Experimental Range (*On the Sensitivity of Hillslope Runoff and Channel Transmission Losses in Arid Piedmont Slopes*) inspired us to look for evidence of percolation past the root zone in small, first order piedmont watersheds in the JER. Two cores were extracted from small streams of the same magnitude as the one in the afore-mentioned study, and one core was taken from a flat area near a drainage divide of one of the streams. The cores were divided into samples of ~10 cm depth. Water potential, gravimetric water content, and chloride concentration were measured for each. Water content was much higher in the fluvial cores than in the interfluvial core, indicating increased infiltration beneath channels. However, chloride profiles from each core showed a chloride bulge. This persistent chloride indicates that appreciable focused recharge has not passed through the vadose zone to the water table in modern times. The chloride bulges below the channels were lower in the profiles than the bulges in the interfluvial core, again indicating greater infiltration in the channels. Vegetation is also denser around the channels, which supports the interpretation that the increased infiltration becomes increased evapotranspiration. The depth at which decreases in water potential data were found, closely correlated with where increases in chloride content, and decreases in gravimetric water content occurred.

17) Exploring Surface Water as the Reservoir of CRE Infecting Patients in SE New Mexico*

Presenter: Kasandra Velarde, Biology, NMT, kasandra.velarde@student.nmt.edu
Co-author: Linda DeVeaux (Biology, NMT)

Many infections by formerly treatable pathogens are acquired during routine medical visits or prolonged hospital stays. Once the antibiotic resistance is established in the pathogen population, human activities can lead to the transfer of antibiotic resistance genes (ARGs) throughout the environment, including reservoirs such as surface waters. Recently, four cases of CRE (*carbapenem-resistant Enterobacteriaceae*), an emerging antibiotic resistant infection, have been found in three adjacent counties of SE New Mexico. The New Mexico Department of Health could find no identifiable health-care source; the only commonality was the Pecos River that traverses these counties. We sampled river water at five different locations in the affected counties, and screened the bacterial population for the presence of CRE-related genes, particularly the VIM gene common to the four patients. We found no carbapenem-resistance genes within five different bacterial communities. However, understanding the role of the environment as a reservoir of antibiotic resistance could give insight on the evolution of emerging pathogens in surface water to predict and control potential outbreaks.

18) Poly- and Perfluoroalkyl Substances (PFAS) Adsorption at the Air-Water Interface*

Presenter: Zahra Abbasian Chaleshtari, Chemical and Materials Engineering, NMSU, abbasian@nmsu.edu
Co-authors: Reza Foudazi (Chemical and Materials Engineering, NMSU)

Poly- and perfluoroalkyl substances (PFAS) are a group of manmade chemicals with each or more than one hydrogen atom on the alkyl chain replaced by a fluorine atom. PFAS have been recognized as contaminants of emerging concern (CECs) due to toxicity, bioaccumulation, and environmental persistence. Therefore, PFAS properties and remediation methods are being widely investigated in recent studies. Study of interfacial properties of PFAS is of great importance as the air-water interface is a retention source for PFAS transport in atmosphere, soil, and groundwater. In the present study, PFAS adsorption at the air-water interface is investigated. PFAS adsorption kinetics and equilibrium at the air-water interface are studied by measuring the dynamic surface tension. We evaluate the effect of perfluoroalkyl chain length, PFAS concentration, and composition of PFAS contaminants on their adsorption at the interface. The results of the present study have environmental implications for proper understanding of PFAS fate and transport.

19) Evaluation of Polychlorinated Biphenyls (PCBs) in Albuquerque Urbanized Area Stormwater*

Presenter: Zach Shepard, U.S. Geological Survey, zshepard@usgs.gov
Co-author: Kali Bronson (Bernalillo County)

The watershed-based MS4 permit for the Middle Rio Grande, New Mexico requires Bernalillo County to develop a strategy to identify and eliminate controllable sources of polychlorinated biphenyls (PCBs) that may cause or contribute to the exceedance of applicable surface water quality standards. Manufacturing of PCBs began around 1929 for use in industrial and commercial applications until their ban in 1979 due to their varying toxicity. Although legacy PCBs are no longer directly used, they do not readily break down and are therefore persistent in the environment. Additionally, some PCBs may still be made indirectly through various manufacturing processes. The U.S. Geological Survey, in cooperation with Bernalillo County, characterized PCB concentrations from four watersheds in the urban Albuquerque area. PCBs were detected in 34 of 36 stormwater samples and in 12 of 13 bed sediment samples collected during wet and dry seasons in 2017-18. Six of the 36 water samples exceeded the New Mexico surface-water quality standard of 14 nanograms per liter for the protection of wildlife habitat and aquatic life for PCBs. However, none of the water samples exceeded the permit level limit of 200 nanograms per liter for PCBs in stormwater systems discharging into the Rio Grande. The PCB congener profiles (contribution to total PCB concentration from each of the 209 distinct PCBs) indicate that sources to stormwater drainage basins in Bernalillo County originate both from legacy Aroclors, and from current-use sources, such as yellow pigments (for example, in printed materials and packaging in urban litter or refuse).

20) Biomineralization of Hypersaline Produced Water Using Microbially Induced Calcite Precipitation*

Presenter: Lei Hu, Civil Engineering, NMSU, leihu@nmsu.edu
Co-authors: Huiyao Wang (Civil Engineering, NMSU), Pei Xu (Civil Engineering, NMSU), Yanyan Zhang (Civil Engineering, NMSU)

Reusing produced water (PW) as the subsequent hydraulic fracturing fluid is currently the most economic and dominant practice in shale oil and gas industry. However, prior to the reuse, high $Ca2^{+}$ present in PW needs to be removed in order to minimize the potential for well clogging and formation damage. In this study, microbially induced calcite precipitation (MICP), as an emerging biomineralization technique mediated by ureolytic bacteria, was employed to remove $Ca2^{+}$ and toxic contaminants from hypersaline PW for the first time. Batch and continuous studies have demonstrated the feasibility of MICP for $Ca2^{+}$ removal from hypersaline PW under low urea and nutrient conditions. Throughout the operation of the continuous biofiltration system with biochar as the media, high removal efficiencies of $Ca2^{+}$ (~96%), organic contaminants (~100%) and heavy metals (~100% for As, Cd, Mn and Ni, 92.2% for Ba, 94.2% for Sr) were achieved when PW co-treated with synthetic domestic wastewater (SDW) under the condition of PW:SDW = 1:1 & urea 4 g/L. Metagenomic sequencing analysis showed that a stable ureolytic bacterial consortium (containing *Sporosarcina* and *Arthrobacter* at the genus level) was constructed in the continuous biofiltration system under hypersaline conditions, which may play a crucial role during the biomineralization process. Moreover, the combination of the MICP and ammonium recovery could significantly reduce the acute toxicity of PW towards *Vibrio fischeri* by 72%. This research provides a novel insight into the biomineralization of calcium and heavy metals from hypersaline PW through MICP technique. Considering the low cost and excellent treatment performance, the proposed process has the potential to be used for both hydraulic fracturing reuse and desalination pretreatment on a large scale.

21) Repeat Post-Wildfire Geomorphic Surveys of North Fork Eagle Creek, New Mexico, 2017 to 2021

Presenter: Alexander P. Graziano, U.S. Geological Survey, agraziano@usgs.gov

About one-quarter of the water supply for the Village of Ruidoso, New Mexico, is from groundwater pumped from wells located along North Fork Eagle Creek in the mountains of the Lincoln National Forest. Concerns regarding the effects of groundwater pumping on surface-water hydrology in the North Fork Eagle Creek Basin and the effects of the 2012 Little Bear Fire, which resulted in substantial losses of vegetation in the basin, led the U.S. Department of Agriculture Forest Service, Lincoln National Forest, to require monitoring of North Fork Eagle Creek for short-term geomorphic change as part of the permitting decision that allows for continued pumping of the production wells. To address the monitoring requirements, annual geomorphic surveys of North Fork Eagle Creek along a 1.89-mile-long study reach between two U.S. Geological Survey streamflow-gaging stations were conducted from 2017 to 2020 (a final survey is planned for the summer of 2021).

Geomorphic monitoring has included annual topographic surveys of 14 select cross sections and annual surveys of all woody debris accumulations and pools in the study reach channel. Preliminary results from the 2018 and 2019 surveys indicated that, since the 2017 survey, seasonal high-flow events have only caused minor observable geomorphic changes (aggradation or degradation of surface materials by about 1–2 feet) in parts of 3 of the 14 surveyed cross sections. However, the number of woody debris accumulations in the channel has substantially increased and some of those accumulations have appeared to influence local geomorphic changes, including the formation of pools. **(Pg. 152)**

22) Preliminary Results of Water Quality Monitoring of the Upper Pecos River*

Presenter: Letisha Mailboy, Natural Resources Management, NMHU, lmailboy@live.nmhu.edu
Co-authors: Megan Begay (Natural Resources Management, NMHU), Jennifer Lindline (Natural Resources Management, NMHU)

Since February 2020, NMHU Environmental Geology students have been collecting biweekly water quality data for the Upper Pecos River (UPR) to establish baseline conditions and assess whether waters are meeting their high quality cold-water designation. Five monitoring sites were established along a 25 km stretch at approximately equal distances to capture conditions above a historic mine site (Willow Creek), at the confluence of a tributary from the proposed exploratory hard rock drilling site (Macho Creek), and at several high-use recreation areas (Terrero Village, Dalton Canyon, and Pecos Village). The team is collecting bi-weekly in-the-field physical-chemical parameters (pH, temperature, dissolved oxygen, electrical conductivity) using

a YSI 556 Multi Probe and collecting grab water samples for turbidity analysis in the NMHU Water Resources laboratory using a Hach TL2300 turbidimeter. The majority of reported turbidity values fell below the 10 NTU threshold. Electrical conductivity increased downstream along the study stretch but remained within the 300 µS/cm threshold. Temperature increased downstream and throughout the summer months, but remained below the 25°C (77°F) segment-specific criterion. Statistical analysis and assessment of amounts and trends in these and other parameters relative to sample data, site location, and stream discharge are ongoing. Biweekly averages are being computed and trends are being assessed. Preliminary findings suggest that the Upper Pecos River is in good health and that the majority of the measured parameters are within range for its domestic water supply, fish culture, high quality cold-water aquatic life, and other designated uses.

23) Determining the Effects of Stream Restoration on Bluewater Creek, New Mexico

Presenter: Daniel Guevara, NM Environment Department, Surface Water Quality Bureau, daniel.guevara@state.nm.us

The Surface Water Quality Bureau (SWQB) of the New Mexico Environment Department (NMED) began an Effectiveness Monitoring program in 2008 to document water quality improvements from Clean Water Act §319 projects. Water quality is measured upstream and downstream of multiple stream restoration projects before and after implementation, to document the effectiveness of projects in improving impaired streams. This monitoring has focused primarily on stream temperature, which is one of the most common causes of stream impairment in New Mexico. Data loggers record stream temperature at 15-minute intervals from spring through fall, which allows for an Analysis of Covariance to quantify the effects of the projects, which primarily involve fencing, planting, and in-stream structures. Results have shown decreases in maximum stream temperatures due to restoration on Bluewater Creek, San Antonio Creek, and Comanche Creek. Other projects have not produced similar results, but monitoring is ongoing to account for the lag time of vegetation growth. These results can provide useful feedback to project managers and restoration practitioners in planning future work. **(Pg. 153)**

24) Monitoring Toxic Metal Uptake by Corn Grown in Agricultural Fields Across Animas and San Juan Rivers*

Presenter: Michael Whiting, Plant and Environmental Sciences, NMSU, mikeaid@nmsu.edu
Co-authors: Guarav Jha (Plant and Environmental Sciences, NMSU), April Ulery (Plant and Environmental Sciences, NMSU), Kevin Lombard (Plant and Environmental Sciences, NMSU)

On August 5, 2015, more than 3 million gallons of metal contaminated water from the Gold King Mine were released into Cement Creek unintentionally, leading to the contamination of the Animas and San Juan Rivers. Analysis of edible produce collected from fields irrigated with Animas River water was done in 2018 and found three corn samples with lead concentrations above the World Health Organization (WHO) guideline value of 0.05 ppm. Since then, the original samples were reanalyzed, resulting in two corn samples out of 30 still being above the WHO guidelines. The purpose of this study is to investigate these findings and to monitor the metals lead, arsenic, and aluminum in the agricultural fields.

Five fields along the Animas and San Juan Rivers were selected for the study. Samples of soil, leaf tissue, corn husk, and corn kernels were collected through the pre-growing, growing, and post-growing seasons. These samples were analyzed using ICP-MS/OES (Inductively Coupled Plasma-Mass Spectrometry/Optical Emission Spectrometry) and PXRF instrumentation, focusing on the elements Pb (lead), As (arsenic) and Al (aluminum).

25) Solar Reforming of Microplastics in Water for H_2 Production and Degradation Using Nanocomposite Photocatalysts

Presenter: E.M.N. Thiloka Edirisooriya, Civil Engineering, NMSU, thiloka@nmsu.edu
Co-authors: Huiyao Wang (Civil Engineering, NMSU), Pei Xu (Civil Engineering, NMSU)

Microplastics are considered to be the most substantial category of anthropogenic particles. Highly stable and durable plastic particles are accumulated due to the plastic debris released into water bodies. Millions of micro- and nano-sized plastics are formed as a result of photodegradation, embrittlement, and fragmentation because of wave action. The long-term presence of these particles in water and their accumulation in the food chain have severely impacted living organisms, including human beings. According to the statistical analysis using Google Scholar, studies on microplastic and nano-plastics have rapidly increased with substantive research interests in toxicity and treatment.

When categorizing the removal technologies in terms of particle size, the particles greater than 1 mm can be effectively removed using membrane bioreactors, retrofiltration, bacterial oxidation, rapid sand filter, and disc filter. Further, the coagulation process is used to remove microplastics, and Al-based coagulants are found to be the most effective. Microplastics within the size range of 10-20 µm are removed using the magnetics extraction method with Fe nanoparticles. Photo reforming of plastic waste has been identified as a much greener removal method because it could generate H_2 during the process. Platinum nanoparticles deposited on zinc oxide (ZnO) nanorods (ZnO-Pt), UV-absorbing TiO_2-Pt photocatalyst, and the toxic CdS/CdOx quantum dots have been used in photo reforming microplastics. Highly functional photocatalysts such as ZnO-Pt, TiO_2-Au, TiO_2-Pt, and graphene oxide/TiO_2/Au ternary nanocomposites prepared using atomic layer deposition and hydrothermal deposition methods are proposed to use in further studies to remove micro- and nano-plastics that can easily pass through the conventional treatment methods. **(Pg. 154)**

26) Assessment of the Cyanobacterial Harmful Algal Blooms (cHABs) and Toxins in the Blooming Water Bodies of New Mexico

Presenter: Sergei Shalygin, Plant and Environmental Sciences, NMSU, nqgood@nmsu.edu
Co-authors: F. Omar Holguin (Plant and Environmental Sciences, NMSU), Peter Cooke (Plant and Environmental Sciences, NMSU)

Desert ecosystems are usually considered terrestrial, where water algal blooms are not quite common. However, there are many water reservoirs in American deserts, and New Mexico is not an

exception. Summer 2019 brought worrisome news that several New Mexican lakes were blooming with potentially harmful cyanobacteria. This message was even televised on the news. Harmful blooms when massively developed may harm small and large animals as well as humans. Cyanobacterial species could produce various toxins belonging to different classes of the chemical compounds. Small doses of toxins such as Microcystin may cause liver damage, and Saxitoxin could stop normal function of lung muscles leading to serious health problems. The purpose of my research was to detect cyanobacterial Harmful Algal Blooms (cHAB) within blooming waters in New Mexico. Collected cyanobacterial biomass was investigated under a light microscope; all three lakes under investigation: Caballo, Snow, and Abiquiu lakes showed presence of potentially toxic cyanobacterial species. Advanced Ultra Performance Liquid Chromatography with tandem mass spectrometry were used in order to detect toxins. Mass spectral Multiple Reaction Method (MRM) was able to detect Microcystin-LR and Microcystis-LL in the water as well as cyanobacterial biomass collected in Caballo Lake in the summer of 2020. Additionally, water samples from Abiquiu Lake showed the presence of Microcystin-LR. Initial concentration estimation showed that Microcystis-LR found in Caballo Lake is present in the 100 micrograms per microliter concentration, which is 100 times higher than the World Health Organization recommendation for base level of Microcystins. Future research is needed to confirm this major finding. Next Generation Sequencing research is required to confirm species composition estimates based on microscopical observations. **(Pg. 155)**

27) The New Mexico Produced Water Database 2020

Presenter: Martha Cather, Petroleum Recovery Research Center, NMT, martha.cather@nmt.edu
Co-author: Raven Goswick (Petroleum Recovery Research Center, NMT)

Produced water management and reuse is of growing concern in New Mexico. Key to management is developing a better understanding of critical data such as volumes, locations, quality, and rates of production/injection. The primary objective of this research was to build a geospatial database of oilfield water volume information that can be linked to the existing produced water quality databases. The NMOCD provides oil, gas, and water production and injection data on a monthly basis. The data are publicly available, but in a format difficult for the average user to manipulate. We have compiled this information into a database that allows users to conduct temporospatial and stratigraphic analysis, to better visualize locations, important formations, and volumes of water production and injection and in doing so to have a better understanding of the overall "budget" for oilfield waters in New Mexico. The database is linked to two pre-existing water quality databases. A second effort of the work was to solicit information from the water management industry concerning management practices so that we could have a clearer idea of the entire budget of water including freshwater additions and recycling of produced water. The static database has been completed and will be available soon; unfortunately, little additional information was forthcoming from industry. A second phase to make the data available online and provide more frequent updates for some data is envisioned for the coming year, along with renewed efforts to engage industry in obtaining the data they say that they need. **(Pg. 156)**

28) Hydrogeochemical Analysis of Springs in the Cibola National Forest: Implication for Springs/Wetlands Sustainability & Geochemical Response to Forest Fire

Presenter: Naomi Delay, Earth and Planetary Sciences, UNM, ndelay567@unm.edu
Co-authors: Laura J. Crossey (Earth and Planetary Sciences, UNM), Livia Crowley (National Forest Service, Cibola NF)

Aridland springs of the Southwest provide habitat for many species and important resources for local communities. The Manzano Mountains of north-central New Mexico provide important sources of recharge to springs, local wetlands, and regional groundwater basins. Ojo del Rancho del Medio (RDM) and Ojo del Rancho del Medio West (RDMW) springs within the Mountainair District of the Cibola National Forest are the focus of this study. Regionally, springs are associated with the Madera Group of Pennsylvanian age, dominated by carbonate lithologies. We use a multidisciplinary approach to quantify spring sustainability and determine the sources and pathways to springs.

Water samples have and will be collected for analyses of major ion chemistry and stable isotopic analysis of deuterium and oxygen in order to determine the flow path, recharge mechanisms, and to determine the sources of soluble ions of these spring waters. Monitoring (conductivity, depth, and temperature) for selected time intervals will help connect water quality to spring discharge and documenting change across rainfall events as well as seasonally.

Preliminary analyses of isotopologues (δD and δ18O) show these springs are within the range of observed values for the nearby Sandia Mountains consistent with winter recharge mechanisms. Preliminary major ion geochemical analyses similarly show these springs are consistent with other Sandia Mountain springs issuing from the Madera Group carbonates.

Monitoring of the water quality of these springs will provide a baseline of the seasonal hydrochemistry and assist in understanding the sustainability of these springs to better inform land management decisions. **(Pg. 157)**

29) Case Study of *Acequias* and Native Bees: Connections and Solutions*

Presenter: Adrienne Rosenberg, UNM, arosenberg1@unm.edu

For hundreds of years, residents in New Mexico have distributed water across the semi-arid landscape through a network of community-controlled ditches called *acequias*. Research has shown that *acequias* provide important ecosystem services, such as recharging aquifers, improving groundwater quality, and supporting wildlife, to the surrounding community and environment. New Mexico is also recognized as hosting some of the most diverse native bee populations in the United States. These keystone and indicator species provide a variety of ecosystem services, such as crop pollination, food for wildlife, and bank stabilization for *acequias* (through riparian vegetation pollination), that are vitally important to landscape functions. Today, against the backdrop of adjudication, *acequias* are in peril of losing their capacity to function under the threats of climate change and waterscape disruption. Native bees are also experiencing precipitous declines due to similar threats of climate change and habitat fragmentation. Yet within the mutual danger to each,

there are solutions for both. This paper argues that *parciantes* can assist in preserving their water rights through the establishment of native bee habitat (and pollinator corridors) on *acequia* fed land while directly curbing the impacts of climate change, waterscape disruption, and habitat fragmentation.

30) Phycoremediation of Contaminated Groundwater with Microalgae for Simultaneous Water Treatment and Biofuel Production at a Legacy Uranium Mining Site

Presenter: Zachary DeLay, Trades, Advanced Technologies and Sustainability, SFCC, zachary.delay@sfcc.edu
Co-authors: Annie Padilla (Trades, Advanced Technologies and Sustainability, SFCC), Ondine Frauenglass (Assistant Director, SFCC), Luke Spangenburg (Biofuels, Center of Excellence, Training Center Corporation, SFCC), Stephen Gómez (Trades, Advanced Technologies and Sustainability, SFCC)

The former uranium-ore processing facility at Ambrosia Lake processed more than three million tons of uranium ore between 1958 and 1963, providing uranium for U.S. national defense programs. BHP, a global mining company, has contracted with NREL and Santa Fe Community College to determine the feasibility for simultaneous phycoremediation and biofuel production from algae grown using water at Ambrosia Lake containing elevated concentrations of radionuclides. SFCC has isolated and cultivated several strains of site-specific algae and tested growth in well water from the site. Initial results suggest algae may remove U and Ra from the groundwater. The cleaned water will be used to irrigate crops that can phytoremediate the legacy site. The biomass from these isolated algae cultures and field crops will be provided to NMSU and NREL for analysis and fuel conversion. The project is a collaboration between NREL, BHP, NMSU, Oregon State University, and SFCC to research sustainable ways to clean up legacy mining impacts and develop feedstocks for biofuels. We will present the background for this project, which can serve as a model for expanded efforts around the world and provide a new opportunity for large-scale algal biomass cultivation and reclamation of contaminated mine water. **(Pg. 158)**

31) Evaluating Soil Lead Bioavailability in Agricultural Fields Across the Animas Watershed*

Presenter: Michael Whiting, Plant and Environmental Sciences, NMSU, mikeaid@nmsu.edu
Co-authors: Bianca Wright (Plant and Environmental Sciences, NMSU), April Ulery (Plant and Environmental Sciences, NMSU)

In 2015, an incident of three million gallons of mine waste being spilt into the San Juan and Animas rivers lead to an increase of studies monitoring lead (Pb), arsenic (As) and aluminum (Al) in corn crops grown in the northern New Mexico area. A 2019-2020 study found a possible contamination of Pb in corn kernels. This study follows up on the previous investigation verifying that Pb contamination is present, and to determine if there is a possible pathway into the edible parts of corn grown in four selected fields of the watershed. Evaluating the soil lead bioavailability in agriculture fields across the Animas and San Juan Watersheds benefits several communities living in this region, including members of the Navajo Nation, local growers, and consumers in and around the Farmington and Aztec area.

32) A Critical Review of Reclamation's Yield Modeling for the New Mexico Unit of the Central Arizona Project

Presenter: Norm Gaume, P.E., retired, water resources engineer/manager/consultant; normgaume@gmail.com
Co-author: Peter Coha (retired, Intel; peter.coha@gmail.com)

It's important in these times when important government decisions are made without regard to the pertinent facts and science to note publicly when public water development reports and developed water yield analyses overstate the scientific data upon which they are based.

During the June 2020 review period for the draft Environmental Impact Statement (EIS) for the Gila River Diversion and Storage Project, Norm Gaume and Peter Coha obtained from the Bureau of Reclamation and operated the Excel spreadsheet models of the yield of the proposed water development project and the downstream impacts of diversions. They found the presentations of the yield model results and the associated economics in the draft EIS and technical memoranda substantially overstated the modeled yield and understated the developed water cost.[1]

- Annual unit costs of developed water are calculated by dividing total annual costs by mean annual net yield. The draft EIS used the term "applied water." The model and Reclamation's written answers to questions revealed that "applied water" included evaporation losses from the project storage ponds. The unit costs were for water diverted into storage, not the cost of water delivered to farms.

- The project benefits were based on a crop mix including 25% pecans. The draft EIS failed to mention the model showed no stored water available for release for 396 consecutive days in 2012 and 2013 and daily irrigation releases of stored water as low as 0.07 cfs in order to provide continuous daily releases.

- The draft EIS contained a literature review of evaporation loss rates from shallow storage ponds without documenting regarding rates that were used. The model contained computed evaporation rates for the Cliff-Gila Valley with annual averages substantially lower than the annual rates used by the New Mexico Interstate Stream Commission for Arizona v. California annual decree accounting and a negative slope from 1967 to 2017.

The poster will show a comparison of the representations and conclusions of the draft EIS with graphically presented modeling data.

The Gila Diversion and Storage Project was allowed to die after $16 million was spent for its planning because the draft EIS showed it was unfeasible. The draft EIS narratives and high-level performance representations made by the draft EIS are falsely superior to the underlying modeling basis of the project's performance.

[1] Gaume, Norm, and Peter Coha, "Comments of Norm Gaume, P.E. (ret.) and Peter Coha pertaining to the Draft Environmental Impact Statement (DEIS) dated April 2020 for the New Mexico Unit of the Central Arizona Project (NM Unit)", June 8, 2020, 27 pages plus attachments **(Pg. 159)**

33) Characterization of Metal Uptake in Corn Grown in a Variety of Soil Types*

Presenter: Mckayla Gilbert, Farmington High School, kaylagilbert02@gmail.com

Farmers along the San Juan River in the Four Corners Region in New Mexico and the Navajo Nation struggle with continual contamination to their irrigation water source and food crop from an abandoned mine spill in 2015, the Gold King Mine (GKM) Spill. Abandoned mines containing toxic waste in southwest Colorado, including GKM, are upstream of New Mexico and the Navajo Nation. Long-term exposure to metals and metalloids such as uranium (U), cadmium (Cd), lead (Pb), and arsenic (As) can have an adverse effect on development of the human body, and the cognitive development of children (Chang et al., 2014). Contaminated *Zea Mays* (Naadą́ą́) samples and control were collected and analyzed, to characterize metal uptake in corn grown in a variety of soil types. Concentration levels of U, Cd, Pb, and As in corn were measured by the Inductively Coupled-Plasma Mass Spectrometer (ICP-MS). The mean concentration for U, Cd, Pb, As were 0.040628 ppb, 5.789 ppb, and 1.296 ppb, respectively. Arsenic results were below detection levels of the spectrometer.

34) Naïve Occupancy of the Rio Grande Cooter (*Pseudemys gorzugi*) Across 16 Survey Sites on the Pecos River in New Mexico and Texas*

Presenter: Laramie B. Mahan, Biology, ENMU, laramie.mahan@enmu.edu
Co-authors: Lawrence G. Bassett (Biology, TXST), Thanchira Suriyamongkol (Biology, ENMU), Michael R. J. Forstner (Biology, TXST), Ivana Mali (Biology, ENMU)

The Rio Grande Cooter (*Pseudemys gorzugi*) is a large riverine turtle that is considered threatened in New Mexico and Mexico, and a species of greatest conservation need in Texas. The species occurs in the Rio Grande drainages in southeast New Mexico, southwest Texas, and northeast Mexico. In the US, the majority of survey efforts have been focused on the smaller tributaries of the Rio Grande watershed including the Black River (NM), Delaware River (NM), and Devils River (TX). The Pecos River itself has not been properly surveyed for the species in over a decade. Yet, the Pecos River is one of most anthropogenically altered rivers in the US, potentially threatening the persistence of the species. During the summer of 2020, we surveyed the Pecos River using hoopnet traps across 16 sites in New Mexico and Texas. We marked each *P. gorzugi* captured and took standard measurements. We collected water-quality parameters such as pH, conductivity, temperature, flow, depth, and turbidity. Overall, we captured *P. gorzugi* at 5 of the 16 sampling sites (4 in NM, 1 in TX), with a naïve occupancy of 31.25%. We captured 11 *P. gorzugi* including 4 females, 6 males, and 1 juvenile. In the summer of 2021, we will repeat our efforts at 16 new localities to develop a single season, single species occupancy model. Determining where *P. gorzugi* occurs along the Pecos River system is important for examining which environmental factors affect species presence/absence, which will aid the assessment of the species' conservation status.

35) A Comparison of Methods to Estimate Water Use for Irrigated Agriculture Near Fort Sumner, New Mexico*

Presenter: Amy E. Galanter, New Mexico Water Science Center, U.S. Geological Survey, agalanter@usgs.gov
Co-authors: Allison Flickinger, Jeb Brown (New Mexico Water Science Center, U.S. Geological Survey), Julie Valdez, Charles Lawler, Matt Nelson (Water Use and Conservation Program, NM OSE)

Irrigated agriculture accounts for most of the water used in New Mexico, yet there is a lack of reliable and readily available data for irrigated agriculture water use. The New Mexico Office of the State Engineer estimates water use for irrigated agriculture using the Blaney Criddle (BC) method which calculates the evapotranspiration (ET) for a given crop type, region, growing season, and meteorological condition and then applies that number to the irrigated acreage. The BC method is time consuming and requires knowledge of the crop type, which is often sparsely available. Remote-sensing methods for crop ET estimation are attractive due to readily accessible data, availability of data for areas of interest, and the potential for quick and frequent output of ET estimates. The USGS completed a comparative analysis between the BC method and a remote-sensing based estimation method (Operational Simplified Surface Energy Balance [SSEBop]) for 5,476 irrigated acres in the Fort Sumner Irrigation District. The SSEBop method estimated 5% less ET (523 acre-ft) than the BC ET estimation, which could be related to the fact that the BC method estimates ET under ideal conditions while the SSEBop method estimates actual ET. This localized case study shows that the SSEBop method was comparable to the BC method and more investigation is merited on a statewide comparison for various scales, topographic settings, and crop types.

36) Estimates of Water Use Associated with Continuous Oil and Gas Development in the Permian Basin, Texas and New Mexico, 2010–2019*

Presenter: Amy E. Galanter, New Mexico Water Science Center, U.S. Geological Survey, agalanter@usgs.gov
Co-authors: Grady P. Ball, Joshua F. Valder, Ryan R. McShane, Joanna N. Thamke, Jeremy S. McDowell, Natalie A. Houston (U.S. Geological Survey)

The Permian Basin, located in west Texas and southeastern New Mexico, is one of the largest conventional oil and gas reservoirs in the United States and is becoming one of the world's largest continuous oil and gas (COG) producing reservoirs. Continuous, or horizontal well drilling techniques, extract oil and gas by directionally drilling and hydraulically fracturing the reservoir rock surrounding the borehole. The extraction of oil and gas from COG reservoirs using hydraulic fracturing requires large volumes of water, yet a comprehensive assessment is needed to estimate the total volume of water. The USGS is conducting a project to assess the entire life cycle of water use in areas of COG development. A framework of scripts and regression analyses were used to estimate direct, indirect, and ancillary water use associated with COG development in the Permian Basin from 2010 to 2019. The framework used to develop the scripts and regression analyses is presented as a method to model and analyze water use in multiple areas of COG development, where water-use data often are lacking. This analysis in the Permian Basin uses a similar

analytical framework to one used to analyze Williston Basin COG development in North Dakota and Montana.

37) Abatement of Lead and Uranium by Fired Natural Clays to Produce Potable Water

Presenter: Jeremy Jones, Chemistry and Biochemistry, NMSU, odinseye@nmsu.edu
Co-authors: Sarah Bockisch, Moticha Franklin, Antonio Lara (Chemistry and Biochemistry, NMSU)

Two of the most dangerous heavy metal contaminates found in drinking water are lead and uranium, both of which cause serious detrimental life threating effects. Modern technologies that combat these toxins in water are generally expensive and difficult to maintain. Most people affected by this problem do not have the means to implement these types of technologies. Clays offer an appropriate solution due to their cation exchange capabilities, but when clays become wet, they are difficult to manage. Alternatively, solid phase fired clay pellets are easy to manage, implement, maintain, and are cost effective. The main objective of this study is to determine the efficacy of fired clay pellets for the abatement of uranium and lead in aqueous solutions. Two clays were chosen, one from New Mexico and one from Arizona. Each fired clay material has been exposed non-competitively and competitively to 250 ppb solution of uranium and lead for seven days. To keep the chemical sorption potential similar between exposures, each metal contributes 125 ppb to the solution in the competitive study. All samples were tested in triplicate and agitated for the duration of the experiment to minimize concentration gradient potential. The supernatant of the exposed samples was analyzed with ICP-MS. All samples exposed to the clay pellets exhibited concentrations below the EPA MCL, 30 ppb for uranium and 15 ppb for lead. Based on this analysis, it can be determined that both clay materials provide an efficacious method in the removal of aqueous uranium and lead. **(Pg. 160)**

38) The Solution to Pollution is Diminution: Use Only Enough

Presenter: Cecilia V. López, Advanced Technology and Sustainability, SFCC, cecilopez20@hotmail.com

Algae blooms are photosynthesising, microscopic bacteria that live in slow moving waters like lakes, rivers, and ponds creating toxins harmful to humans, pets, fish, and ecosystems. Algal blooms are caused by hot temperatures, climate change, upstream pollution, waste water from treatment plants, and runoff from farms.

Solutions

It isn't realistic to kill off bacteria in lakes and reservoirs as treatments can kill fish and harm the ecosystem. We can, however, reduce nutrients like phosphorus and nitrogen from getting into rivers and runoffs that feed into the lakes by working with New Mexican farmers and educating them on what they can do to help prevent harmful algal blooms, HABs.

Only use what you need.

- Nitrogen and phosphorus are the nutrients found in fertilizers that cause harmful algal blooms. Educating farmers on the benefits of only using the amount of fertilizer needed for optimum crop growth and a quality product would decrease the amount of nutrients found in runoff.
- Giving farmers incentives to use alternative farming methods could also directly affect the amount of nutrients found in runoff. Dry farming is a farming method that requires little to no irrigation for crop growth and would completely dissolve the issue of having nutrient rich runoff that creates HABs. Though New Mexico has a rugged landscape and rainfall is scarce, studies show dry farming to be a successful, alternative farming method. It has been used by New Mexican pueblos for many years, and can be adopted by many New Mexican farmers if given governmental incentives. **(Pg. 161)**

39) Comparison of Water Movement in Pecan Fields Under Different Irrigation Scenarios; Implications to the Water Cycle

Presenter: Jorge Preciado, NM WRRI, NMSU, preciado@nmsu.edu
Co-authors: Alexander "Sam" Fernald (NM WRRI), Richard Hereema (Plant and Environmental Sciences, NMSU), Salim Bawazir (Civil Engineering, NMSU), Manoj Shukla (Plant and Environmental Sciences, NMSU), Curt Pierce (Plant and Environmental Sciecnes)

Water balance is important to provide information and to conserve water: the flow of water in the system can be used to help manage the water supply, and changes in management can increase water productivity in arid regions. For this study, the soil-water content was measured from one soil column within orchards using time domain reflectometry probes (CS655 12cm, Campbell scientific) installed at different depths in the root zone of pecans and stored measurements in a Campbell Scientific data logger CR300. Water that passes the root zone was considered deep percolation. This study estimates recharge and models water flow through the soil in drip and flood irrigated pecan orchards to better understand surface water/groundwater interactions for improved river basin water management and quantifies water stored in the soil and lost through evapotranspiration.

This research is expected to provide a better estimate of the water consumed by pecans, and the amount of water that percolates. Thereby, we will have a better quantification of the water that is used in agriculture and water that percolates to recharge the basin. The project will evaluate the best irrigation scenario for the Mesilla Valley, and make projections of the different irrigation methods to grow sustainable pecans in the valley. It will add to our understanding of the implications to the water cycle. This will help lead to better agricultural practices in order to achieve crop sustainability in the area. **(Pg. 162)**

40) Acoustic Pipe Microphone Calibration in a Sand-rich New Mexican Ephemeral Channel*

Presenter: Kyle Stark, Earth and Environmental Science, NMT, kyle.stark@student.nmt.edu
Co-authors: Daniel Cadol (Earth and Environmental Science, NMT), Jonathan B. Laronne (Geography and Environmental Development, Ben Gurion University of the Negev), David Varyu (Technical Service Center, Bureau of Reclamation)

Monitoring the transport of bedload sediment (the fraction of sediment transported via traction along the bed of a river) is notoriously difficult, time-consuming, and expensive. Transport rates are usually estimated between flood events using sediment traps, scour chains, or through geomorphic analysis. Very few experiments attempt to monitor directly and continuously. One such location is the sediment monitoring and research facility in the Arroyo de los Pinos watershed, an ephemeral tributary of the Rio Grande. Samplers emplaced in the channel bed operate at near 100% efficiency (i.e., they capture bedload at rates equal to its transport downstream) but have a limited capacity. In ephemeral channels such as the Pinos, their capacity is often reached less than 20% through the duration of the flow.

One solution to this problem is to install instruments that measure bedload indirectly. At the Pinos, we have chosen to use acoustic pipe microphones, which record the acoustic response from the impact of sediment on a hollow pipe. These instruments can monitor the channel continuously, even after the samplers reach capacity. The data presented here is an initial calibration of these instruments from the Pinos, a sand-rich channel. We present two methods of calibration; only one improves the correlation between measured bedload flux and acoustic pipe microphone response above the base model. With careful calibration of these instruments, river channels can be monitored for bedload transport at a fraction of the cost.

41) Sustainability in a Human-Dominated Region: Agricultural Use of Natural Capital

Presenter: Yining Bai, New Mexico Water Resources Research Institute (NM WRRI), NMSU, ynb@nmsu.edu
Co-authors: Saeed P. Langarudi (NM WRRI, NMSU), Alexander "Sam" Fernald (NM WRRI, NMSU)

Irrigation, drainage, and conservation assets, as forms of natural resources serving US agriculture, amount to billions. Natural resource capital could be depreciable and not considered as one of the operational aspects of policymaking. However, the approach to compiling water into traditional forms of capital is elusive. To agriculture in the arid or semi-arid area, the value of water determines agriculture's future sustainability. Based on summarizing the quantitative framework, a model was built on the system dynamics platform and integrated with economic development dynamics, population growth, land uses, and climate change. The use of water and irrigated land as critical natural capital in the Lower Rio Grande (LRG), a southwest region in the US, was investigated by bringing together the ecological footprint (EF), water footprint (WF), and corresponding capacity indicators into an improved three-dimensional model. Results showed that the LRG has long been operating in a state of overshoot due to a shortage of annual natural capital flows and accumulated depletion of stocks. From 2010 to 2015, an EF depth of 5.9 was accumulated. Concerning water use, the LRG is a debtor.

Overall, LRG's economic growth did not show signs of decoupling from the EF and WF. These findings highlight the employment of valuing natural capital in the form of water reveals that the integration of natural capital value links into a socio-hydrology system may change the implications of agriculture policy analysis. This integrated model provided deep insight into the structural and characteristic dynamics of both flows and stocks while avoiding unexpected consequences of policies across various components within single forms of natural capital from a healthy sustainability perspective. Our study enhances understanding of the critical role of natural capital in ensuring regional sustainability and improving human welfare. **(Pg. 163)**

42) ZiaMet, the New Mexico Mesonet

Presenter: David Dubois, Plant and Environmental Sciences, NMSU, dwdubois@nmsu.edu
Co-author: Stan Engle (Plant and Environmental Sciences, NMSU)

Our current ZiaMet weather observational network consists of 26 stations, with 10 being configured as agricultural weather stations. These 10 stations consist of 3-meter wind and direction, 2-meter air temperature and relative humidity, solar radiation, rain gauge, and soil temperature at 10-cm depth. These agricultural stations routinely are used to calculate evapotranspiration that farmers can use for crop irrigation scheduling. The remaining 16 station are former NOAA US Regional Climate Reference Network weather stations, with triple redundant 1.5-meter air temperature sensors and one precipitation gauge, using triple redundant vibrating wire sensors. The data supports numerous programs including agriculture, water management, industry, emergency management, transportation, federal and state government, education, and the media. All of the data is telemetered to the NM Climate Center's data center in real time and available online: http://weather.nmsu.edu. Data is also sent nationwide to Mesowest so that anyone can use the real-time data, https://mesowest.utah.edu/. We are part of the National Mesonet Program that provides the National Weather Service (NWS) with data from approximately 35,000 real-time weather stations, including surface and upper-air data. Our goal is to expand the current ZiaMet network across the state to provide New Mexicans with a high quality source of weather information. More high-quality data leads to more accurate forecasts and more well-informed decision-making during critical weather situations. The ZiaMet network helps fill both temporal and spatial gaps that the federally owned programs such as the Automated Surface Observing System stations do not cover. **(Pg. 164)**

43) Nitrogen, Carbon Dioxide and Argon Adsorption for Surface Area of an Unknown New Mexico Clay in Order to Elucidate Uranium Abatement

Presenter: Moticha M. Franklin, Chemistry and Biochemistry, NMSU, moticha@nmsu.edu
Co-authors: Jeremy Jones (Chemistry and Biochemistry, NMSU), Antonio Lara (Chemistry and Biochemistry, NMSU)

Uranium contaminated drinking water on the Navajo Nation has been extremely detrimental to the surrounding Four Corners region. Technologies to purify water, such as reverse osmosis, are not appropriate for the region. An appropriate solution is needed - inexpensive, simple to implement, and requiring readily available materials. Clays are the answer. Due to their cation exchange capabilities, clays bind and sequester heavy metals in water. However, muddy suspensions, upon adding water to the clay in its powder form are difficult to manage. For this reason, we fabricated clay pellets. A Gallup, New Mexico soil was used because it is found juxtaposed to the uranium affected area. The capacity for clays to sorb heavy metals is directly related to the surface area of the clay. The ASAP 2050 Extended Pressure Adsorption Analyzer was used with nitrogen (N_2), carbon dioxide (CO_2) and argon (Ar) sorbates to determine the surface area of the Gallup clay in its different forms. We hypothesize that fabrication of clay

pellets will decrease the available surface area, relative to clay powder. Brunauer–Emmett–Teller isotherm sorption measurements follow: N_2 sorbate (powder 67 m²/g; pellets 41 m²/g); CO_2 sorbate (powder 42 m²/g; pellet 31 m²/g) and Ar sorbate (powder 63 m²/g: pellet 38 m²/g). The reduction of surface area on pellet fabrication verified the hypothesis. Despite the loss of surface area, pellet manageability, relative to the muddy clay suspension, is a desirable trade-off.

This research was supported by funds from the New Mexico State Legislature (NMWRRI2018-19), administered by the New Mexico Water Resources Research Institute and Water Resources Research Institute FY19 Student Water Research Grant NMWRRI-SG-2019. **(Pg. 165)**

44) Aquaponics Cuts Path Toward Water-Neutral Agriculture in New Mexico

Presenter: R. Charlie Shultz, Controlled Environment Agriculture, SFCC, richard.shultz@sfcc.edu
Co-author: Nate Downey (Lettuce Etc LLC, SFCC)

The Santa Fe Community College's Controlled Environment Agriculture (CEA) program teaches food-production using a range of closed-loop, water-recirculating systems including conventional hydroponics, aquaponics, and hybrid systems. Along with their exceptionally efficient use of nutrients and little-to-no effluent discharge, many of these systems grow fish and plants while recycling 98% of their water daily. Theoretically, crops could grow using roof-water catchment alone (given 12" precipitation/year) and be primarily "water neutral."

Since margins in farming are thin and aquaponics systems require significant up-front expenditures, two often-insurmountable hurdles for commercial aquaponics are:

- The low (wholesale) prices farmers get from grocery stores, restaurants, and institutions
- The time it takes to work a busy day at a competitively priced farmers market

A recent internship project by an SFCC student tested how a subscription-based, farm-to-home delivery model would function in Santa Fe.

What if farmers could sell to their neighbors? What would the costs and logistics of a farm-to-home delivery-model look like? How would the packaging and delivery-routing work? How much would people appreciate the flavor of exceptionally fresh aquaponics produce?

This poster will show that 88% of 170 survey respondents chose "Loved it!" in the multiple-choice "flavor" question, that substantial majorities appreciated our packaging and delivery service, and that 73% said they would pay more than grocery-store prices for such a highly ecological product. After analyzing about 8,000 survey-question responses, we conclude that such a business model represents a clear path to a primarily water-neutral form of agriculture in New Mexico. **(Pg. 166)**

45) Effect of Chloride Salt Solutions on the Unconfined Compressive Strength of Heat-Treated Clay Pellets Made for the Abatement of Uranium in Contaminated Water

Presenter: Joshua Herrera, Chemistry and Biochemistry, NMSU, josherr@nmsu.edu
Co-authors: Jeremy Jones (Chemistry and Biochemistry), Antonio Lara (Chemistry and Biochemistry)

Uranium contamination in drinking water is an ongoing crisis for citizens of the Navajo Nation. This problem can be mitigated with locally produced clay pellets known to abate uranium, but parameters that effect the robustness of these pellets must be understood before they are utilized. It is known that chloride salt solutions affect the plasticity and liquid limit of clays, but there is little study on how these solutions alter the robustness of a clay, especially after heat-treatment. This is surprising given how cations affect clay platelet coordination, such as with potassium in illite clays. To better understand this effect, chloride salt solutions were mixed into two clays, a sodium-bentonite clay and a local illite-smectite clay, at specific weight ratios during the pellet fabrication process. The chloride salt solutions used were LiCl, NaCl, and KCl with each at a concentration of 0.8M. The robustness of each set of pellets was quantified by the maximum compressive force (MCF) measured during unconfined compression testing. The addition of NaCl had little to no effect on the pellet robustness. The bentonite pellets maintained a MCF of 700±100 ftlb (n=15) while the illite-smectite pellets' MCF slightly decreased from 2300±200 ftlb (n=15) to 2000±300 ftlb (n=15). The addition of the other chloride salts, however, has preliminarily shown to increase pellet robustness. The bentonite pellets' MCF increased to 900±100 ftlb (n=5) when using LiCl and 1300±300 ftlb (n=5) when using KCl. This finding suggests that externally added cations can have a significant effect on heat-treated pellet robustness. **(Pg. 167)**

46.) Multilevel Assessments of Contribution of Livestock Manure to Nitrogen Budget in Arid-land Ecosystems: The Case of Dairies in New Mexico

Presenter: Suraj Ghimire, Economics, UNM, ghimires@unm.edu
Co-author: Jingjing Wang (Economics, UNM)

The livestock industry is one of the major contributors of nitrogen pollution. Nearly one-third of the global human-induced nitrogen emissions is contributed by this sector. The intensification of dairy farms has resulted in an oversupply of nitrogen in smaller land pockets causing degradation of environmental and human health. New Mexico leads the country in terms of the average number of cows per large dairy farms and has held this position since 2002. A study by Johnson et al. (2003) indicates that nearly two-thirds of the New Mexican dairies have improper management of manure leading to groundwater pollution. This study aims to quantify the contribution of large dairy farms towards the nitrogen budget of the arid land ecosystem and recommend optimal abatement strategies. First, we modeled the spatial distribution of large dairy farms in New Mexico based on herd and land sizes and identified four hotspot watersheds. Then, we performed a watershed level assessment of the nitrogen balance by comparing the amount of excreted nitrogen with the assimilative capacity of croplands using remote sensing data. This assessment showed that there is an excess of nitrogen and the croplands alone cannot

assimilate it. Therefore, we suggested including rangelands as a possible nitrogen sink and recalculated the nitrogen budget. After the inclusion, the assimilative capacity of the system exceeded the amount of excreted nitrogen. This strategy was deemed economically viable in our cost-benefit analysis. Therefore, we recommend including rangelands as a possible abatement strategy to contain nitrogen pollution. **(Pg. 168)**

47) Influence of Saline Irrigation Water on Soil Chemistry and *Atriplex* sp. Growth*

Presenter: Sarah M. Cerra, Plant and Envrionmental Sciences, NMSU, scerra@nmsu.edu
Co-author: Manoj K. Shukla (Plant and Envrionmental Sciences, NMSU)

Increased temperatures and decreased precipitation in the southwestern United States has prompted growers to use brackish groundwater for agriculture. The objectives of the study are to determine the impacts of ions in brackish groundwater irrigation on soil chemistry and the growth of *Atriplex canescens* and *A. lentiformis*. We hypothesized that ions from the concentrate will accumulate in the soil in a bell pattern from the drip source as the wetting front moves away from the source. Soil samples were collected from three distances from the drip source in two directions. At each distance, samples were collected from two depths. Using the soil paste extract method, sodium, calcium, magnesium, and chloride ions were collected. Growth of six plants was observed over three years and plant ion concentrations were determined at the end of year 1 and year 3. Evapotranspiration rates were obtained using the Hargreaves and the Blaney Criddle Equations. Plant growth and biomass stayed nearly the same over time. Ions accumulated along the wetting front of the drip irrigation creating a favorable environment for root growth. Plant growth over the study supports continued research of *A. canescens* and *A. lentiformis* for cattle fodder.

48) Improving Green Water Use Proportion in a Center Pivot Irrigation System by Using Circular Grass Buffer Strips

Presenter: Paramveer Singh, Plant and Environmnetal Sciences, NMSU, param@nmsu.edu
Co-authors: Sangu Angadi (Agriculture Science Center, NMSU), Robert Lascano (Wind Erosion & Water Conservation, USDA-ARS), Sultan Begna (USDA-ARS), Dave Dubois (Plant and Environmental Sciences, NMSU), Rajan Ghimire (Agriculture Science Center, NMSU), John Idowu (Plant and Environmental Sciences)

Circular Grass Buffer System (CBS) is a simple, elegant and cost-effective strategy that involves rearranging the dryland portion of partial pivots into circular buffer strips of native perennial grasses alternating with crop strips to offer several benefits including improving efficiency of the water cycle. To explore and gauge the benefit of CBS in enhancement of rainwater capture and use by irrigated center pivot circles, a set of observations were made around a 44 mm rainfall event at NMSU ASC Clovis, NM. With CBS, there was an 11.7 mm increase in soil moisture as compared to 7.8 mm without it (Control-CT) after rainfall. Over four days from the rain event, corn in CBS extracted 1.1 mm more water than CT. Although the amount seems small, it was enough to reduce water stress as corn leaf water potential in CBS was -13.2 as compared to -15.1 bar in CT. Attributing to these favorable conditions, CBS reported a 1426 kg ha^{-1} increase in biomass, while in CT it was 1150 kg ha^{-1}. Results indicates that with CBS, storage and use of rainwater by irrigated agriculture increased, which alleviated water stress and improved crop growth. Therefore, CBS may prove effective in sustaining dwindling groundwater reserves of the Ogallala Aquifer (OA) by reducing irrigation inputs without hampering crop growth. **(Pg. 169)**

49) Sedimentology and Topography of a Confluence Outlet of an Ephemeral Tributary to the Mid Rio Grande – Arroyo de los Pinos

Presenter: Sharllyn Pimentel, Earth and Environmental Science, NMT, sharllyn.pimentel@student.nmt.edu
Co-authors: Daniel Cadol (Earth and Environmental Science, NMT), Jonathan B. Laronne (Geography and Environmental Development, Ben-Gurion University of the Negev), Kyle Stark (Earth and Environmental Science, NMT)

Ephemeral streams contribute to the dynamic fluvial geomorphology in perennial streams. The river confluences are point sources of sediment and water delivery downstream. Previous confluence studies have concentrated on the hydrodynamics, topography, and sedimentology downstream of the confluence in the main stem, with limited information on the tributary proper. Focusing on semi-arid ephemeral outlets is important because the sediment and hydraulic regime of the tributary contrasts strongly with the main stem. These tributaries infrequently flow after localized high intensity rainfall events and the sediment delivered to main trunk rivers is often much coarser than the mainstem bedload. Our aim is to quantify confluence characteristics of planform geometry, discharge ratios, bed discordance, and sediment stratification at the confluence of a novel bedload research station, the Arroyo del los Pinos, into the Rio Grande.

Structure from Motion (SfM) photogrammetry is used to generate Digital Elevation Models (DEMs), and then the DEMs of Difference (DoD) were analyzed to compare multi-temporal topographic and volumetric changes after every flood event of the Pinos. Stratification based on trenching of the tributary bed sediments details the hydrodynamic conditions during deposition of the morphological units at the tributary.

Deposition of an asymmetrical tributary mouth bar occurred because the Rio Grande basin experienced an abnormally high flow stage related to above average snowmelt in the spring of 2019. Cross-stratification of the deposits indicated flow separation along the tributary mouth and the development of a recirculating eddy within the tributary during high flows on the Rio Grande. **(Pg. 170)**

50) The Relationship Between Firing Temperature and the Sorption Effectiveness of Fired Clay Pellets

Presenter: Sarah Bockisch, Chemistry and Biochemistry, NMSU, bockisch@nmsu.edu
Co-authors: Jeremy Jones (Chemistry and Biochemistry), Antonio Lara (Chemistry and Biochemistry)

Uranium contamination in drinking water is prevalent in the Four Corners area of the Southwest. Ingesting aqueous concentrations of heavy metal uranium greater than 30 ppb has long been known to cause a variety of serious health effects as per the

EPA. Traditional methods for uranium removal are often too expensive and complex to be a viable option for lay persons suffering from this contamination and require utilities that many do not have access to. Fired clay pellets offer a good alternative to these removal methods. However, a means to measure the concentration of uranium in the water is essential, and enhanced fluorimetry is an instrumental method with several advantages over other analysis methods. Firing the clay powder into a pellet gives it a manageable structure while still retaining its sorption properties, and the firing temperature affects its relative ability to sequester uranium. Upon abatement, the uranium concentration can be analyzed using fluorimetry. To this end, low, medium, and high firing temperatures for the clay were tested. These fired clay pellets were subsequently exposed to a 125 ppb uranium solution for 24-, 48-, and 72-hour periods. The resulting solutions were analyzed using polyphosphate enhanced fluorimetry and ICP-MS, an orthogonal analytical method, for comparison. Analysis showed similar sorption by both low-temperature fired clay and mid-temperature fired clay, and almost no uranium sequestration by the high-temperature fired clay. Additionally, similar trends between data obtained by fluorimetry and data obtained by ICP-MS could also be seen. **(Pg. 171)**

51) Biodegradable Porous Hydrogels Designed for Soil Water Retention

Presenter: Ryan Zowada, Chemical and Materials Engineering, NMSU, rzowada@nmsu.edu
Co-authors: Catherine Brewer (Chemical and Materials Engineering, NMSU), Reza Foudazi (Chemical and Materials Engineering, NMSU)

Arid regions have difficulty retaining water in soil due to climate effects as well as poor soil properties. Sandy soils have low water holding capacity allowing high levels of water loss from evaporation and gravity (i.e., drainage). We are developing a foam-templated biodegradable porous hydrogel as a soil additive that will better retain water in the soil and act as a water reservoir for plant life. The interconnected porosity of the hydrogel will both increase the affordability of a soil additive (50 – 80% porosity), and increase water availability by holding water in macroporous channels rather than the polymer matrix. **(Pg. 172)**

52) Electrical Resistivity Mapping of Rio Grande River-Groundwater Interactions

Presenter: Autumn Pearson, Plant and Environmental Sciences, NMSU, autumnpe@nmsu.edu
Co-authors: Dale Rucker (HydroGEOPHYSICS, Inc.), Chia-Hsing Tsai (Plant and Envrionmental Sciences, NMSU), Erek H. Fuchs (Elephant Butte Irrigation District), Kenneth C. Carroll (Plant and Environmental Sciences, NMSU)

Surface-groundwater interactions including connectivity remain a challenge to characterize, 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, 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. **(Pg. 173)**

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Evaluation of Heavy Metal Adsorption onto Microplastics

Jasmine Anne Quiambao

Department of Civil, Construction & Environmental Engineering, University of New Mexico, Albuquerque, New Mexico, 87131, United States

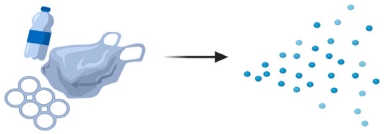
Co-Authors: Jorge Gonzalez-Estrella and Kerry Howe

OBJECTIVE

To evaluate the adsorption of heavy metals onto microplastics in contaminated freshwater systems.

INTRODUCTION

Microplastics



Plastics
- Light-weight
- Durable
- Versatile
- Low-cost production
- Non-biodegradable

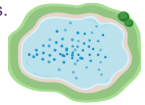
Microplastics (MPs)
- Water-insoluble; polymer particles with diameter of < 5 mm.
- **Primary source:** Personal care products manufactured with < 5mm (e.g. body wash, toothpaste, etc.).
- **Secondary source:** Fragmentation of plastic bags, bottles, fishing nets, etc.

Environmental Effects
- Improper disposal leads to polluting the environment.
- MPs accumulate in aquatic ecosystems.



- **Physical impact**: entanglement & ingestion (diameter of < 150 µm).
- **Chemical impact:** release of additives, pesticides, and pollutants from MPs.
- **Biological impacts:** microorganisms colonizing the surface of MPs.

Microplastics in Freshwater Systems
- Source: anthropogenic activities.
- **MP studies:** < 4% of MPs in freshwaters & ~ 96% in seawater.

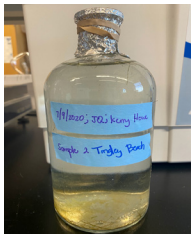


Synergy with other Contaminants
- The **main concern:** heavy metal can adsorb onto MPs surface.
- The physicochemical properties of MPs and heavy metals and environmental characteristics drive the adsorption.

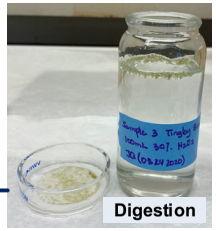
MATERIALS AND METHODS

Task 1: Detection of Microplastics in Freshwater

Sampling Locations:
- Paguate River
- Freshwater reservoirs near the Jackpile mine of Laguna Pueblo
- The Rio Grande
- Tingley Beach
- Field control (1L)



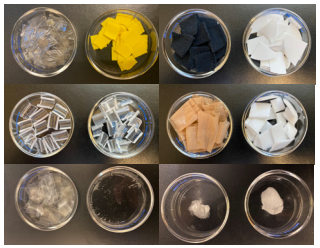




To assure the quality of **visual inspection** and subsequent **polymer identification**.

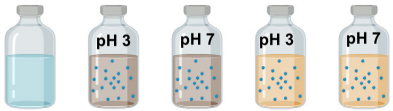
- Digestion: 100 mL of 30% (v/v) H_2O_2 in oscillation incubator at 50°C and 80 rpm for 48h.

Microplastics Characterization



- Nine (~1 cm^2) plastic materials and three commercial microspheres for characterization.
- ZETA potential and BET analyses

Task 2: Adsorption Kinetic Experiment

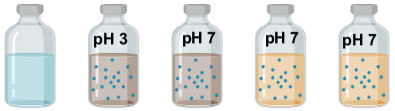


Control | 10 $mg\ L^{-1}$ **As** | 10 $mg\ L^{-1}$ **U**

Three microplastics: 0.1 g of polyethylene (PE), polystyrene (PS), and polymethyl methacrylate (PMMA) commercial microspheres.

Two heavy metals: Arsenic (As) and Uranium (U)
- Ultra-pure water (18 MΩ) ~ pH 3 and pH 7 (±0.2)
- 50 mL samples (triplicate) and agitated at 150 rpm for 7 days at 25°C.

Task 2: Adsorption of Heavy Metal onto Microplastic



Control | Arsenic (As) | Uranium (U)

Three microplastics: 0.02 g of PE, PS, and PMMA.

Two heavy metals: 10, 20, 30, 40, and 50 $mg\ L^{-1}$ of As and 2, 5, 10, 15, 20 $mg\ L^{-1}$ of U
- Ultra-pure water (18 MΩ) ~ pH 3 and pH 7 (±0.2)
- 20 mL samples (triplicate) and agitate at 150 rpm for 48 hr at at 25°C.

Analyses
- Attenuated total reflection fourier-transform infrared (ATIR-FTIR) spectroscopy
- Energy Dispersive X-Ray Spectroscopy (EDS)
- Scanning electron microscopy (SEM)
- X Ray Photoelectric Spectroscopy (XPS)
- Inductively coupled plasma optical emission spectroscopy (ICP-OES)

Expected Outcomes

- MPs in static freshwater systems used for recreational activities.
- MPs found in freshwater near mine sites will likely contain higher metal concentrations on their surface.
- U and As adsorption onto microplastics depend on the type of polymer and pH.

Environmental Implications

The synergy of these pollutants may increase potential toxic effects on human health and the environment.

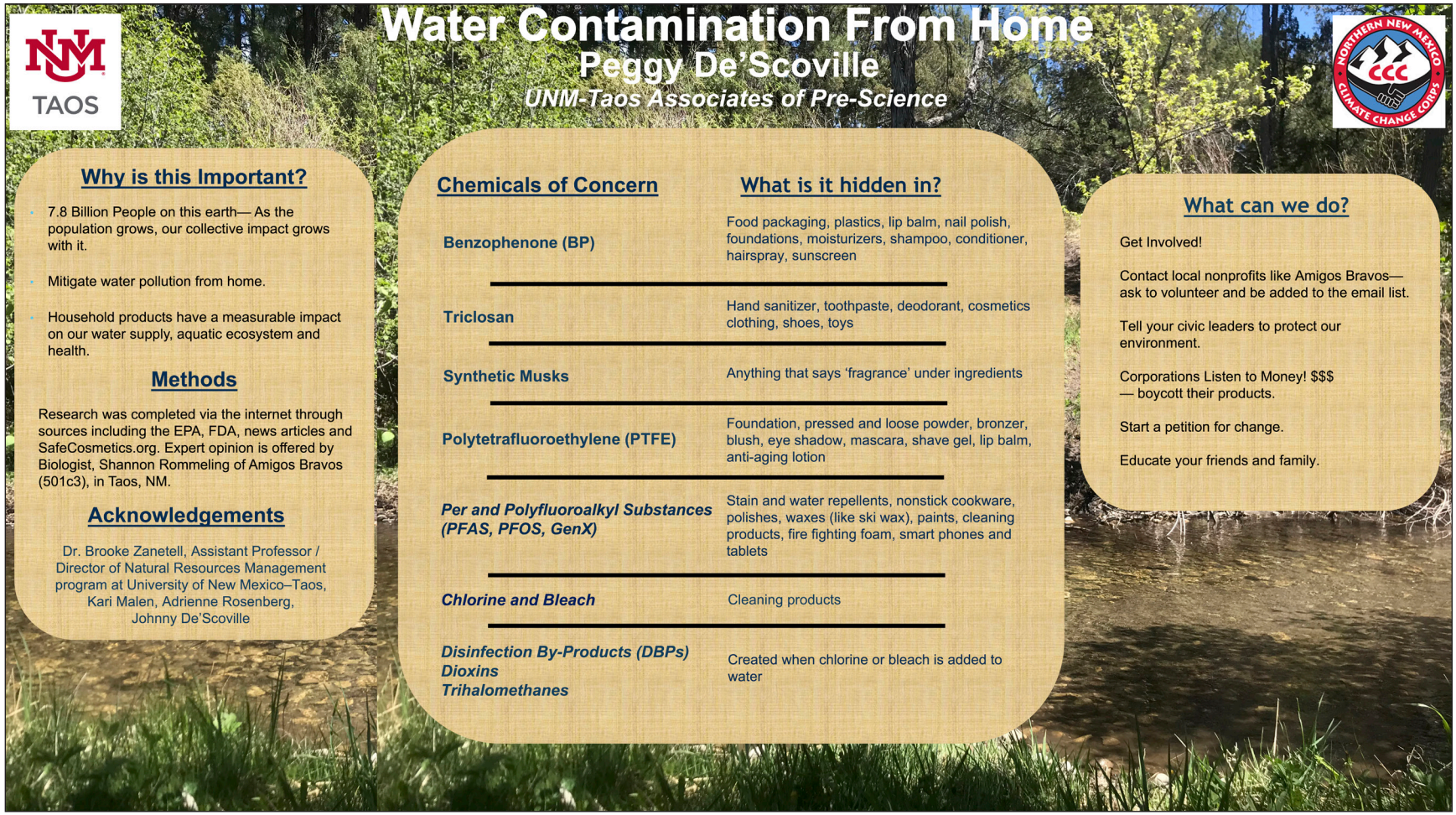
Future Work

- Spectroscopy analyses on task 1 methodology.
- Adsorption kinetic and adsorption isotherm experiments.

Acknowledgements

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Abstract 1) Evaluation of Heavy Metal Adsorption onto Microplastics (Pg. 125)



Abstract 2) Understanding Water Contamination by Household Chemicals: A Guide to Stop Polluting Taos Water (Pg. 125)

Juvenile drift of an invasive crayfish in the Pecos River, NM

Sara A. Ricklefs and Jesse E. Filbrun
Dept. of Biology, Eastern New Mexico University, Portales, NM

Background and Research Objectives

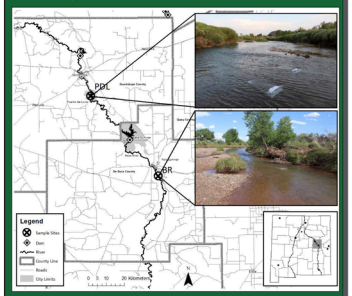
Background

- In 2019 and 2020, we passively collected drifting juvenile crayfish in the Pecos River as part of an ongoing Drifting Egg and Larval Fish Survey (DELFS). We found no peer-reviewed literature describing juvenile crayfish drift.
- Juvenile crayfish are morphologically ambiguous and, therefore, difficult to identify taxonomically.

Research Objectives

1. Identify the juvenile crayfish drifting to species level using DNA barcoding.
2. Report the timing and extent of drifting behavior of juvenile crayfish relative to environmental conditions.

Study Sites



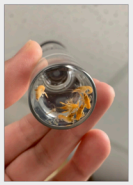
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Methods

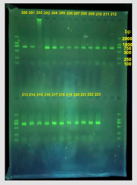



- Juvenile crayfish were collected in drift nets (500 µm) deployed in 30-minute sets with flow meters.
- Adult vouchers were collected, identified using gonopod morphology, and barcoded alongside juveniles.





- Specimens were sorted by organism, preserved in 90% ethanol, and stored at -20°C.
- Each specimen was photographed; CLs were measured and recorded via ImageJ software.

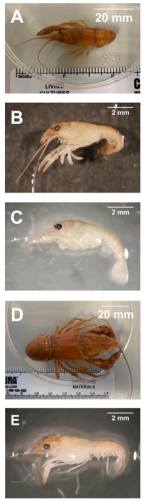



- Genomic DNA was extracted from tail muscle of adults and whole juveniles.
- Mitochondrial cytochrome *c* oxidase I (COI) DNA barcode was amplified by PCR using universal arthropod primers.

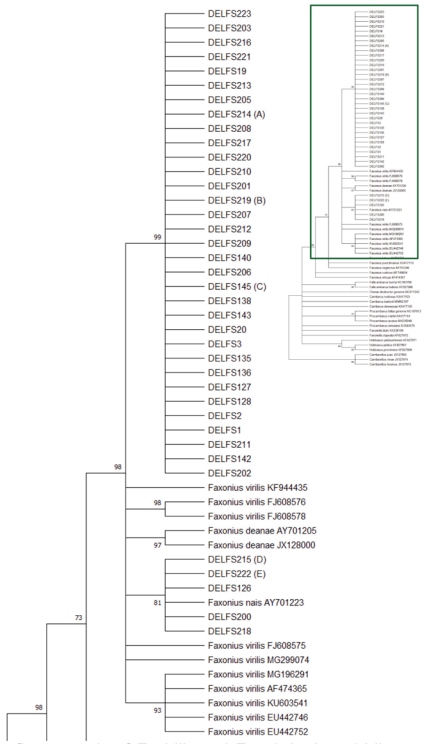
Environmental Conditions and Juvenile Drift

Date	Juveniles Collected (#)	Water Temperature (°C)	Discharge (cfs)	Turbidity (NTU)
Puerto De Luna				
4/6/2019	7	17.7	83	5
4/7/2019	2	17.7	81.2	5
5/9/2019	5	15.3	91.9	14
Bosque Redondo				
4/27/2019	59	20.8	68.8	64
4/28/2019	23	20.8	56.8	64
5/28/2019	2	19.1	152	42
4/16/2020	14	17.6	43.5	6
4/27/2020	21	21	51.3	10
4/29/2020	3	21.3	41.1	8
5/11/2020	10	18.8	66.4	16
5/14/2020	6	21.1	57.4	12
5/20/2020	2	23.4	49	12
5/28/2020	1	24.6	70.9	11
6/2/2020	2	26.6	65.2	15
	Average:	**20.4**	**69.9**	**20.3**

COI Barcoding Results



Above: Photographs of samples are provided with their respective labels.
Right: Bootstrap Consensus tree of GenBank references and DELFS specimens by sample ID.



Discussion

- Our study includes the first records of *F. virilis* and *F. nais* in the middle reach of the Pecos River.
- Invasions of *F. virilis* have caused hybridization with and depletion of native species. Drift dispersal could impact the rate of watershed invasion.
- Educating the general public about how crayfish introductions commonly occur is a worthwhile endeavor not only in New Mexico, but worldwide.

Acknowledgments

This study is funded by internal Faculty Research Grants awarded to Jesse Filbrun. Field collections were approved by NMDGF (Permit # 3678) and ENMU (IACUC # 2019-0301-03). We thank Rick Raymondi for assistance in the field and with DNA extraction and PCR analysis. We thank Dr. Chris Taylor for assistance with adult voucher species confirmation.

Abstract 3) Juvenile Drift of an Invasive Crayfish in the Pecos River, New Mexico (Pg. 125)

Flow Connectivity and Sediment Transport Modeling in Flashy Ephemeral Channel Networks

Sandra Glasgo[1], Daniel Cadol[1], Madeline Richards[2], Jonathan Laronne[2], Kyle Stark[2]

1 New Mexico Institute of Mining and Technology, Socorro, NM ‖2 Ben Gurion University of the Negev

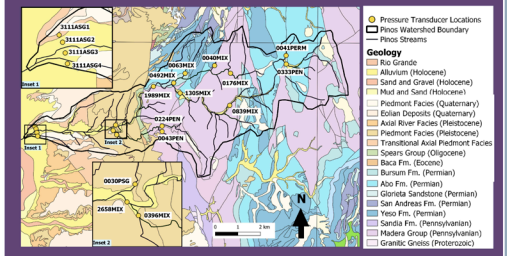
Abstract

In large river systems such as the Rio Grande, sediment influx and water delivery from ephemeral streams is difficult to quantify and track. Yet is has major management implications to such diverse issues as reservoir sedimentation, sediment plugs and avulsions, flooding, and additions to streamflow. In the Arroyo de los Piños, one such ephemeral system, we have been monitoring discharge at 18 different points for two years in an effort to quantify water and sediment delivery from the ephemeral channels. The data collected in the past, present, and future will allow for a better understanding of how the network connects across a range of precipitation intensities and magnitudes, and how these interactions control water and sediment delivery to the watershed outlet. Initial data support the prevailing understanding that the primary controls on local runoff generation are rainfall intensity, lithology, and sub-basin size.

To investigate how these flow events influence sediment discharge, future work will focus on building open channel flow models with sediment transport capability. First, we will focus on the outlet reach, where discharge and bedload data collected primarily during the 2018 monsoon season will be used to evaluate the quality of the sediment transport modules within the Army Corp of Engineers models HEC-RAS 1D/2D and ADH. If successful, we will then be able to model sediment transport in other reaches upstream in the channel network. Combined with our flow connectivity data, this would enable an unprecedented quantification of sediment transport connectivity within ephemeral fluvial systems.



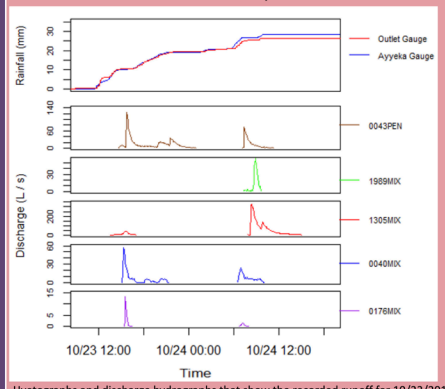
Location map of basins of interest and the planform geometry of the confluence. The arrows indicate flow.



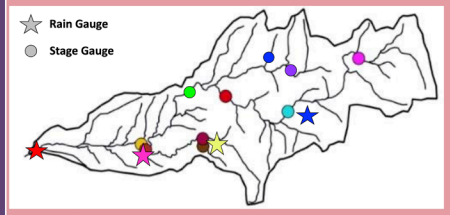
Location map of Arroyo de Los Pinos streams and pressure transducer sites

Flood Events

Small Event: October 23-24, 2018

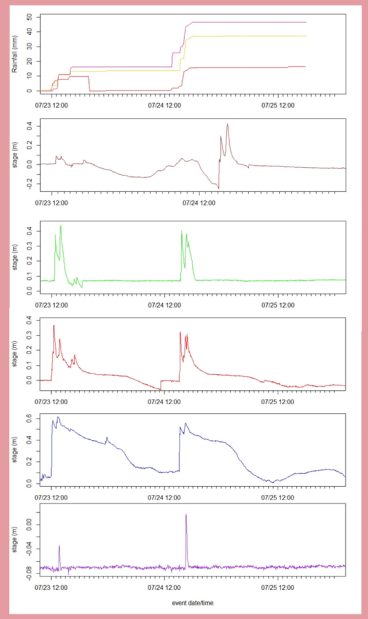


Hyetographs and discharge hydrographs that show the recorded runoff for 10/23/2018.



Schematic of watershed with locations of transducers

Larger Event: July 23-24, 2020



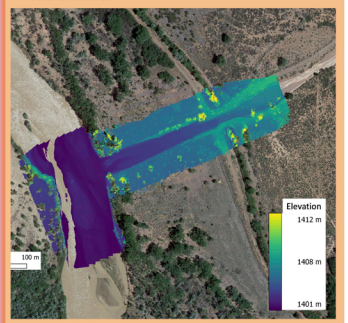
Stage hydrographs from loggers that recorded the flood events on 7/23/20 and 7/24/20.

Discussion

- Greater integration of flow from downstream sites in the large watershed.
- Small sub-watersheds produced larger runoff ratios
- Large watersheds have higher rainfall threshold to produced runoff
- Storms with greater rainfall depth are more likely to produce flow in large sub-basins but have similar probabilities of missing small sub-basins
- Comparison of downstream gauging sites shows significant channel transmission losses (bed seepage)

Future Work

Discharge, bedload, and topographic data collected during the monsoon season of 2018 will be used to build open channel flow models with sediment transport capability. These models will be used to evaluate the quality of the sediment transport simulation capabilities within the Army Corp of Engineers models HEC-RAS 1D/2D and ADH. Modeled sediment flux will be compared against monitored sediment flux near the confluence of the Pinos and Rio Grande.



References

Richards,M. (2020). RAINFALL-RUNOFF RELATIONSHIPS IN THE ARROYO DE LOS PINOS SOCORRO NEW MEXICO. MS Thesis, New Mexico Institute of Mining and Technology, Socorro New Mexico.

Acknowledgements

Support for this research is being provided by:
- Water Resources Research Institute
- US Army Corps of Engineers
- US Bureau of Reclamation

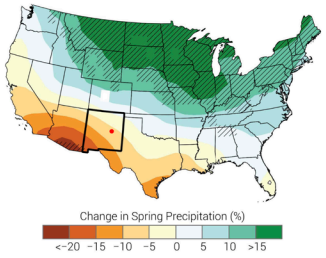
Abstract 7) Flow Connectivity and Sediment Transport Modeling in Flashy Ephemeral Channel Networks (Pg. 126)

Quantifying patterns of drifting fish eggs and larvae in the middle Pecos River

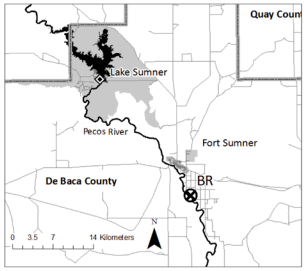
Jesse E. Filbrun, Richard M. Raymondi, and Sara A. Ricklefs,
Department of Biology, Eastern New Mexico University, Portales, NM

Rationale

- Native fishes of NM are collapsing because of habitat fragmentation.
- We established a long-term survey of fish eggs and larvae in the Pecos River to quantify reproductive effort relative to environmental drivers.
- Water managers may use survey results to inform best practices that reduce threats to native fishes.



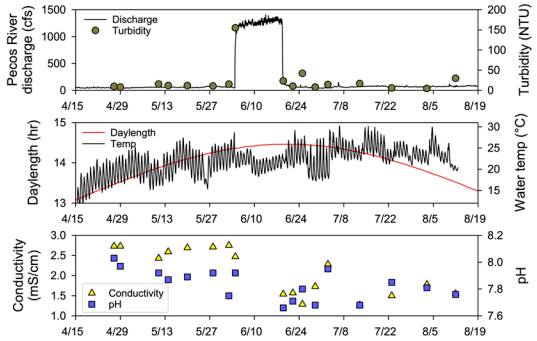
Predicted change in spring precipitation (%) for the middle 21st century (versus mid 20th century) under a higher emissions scenario (NOAA Technical Report NESDIS 149-NM).



Location of our survey site in the Pecos River near Bosque Redondo Park (BR).

Jesse E. Filbrun, Ph.D.
Assistant Professor of Biology
Eastern New Mexico University
Email: jesse.filbrun@enmu.edu
Website: filbrunlab.weebly.com

Environmental conditions



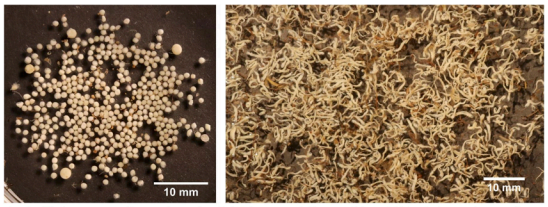
Environmental variation at the BR site during 2020. Top: discharge and turbidity; middle: daylength and water temp.; bottom: conductivity and pH.

Fish collections

- Fish eggs and larvae were sampled from April–August 2020 using drift nets (500 µm mesh) set for 30 min and equipped with flow meters.
- Fish larvae were also collected using light traps baited with glow sticks.
- Samples were rapidly chilled to euthanize fish eggs and larvae, then preserved in 90% ethanol.
- Environmental and water quality variables were recorded, plus USGS gage station stream discharge.

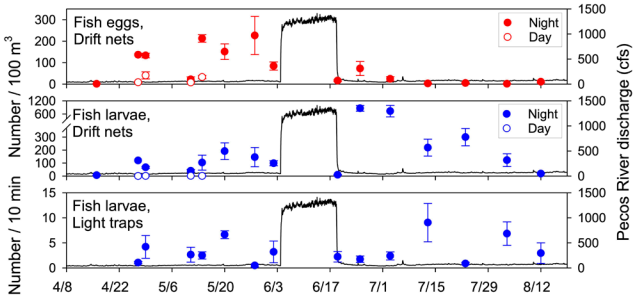


Top: Quatrefoil light traps; bottom: Drift net



Left: Fish eggs collected on April 27 in one drift net (N = 448); right: subset of fish larvae collected on July 3 in one drift net (N = 2,518 in total)

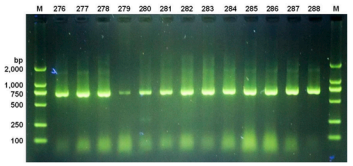
Fish egg and larval catch rates



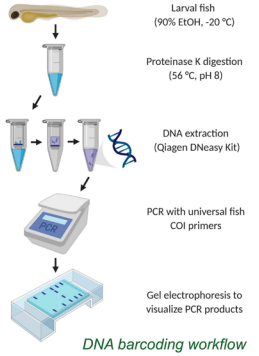
Catch rates of fish eggs and larvae at the BR site during 2020.

DNA barcoding

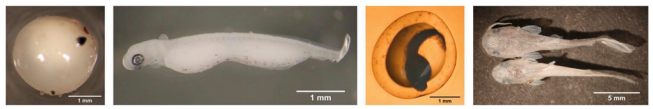
- Fish eggs and larvae representing unique morphotypes were identified to species level using the COI barcode.
- Barcoded specimens were photographed to construct a digital reference library.



Electrophoresis gel of larval fish specimens (276–288) showing the COI barcode product (~650 bp).



DNA barcoding workflow



Left to right: River Carpsucker egg, River Carpsucker larva, Speckled Chub egg, and Flathead Catfish (top) with Channel Catfish (bottom).

Acknowledgments

This survey was funded by a NM WRRI Faculty Water Research Grant, internal grants awarded by ENMU, and grants awarded by the Western Division and Arizona/New Mexico Chapter of the AFS. Collections were approved by New Mexico Department of Game and Fish (Permit # 3678) and ENMU (IACUC # 2019-0301-03).

Abstract 9) Quantifying Patterns of Drifting Fish Eggs and Larvae in the Middle Pecos River (Pg. 127)

The Environmental Legacy of Uranium Mining & Milling in New Mexico

Bruce Thomson
Civil, Construction & Environmental Engineering
University of New Mexico
(bthomson@unm.edu)



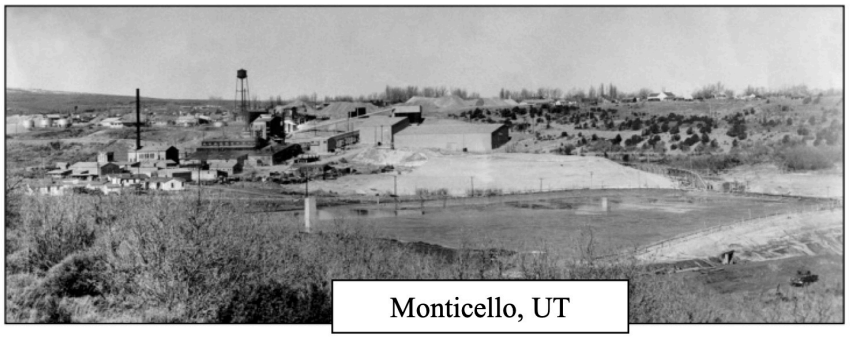
Fiestaware

Early Uses & Source of U for Manhattan Project

- Uranium (U) was discovered in 1789 by Klaproth (German chemist) from mineral pitchblende (UO_2)
- Prior to discovery of fission of heavy elements demand for U was small. Used for color in glass & glaze in ceramics (No. Food placed on Fiestaware won't cook itself!!)
- Discovery of fission in 1938/1939 led to explosion in U demand and consequent development of U resources around the world.
- Manhattan project used 6,000 tons of U ore
  - 67% from Shinkolobwe Mine – Belgian Congo, now DRC (up to 65% U_3O_8)
  - 17% from Canada
  - 14% from western CO
- Domestic U came from mines in western CO which mined carnotite ($K_2(UO_2)_2(VO_4)_2 \cdot 1\text{-}3H_2O$)
  - Originally mined for Ra, price was then $70 K/g - $120 K/g ($3.0 M/g in 2020)
  - Mines switched to V for steel alloy, including re-processing of tailings
  - Mines switched to U ~1942, including re-processing of tailings

- Stunningly ironic that world class U reserves were found <150 miles from Los Alamos, NM

THE UNIVERSITY of NEW MEXICO



Monticello, UT

Developing an Effective Monitoring Strategy Using Photogrammetry and 3D Mapping to Measure the Impact of a Plug and Spread Composite Treatment in a Degraded Alluvial Fan in the Semi-Arid Grasslands of the Southwest

Meagen Larson[1*], Dr. Blanca Céspedes[1], Dr. Julie Tsatsaros[1], Dr. Craig Conley[1,2], Sara Amina Sena[3]
[1] Forestry Department, New Mexico Highlands University, P.O. Box 9000, Las Vegas, NM, 87701
[2] Human Performance & Innovation and Organizational Learning Group, USFS, Rocky Mountain Research Station, Missoula, MT
[3] Hermit's Peak Watershed Alliance, 289 County Road A2, Sapello, NM, 87745

INTRODUCTION

The degradation of alluvial fans in semi-arid grasslands of the Southwest is often the result of channel incision and has been shown to contribute to a loss of hydrologic connectivity between montane areas and lowland grassland areas. In this study we examine the impact of the Plug and Spread (Figure 1) composite restoration treatment (Zeedyk, 2015) by measuring sediment aggradation as an indicator of restored sheet flow to the fan surface using photogrammetry and 3D mapping. Understanding the impact of restoration in degraded alluvial fan systems can be applied to land management strategies to increase water availability, forage production and groundwater recharge potential in increasingly warmer, less predictable climatic conditions.

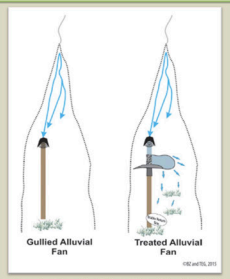


Figure 1. Illustration of Plug & Spread treatment in alluvial fan system (Zeedyk, 2015)

METHODS & OBJECTIVES

- **March – June 2020** Plug and Spread composite treatment to reroute runoff back to alluvial fan floodplain, ancillary structures to stabilize sheet flow and prevent future channelization (Figure 2)
- **June 2020** Post-restoration, pre-monsoon season unmanned aerial vehicle (UAV) flight with New Mexico Forest & Watershed Restoration Institute (NMFWRI) to capture pre-monsoon season imagery for baseline analysis (Figure 4)
- **August – December 2020** Develop methodology using Pix4D, ArcMap, and ArcGIS Pro software for image synthesis and to determine accuracy of digital elevation model (DEM) products and 3D model generation, develop analytical analysis to quantitatively determine effectiveness of treatment
- **November 2020** Post-restoration, post-monsoon season UAV flight with New Mexico Forest & Watershed Restoration Institute to capture post-monsoon imagery used to calculate differences in elevation height and sediment volume before/after the monsoon season as an indicator of restored sheet flow to the fan floodplain

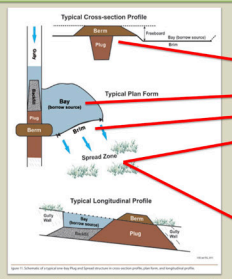




Figure 2. Profile illustration of Plug & Spread treatment (Zeedyk, 2015) and associated restoration structures within study site

ANTICIPATED OUTCOMES

This study aims at developing a methodology using UAV imagery, photogrammetry, and 3D mapping as an effective monitoring tool to determine the impact of a Plug and Spread composite restoration treatment. If the research objectives are met, we expect to see the following:

- Pix4D Mapper synthesis of UAV collected imagery (Figure 5) will generate accurate DEMs (Figure 7) of pre- and post-monsoon season flyovers in which elevation height differences will be detected as a result of sediment aggradation
- Lidar generated point clouds (Figure 8) in conjunction with 2D orthophotos (Figure 6) will construct accurate 3D models pre- and post-monsoon season in which changes in sediment volume will be detected a result of sediment aggradation
- Multiple Pairwise Comparison statistical analysis will provide quantifiable, measurable evidence into the effectiveness of a Plug and Spread composite treatment as a viable technique for restoring hydrologic connectivity in this particular alluvial fan in a semi-arid grassland ecosystem
- Photo monitoring will provide qualitative evidence into the effectiveness of a Plug and Spread composite treatment by tracking increases in vegetative cover and decreases in % bare ground

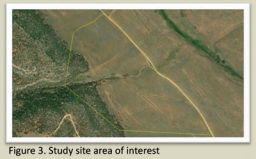


Figure 3. Study site area of interest



Figure 4. NMFWRI UAV flight path, pre-monsoon flight

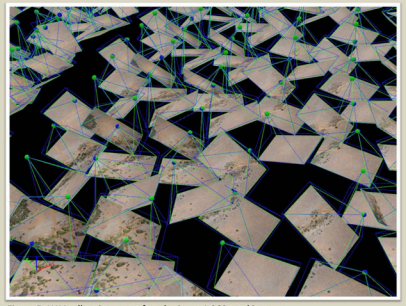


Figure 5. UAV collect imagery of study site - ~1,360 total images



Figure 6. Pix4D generated 2D orthophoto

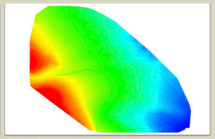


Figure 7. Pix4D generated DEM

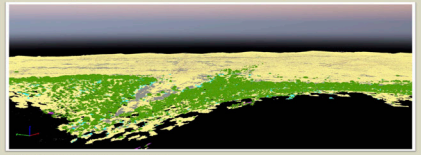


Figure 8. Lidar generated point cloud

SUMMARY

This research project combines traditional ecological knowledge, site-specific restoration treatments, and GIS technology to develop an effective monitoring strategy to measure the impact of a Plug and Spread composite treatment. Changes in sediment height and volume will be measured as indicators of restored sheet flow through 2D and 3D digital modeling between two UAV flights, before and after the 2020 monsoon season. In precipitation driven systems, the amount, frequency, and duration of precipitation events will determine the impact of the Plug and Spread composite treatment and the anticipated outcomes of this study. Despite the lack the predictability, by plugging the incised channel, we are effectively capturing and rerouting any amount of water back on to the fan floodplain that would otherwise be accelerated out of the alluvial fan system.

REFERENCES & ACKNOWLEDGMENTS

Thank you to Dr. Blanca Cespedes, Dr. Julie Tsatsaros, Dr. Craig Conley, Sara Amina Sena, Bill Zeedyk, Joe Zebrowski, Patti Dappen, Katie Withnall, Josh Miner, & Sol Ranch
For more information, please contact Meagen Larson at mlarson2@live.nmhu.edu

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Abstract 11) Developing an Effective Monitoring Strategy Using Photogrammetry and 3D Mapping to Measure the Impact of a Plug and Spread Composite Treatment in a Degraded Alluvial Fan in the Semi-Arid Grasslands of the Southwest (Pg.127)

Isotopic niche overlap among freshwater turtles in the Pecos River system, USA

Thanchira Suriyamongkol, Vinicius Ortega-Berno, Laramie B. Mahan, and Ivana Mali
Department of Biology, Eastern New Mexico University. Portales NM 88130

Introduction and Objectives

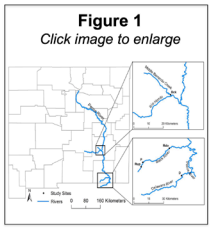
- The Pecos River system (PRS) is one of the most antropogenically altered river systems in the US. It is home to six freshwater turtle species, including a species of conservation concern *Pseudemys gorzugi* (Rio Grande Cooter)
- Although native to PRS, *Trachemys scripta* (Red-eared slider) has been widely spread throughout the world. Where introduced, *T. scripta* is known to compete for resources with native freshwater turtles
- Assessing dietary habits and resource competition is fundamental for understanding species ecology and their roles in the ecosystem
- Stable isotope analyses of carbon and nitrogen examines diet on a longer time span, and can be used to determine niche overlap among turle species inhabiting the same locality

Objective: To quantify isotopic signatures of *P. gorzugi*, and determine the extent of niche overlap of *P. gorzugi* and *T. scripta* across different habitats in the Pecos River tributaries

Study sites and Methods

- Our study was conducted at 5 locations across three Pecos River tributaries in New Mexico (Fig.1)
- We captured turtles from May to September of 2019 using hoop net traps; samples from site P were taken in 2017 via snorkeling
- For each turlte captured, we collected at least one of the three tissue samples: nail, blood, and carapace for stable isotope analyses
- Stable Isotope analyses of $\delta^{15}N$ *or* $\delta^{13}C$ were done by UC Davis Stable Isotope Facility
- Isotopic compositions were determined using the formula: $\delta^{15}N$ *or* $\delta^{13}C$ *= [(Rsample – Rstandard)/ Rstandard] x 1000*, and all results were expressed in delta notation (δ) in parts per thousands (‰)
- We used Stable Isotope Bayesian Ellipses (SIBER) package in R to estimate Bayesian Layman's isotope metrics
- We calculated the Bayesian standard ellipse areas (SEA_B) and standard ellipses corrected for the small samples size (SEA_c) as a measure of isotopic niche for *P. gorzugi* across all habitats and *T. scripta* where it co-occurs with *P. gorzugi*

Figure 1
Click image to enlarge



Results

Click figures to enlarge





Trachemys scripta ***Pseudemys gorzugi***

Figure 2

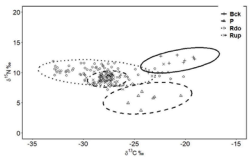


Figure 3

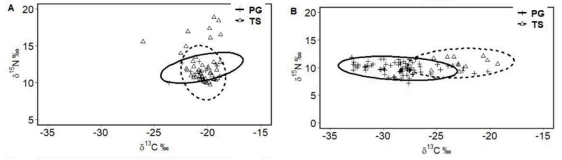
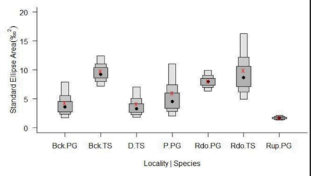


Figure 4



Discussion

- This study is the first to compare isotopic niches of two naturally occurring freshwater turtle species of the PRS
- Our study shows that local resource availability may influence *P. gorzugi* niche width. We speculate that isotopic partition of *P. gorzugi* among surveyed sites reflects the local availability of resources and their isotopic signatures
- At the sites where both species occur, we documented niche overlap, especially for $\delta^{15}N$ values. it is likely that the species are competing for similar resources although *T. scripta* generally showed wider ranges for $\delta^{13}C$ and $\delta^{15}N$
- Isotopic similarity does not necessarily represent ecological or dietary similarity; different food resources could contain identical isotopic compositions
- Future studies should focus on expanding surveyed locations across *P. gorzugi* range (i.e., Texas) and conducting a thorough assessment of site-specific food sources in order to construct mixing models of prey item distribution in *P. gorzugi* diets



Acknowledgments

We thank New Mexico Water Resources Research Institute for funding. We also thank undergraduate and graduate students from ENMU for their help with tissue collection. This project was approved by NMDGF authorization #3621 and ENMU IACUC (03-02/2016; 2019-0226-01A1)

Abstract 12) Isotopic Niche Overlap Among Freshwater Turtles in the Pecos River System, USA (Pg. 128)

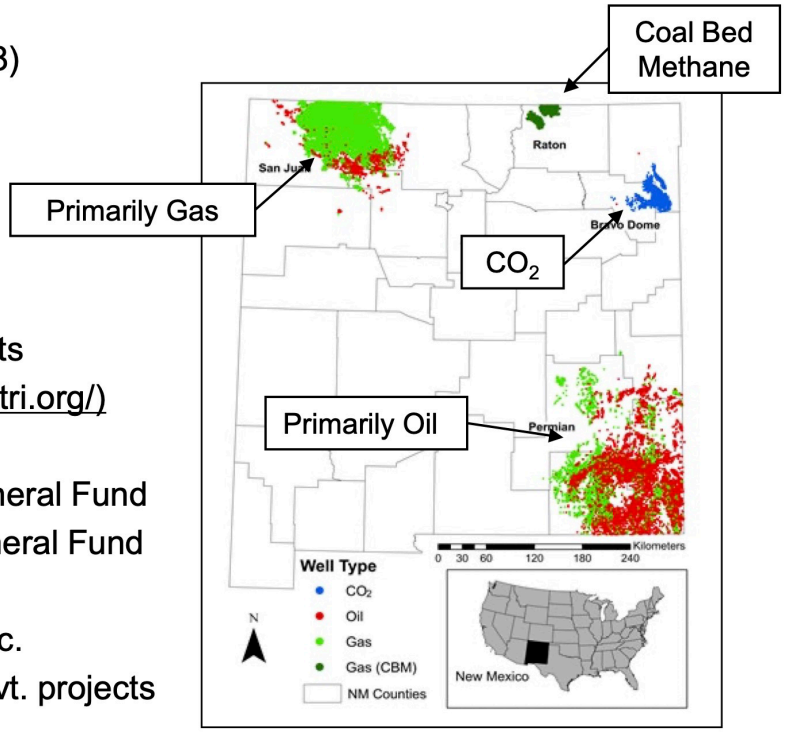
Analysis of the Relationship Between Water, Oil and Gas in New Mexico: Past and Future Trends

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- Contribution to NM's economy (LFC Finance Facts, 2018)
  - Oil production value: $6 - $8 B
  - Gas production value: $5 - $7 B
- ~$2 B in direct revenues to NM
  - ~$1B to General Fund
  - $400 - $500 M for Capital Outlay
  - Property & gross receipts taxes to local governments
  - > 30% of General Fund revenues in 2018 (www.nmtri.org/)
- General rule of thumb
  - $1/bbl increase in oil price produces $9.5 M for General Fund
  - 10% increase in gas price produces $6.5 M for General Fund
- 21 beneficiaries
  - Land grant permanent fund – Schools, hospitals, etc.
  - Severance tax permanent fund – Retire debt for govt. projects
- But O&G development has a large water footprint for:
  - Well development by hydraulic fracturing (HF or fracking)
  - Wastewater from production (produced water)



THE UNIVERSITY of NEW MEXICO

Environmental Flow Analysis for Rio Grande Silvery Minnow Recruitment

Michael D. Porter
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Aubrey Harris, PE
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Introduction

- Environmental flow parameters for Rio Grande Silvery Minnow
- Functional analysis evaluated the relationships of metrics
- Fish population metrics calculated from monitoring data
  - Spring-summer recruitment
  - Fall population index
- Environmental metrics
  - Seasonal hydrology (magnitude, duration),
  - Habitat suitability based on hydraulic analyses
- Environmental flow parameters supports adaptive management
- Inform water management strategies
- Inform restoration design criteria.

Functional Analysis Methods

- Functional analysis evaluates the relationships of fish and environmental metrics
- **Fish metrics were derived from population monitoring data**
  - Recruitment slope measures reproductive success from May through July
  - October Index estimates fish population at the end of irrigation season
- **Environmental metrics (100+) were derived to characterize spring runoff**
  - Flow data was from the USGS Gage at Central Bridge in Albuquerque
  - Hydrologic metrics were derived using the Ecosystem Function Model (EFM) from the Hydrologic Engineering Center (HEC)
  - Hydraulic metrics were derived using HEC River Analysis System (RAS) based on EFM flow metrics
- **R software** used to generate linear models of fish and environmental metric pairs
- Higher correlation (r^2) with smaller **AIC** score of fish metric with environmental metric indicates the strength of interaction
- Evaluate the ecological and biological relevance of metric interactions

Fish Metric	Formula	Date
Recruit Slope	lm(fish/area*100)	May 1 - Aug 9
October Index	fish/area*100	October

Results

Functional analysis suggests the **14-21 day maximum-minimum flow** is important for silvery minnow production

- Good flow is correlated with higher Silvery Minnow Recruitment and the subsequent October Index
- Poor flow is correlated with low Recruitment and October Index
- Threshold flow represents flow magnitude between 1130-2100 cfs for 14-21 days duration that warrant additional analysis to identify useful minimum spring runoff

Environmental flow (Spring runoff)	21-day maximum-minimum flow range		14-day maximum-minimum flow range		Recruitment (slope)		October Index (CPUE)	
	Min	Max	Min	Max	Min	Max	Min	Max
Good flow	2460	5610	2630	5780	0.26	1.15	0.42	36.83
Threshold flow	1130	1870	1400	2100	0.06	0.07	0.15	0.79
Poor flow	426	759	499	1040	0.00	0.07	0.01	0.55

Conclusions

Additional analyses focusing on the 1130-2100 cfs magnitude for 14-21 days duration should refine the minimum environmental flow for successful Silvery Minnow reproduction

Acknowledgements

Thanks to:
- U.S. Army Corps of Engineers Upper Rio Grande Water Operations
- U.S. Army Corps of Engineers Middle Rio Grande Endangered Species Collaborative Program
- U.S. Army Corps of Engineers Engineering Research and Design Center
- U.S. Bureau of Reclamation
- American Southwest Ichthyological Researchers

Abstract 14) Environmental Flow Analysis for Rio Grande Silvery Minnow Recruitment (Pg. 128)

Establishing methods to artificially spawn Pecos River minnows

Rick Raymondi and Jesse Filbrun

Dept. of Biology, Eastern New Mexico University, Portales, NM

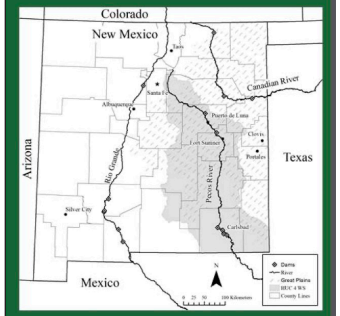
Background and Research Objectives

Background

- New Mexico is in a period of prolonged drought exacerbated by climate change.
- Fishes of the Great Plains are vulnerable to habitat fragmentation from dam construction and regional drying.
- Quantifying the effects of water management on native fishes is critical for future conservation efforts.

Research Objectives

- Establish artificial spawning methods for native fishes.
- Investigate the effects of high discharge on larvae of native fishes using an artificial stream tank.

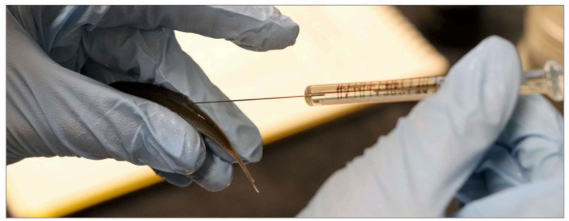


A map the Pecos River watershed (shaded area) and the Great Plains ecoregion (hatch lines).

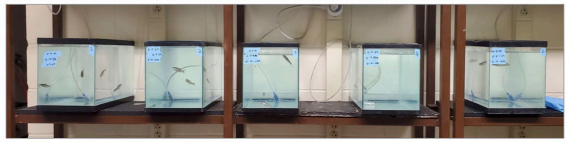
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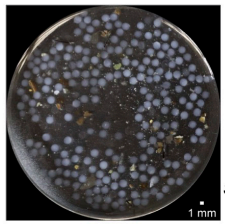
Methods

- Target species were collected from the Pecos River using backpack electrofishers and transported back to the Behavior Ecology Laboratory at ENMU.
- Fish were acclimated in species specific tanks for a minimum of 24-hours before injection trials.
- Specimens were assessed for maturity with gravid females and ripe males selected and anesthetized with MS-222 before Ovaprim® injection.
- Injected fish were placed in aquaria with different environmental variables and monitored for spawning activity.



Above: intramuscular injection with Ovaprim® behind the dorsal fin of Plains Minnow. Below: specimens in spawning aquaria post injection.





Left: unfertilized Plains Minnows eggs 12-hours after injection. Right: positive results from a successful reproduction event; Red Shiner minnow at 12 weeks.

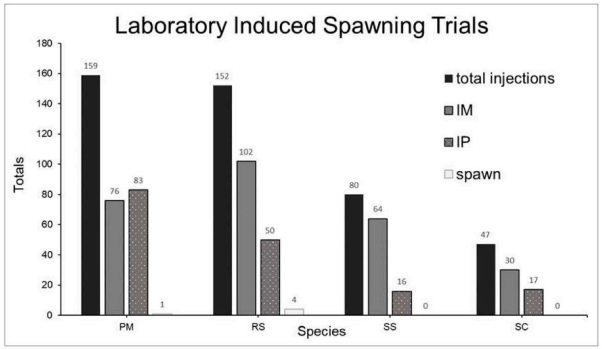


Life History Traits of Candidate Fishes

Species	Spawning Behavior	Egg Type	Status
Speckled Chub[1] *Macrhybopsis aestivalis*	pelagic broadcast	semibuoyant nonadhesive	native
Plains Minnow[1] *Hybognathus placitus*	pelagic broadcast	semibuoyant nonadhesive	non-native
Sand Shiner[1] *Notropis stramineus*	broadcast	demersal adhesive	native
Red Shiner[2] *Cyprinella lutrensis*	speleophils	demersal adhesive	native

Life histories of candidate species that represent different life histories of cyprinids in the Pecos River.

Results



Results form spawning trials. IM = intramuscular, IP = intraperitoneal, spawn = single tank event, PM=Plains Minnow, RS=Red Shiner, SS=Sand Shiner, SC=Speckled Chub.

Discussion

- We performed 438 Ovaprim® injections between June and August with only five unique spawning events occurring. One event was the release of unfertilized eggs by Plains Minnows with the four successful reproductive events by Red Shiner.
- We believe that Ovaprim® will aid in the laboratory induced spawning of Pecos River minnows but water chemistry, flow, and substrate play a critical role. Future trials should mimic Pecos River water chemistry in the lab as river chemistry changes pre- and post-reservoir release.

References

[1]Platania, S.P., Altenbach, C.S. 1998. Reproductive strategies and egg types of seven Rio Grand basin cyprinids. Copeia 3: 559–569.

[2]Simon, T. P. 1999. Assessment of Balon's reproductive guilds with application to Midwestern North American Freshwater Fishes, pp. 97-121. *In*: Simon, T.L. (ed.). Assessing the sustainability and biological integrity of water resources using fish communities. CRC Press. Boca Raton, Florida. 671 pp.

Acknowledgments

This study is funded by internal Faculty Research Grants awarded to Jesse Filbrun, NM WRRI (NMWRRI-SG-2020) and the New Mexico State Legislature. Field collections were approved by NMDGF (Permit # 3678) and ENMU (IACUC # 2019-0301-03, 2020-0317-05). We thank Sara Ricklefs for assisting in specimen collection and injection trials.

Abstract 15) Establishing Methods to Artificially Spawn Pecos River Minnows (Pg. 129)

Repeat Post-Wildfire Geomorphic Surveys of North Fork Eagle Creek, New Mexico, 2017 to 2021

Alexander P. Graziano
U.S. Geological Survey, New Mexico Water Science Center

Introduction

About one-quarter of the water supply for the Village of Ruidoso, New Mexico, is from groundwater pumped from wells located along North Fork Eagle Creek in the mountains of the Lincoln National Forest (U.S. Department of Agriculture [USDA] Forest Service, 2016) (fig. 1 and fig. 2). Concerns regarding both the effects of groundwater pumping and the 2012 Little Bear Fire (fig. 3) on the surface water hydrology of North Fork Eagle Creek, led the USDA Forest Service, Lincoln National Forest, to require monitoring of North Fork Eagle Creek for short-term geomorphic change as part of the permitting decision that allows for continued pumping of the production wells (USDA Forest Service, 2016).

To address the geomorphic monitoring requirements, annual geomorphic surveys of North Fork Eagle Creek along a 1.89-mile-long study reach between the North Fork Eagle Creek near Alto, New Mexico, streamgage (U.S. Geological Survey [USGS] site 08387550) and the Eagle Creek below South Fork near Alto, New Mexico, streamgage (USGS site 08387600) (fig. 2 and fig. 4) were conducted from 2017 to 2020. (A final survey is planned for the summer of 2021).

Methods

- Annual topographic surveys of 14 select cross sections using real-time kinematic global navigation satellite systems (RTK GNSS)
- Annual surveys of all woody debris accumulations and pools in the channel of the study reach, which include:
    - Identifying and cataloguing all woody debris accumulations and pools
    - Taking photographs of all woody debris accumulations and pools
    - Classifying woody debris accumulations by their potential to form debris jams
    - Measuring all pools for residual depth
- Qualitative annual surveys of other features of geomorphic significance (for example, channel bifurcations, flood deposits, and fine-sediment accumulations)

Study area

Figure 1. Location of Study Area in New Mexico



Figure 2. Study Area in the Eagle Creek Basin (modified from Matherne and others, 2010)

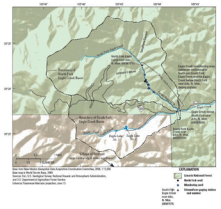
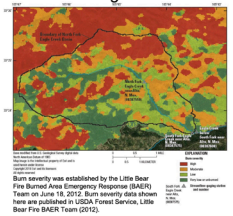
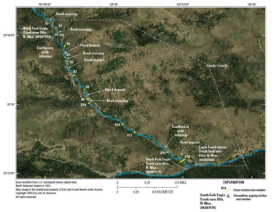


Figure 3. Burn Severity of the Little Bear Fire of 2012 in the North Fork Eagle Creek Basin



Burn severity was established by the Little Bear Fire Burned Area Emergency Response (BAER) Team on June 18, 2012. Burn severity data shown here are published in USDA Forest Service, Little Bear Fire BAER Team (2012).

Figure 4. Study Reach with Locations of Cross Sections and Other Features



Large sections of the study reach (fig. 4) are characterized by intermittent streamflow (Matherne and others, 2010). Where streamflow is normally continuous (including at the upper and lower portions of the study reach, near the streamgages), the discharge typically remains less than 2 cubic feet per second throughout the year (Graziano, 2019).

Results & Conclusions

Figure 5. Discharge at the North Fork Eagle Creek Streamgage (08387550) between the 2017 and 2019 Surveys

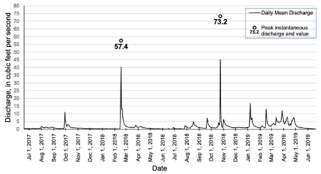
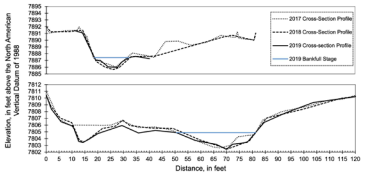


Figure 6. Example North Fork Eagle Creek Cross Sections, 2017 to 2019 (*Data are preliminary and subject to revision*)



Geomorphic change to the study reach is expected to be largely driven by seasonal high-flow events, specifically those with peak discharges greater than 50 cubic feet per second that have about a 2-year recurrence interval and tend to occur during the North American monsoon months of July, August, and September or result from snowmelt runoff in the winter and spring months (Graziano, 2019).

Preliminary results from the 2018 and 2019 surveys indicate that seasonal high-flow events (fig. 5) have only caused minor observable geomorphic changes (aggradation or degradation of surface materials by about 1–2 feet) in parts of 3 of the 14 surveyed cross sections (fig. 6). However, the number of woody debris accumulations in the channel has substantially increased and some of those accumulations have appeared to influence local geomorphic changes, including the formation of pools (fig. 7).

Figure 7. Photos of Woody Debris Accumulations from the 2019 Survey



Disclaimer: This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

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U.S. Department of Agriculture [USDA] Forest Service, 2016, Record of decision, North Fork Eagle Creek Wells Special Use Authorization: U.S. Department of Agriculture Forest Service, 28 p., accessed July 18, 2018, at https://www.fs.usda.gov/project/?project=9603.

Acknowledgements

This study is being conducted in cooperation with the Village of Ruidoso

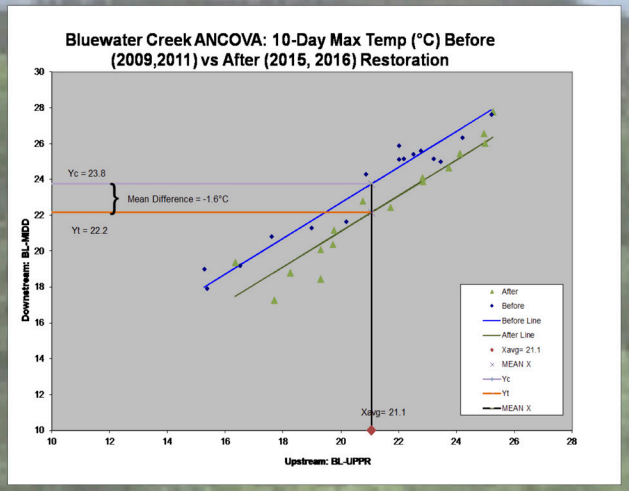
Abstract 21) Repeat Post-Wildfire Geomorphic Surveys of North Fork Eagle Creek, New Mexico, 2017 to 2021 (Pg. 130)

Determining the Effects of Stream Restoration on Bluewater Creek, New Mexico

Daniel Guevara, Watershed Scientist
NMED Surface Water Quality Bureau



Bluewater Creek project reach before restoration (2009).



ANCOVA Chart showing decrease in stream temperature on Bluewater Creek Upstream/Downstream Before/After restoration



Bluewater Creek Project Reach After Restoration (2017).



Restoration and best management practices have improved water quality on Bluewater Creek in Cibola County NM. Prior to the improvements, Bluewater creek was heavily impacted by off-road vehicle use and grazing. Staff from the Surface Water Quality Bureau (SWQB) at the New Mexico Environment Department (NMED) documented water quality problems such as high nutrients, turbidity, and temperature. Starting in 2009, Wild Earth Guardians conducted a Clean Water Act (CWA) Section 319(h) project to build fencing exclosures to restrict access for herbivores and off-road vehicles to the riparian area, and to re-plant native vegetation including cottonwood trees and willows. Additionally, the Cibola National Forest improved grazing management in the upper watershed by rounding up wild horses that were impacting the area. The results were impressive as the area was transformed from a denuded channel to a lush riparian forest in just a few years. Subsequent water quality surveys indicated that nutrient and turbidity levels had improved, and these impairments were removed from the 303(d) List of Impaired Waters. The success of this work indicates that these proven methods could be applied in other similar locations to improve steam habitat and water quality.

Methods

- Onset Hobo Water Temp Pro V2 loggers recorded stream temp on 15 minute interval
- Spherical densiometer provided percent canopy cover values
- Before/After Upstream/Downstream Study Design for statistical analysis
- Analysis of Covariance (ANCOVA) quantified the effects of restoration. (Grabow, Spooner, et al. 1998)

New Mexico Environment Department – Surface Water Quality Bureau
https://www.epa.gov/nps/nonpoint-source-success-stories-new-mexico

Abstract 23) Determining the Effects of Stream Restoration Projects on Water Quality in Northern New Mexico (Pg. 131)

Solar reforming of microplastics in water for H_2 production and degradation using nanocomposite photocatalysts

E. M. N. Thiloka Edirisooriya, Huiyao Wang, Pei Xu

Department of Civil Engineering, New Mexico State University, Las Cruces, NM

Introduction

- Microplastics are the most substantial category of anthropogenic particles.
- Highly stable and durable plastic particles are accumulated due to the plastic debris released into water bodies.
- Millions of micro- and nano-sized plastics are formed as a result of photodegradation, embrittlement, and fragmentation because of wave action.
- The long-term presence of these particles in water and their accumulation in the food chain have severely impacted living organisms, including human beings.
- The research objective is to develop efficient and sustainable methods to degrade micro- and nano-plastics from water using photocatalysis while producing hydrogen (H_2) under solar reforming.

Classification, Sources, and Properties of Microplastics

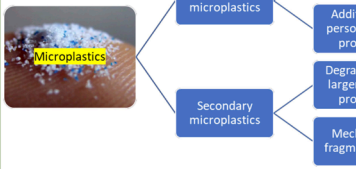


Figure 1: Classification of microplastics

Table 1: Properties of micro and nano plastics

Property	Nanoplastics	Microplastics
Composition	Mixture of polymers, highly weathered	Different polymers
Size	1 nm-1 µm	Lower limit 1 to 20 µm Upper limit 1 -5 mm
Size distribution	Polydisperse (continuum of size)	Polydisperse
Shape	Asymmetrical	Pellets, fragments and fibres or irregular
Surface charge	Uncontrolled with the presence of different species	

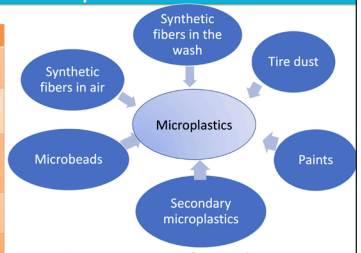


Figure 2: Sources of microplastics

Toxicity

- MPs may be toxic due to their inherent ability to induce intestinal blockage or tissue abrasion.
- In earthworms (*Eisenia andrei*), fibrosis, congestion and inflammatory infiltrates were observed after exposure to MPs (from 62 to 1000 mg/kg of polyethelene).
- In sea bass (*Dicentrarchus labrax*), moderate to severe histopathological alterations of the intestine were measured, after 30-90 days of exposure to poly vinyl chloride MP through ingestion.
- limited absorption (0.2%) of polylactide-co-glycolide microparticles (3 mm) was measured in human mucosal colon tissue. The mucosal colon tissue of patients with inflammatory bowel disease, showed increased transport (0.45% as compared to 0.2% in healthy controls) in relation to greater gut permeability. (Table 3)

Removal technologies

Table 2: Summary of removal technologies of micro and nano plastics

Size range of plastics	Method	Remarks
Microplastics (1 mm – 5 mm)	Membrane bioreactor	Removal efficiency 99.9%
	Rapid sand filter	Removal efficiency 97%
	Disc filter	Removal efficiency 95%
	Coagulation process	Removal efficiency below 40%
	Ultrafiltration process	Higher removal efficiency than that of coagulation process
Microplastics (10-20 µm)	Magnetic Polyoxometalate-Supported Ionic Liquid Phases (magPOM-SILPs)	Removal efficiency over 90%
Nanoplastics	Advanced oxidation process	Much greener approach
	ballasted flocculation	Removal efficiency 88% (Lab scale)
	Filtration with a 0.22 µm filter	Removal efficiency 92 % (Lab scale)
	centrifugation at 10,000 rpm	Removal efficiency 99% (Lab scale)

Advanced oxidation & Photo reforming

- Advanced oxidation includes homogeneous or heterogeneous photocatalysis.
- In photocatalysis many pollutants in the water are breakdown at the room temperature by oxidation.
- Either sunlight or artificial light can be used as energy source.
- Owing to its low production cost and good chemical stability, it has been widely employed in photo-degradation of organic compounds (Table 4)

- Application of photocatalysis to H_2 production from organic substrates is usually called photo reforming, makes use of semiconductors to promote redox reactions, namely, the oxidation of organic molecules and the reduction of H+ to H_2 (Table 4)

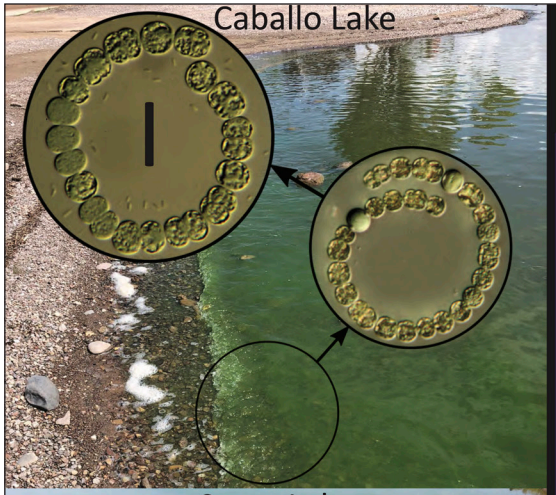
Conclusions

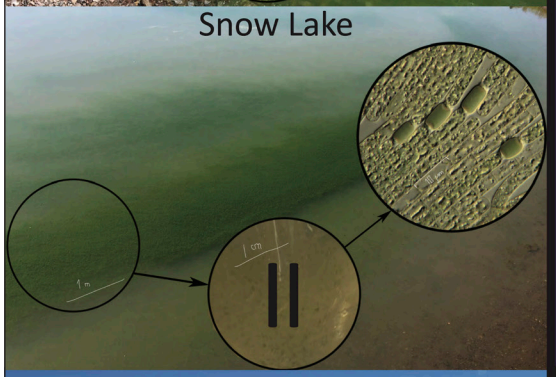
Highly functional photocatalysts such as ZnO-Pt, TiO_2-Au, TiO_2-Pt, and graphene oxide/TiO_2/Au ternary nanocomposites are proposed to use in further studies to remove micro- and nano-plastics that can easily pass through the conventional treatment methods. Development of highly functional nanocomposite photocatalysts to clean water and convert microplastics from a waste to H_2 energy is proposed as an environmental remediation of microplastic pollution

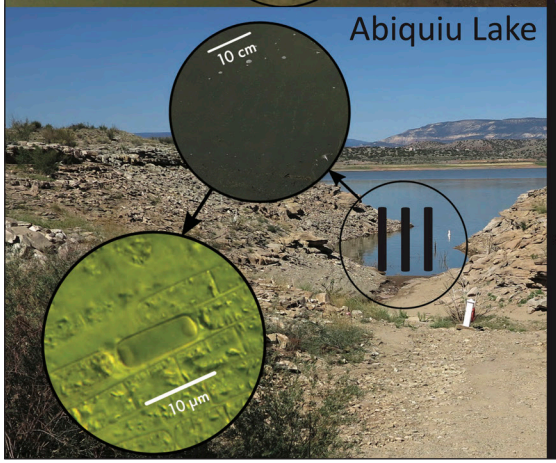
Acknowledgements

Funded by the 2020-2021 Student Water Research Grant Program of the New Mexico Water Resources Research Institute (NM WRRI).

Abstract 25) Solar Reforming of Microplastics in Water for H_2 Production and Degradation Using Nanocomposite Photocatalysts (Pg. 131)







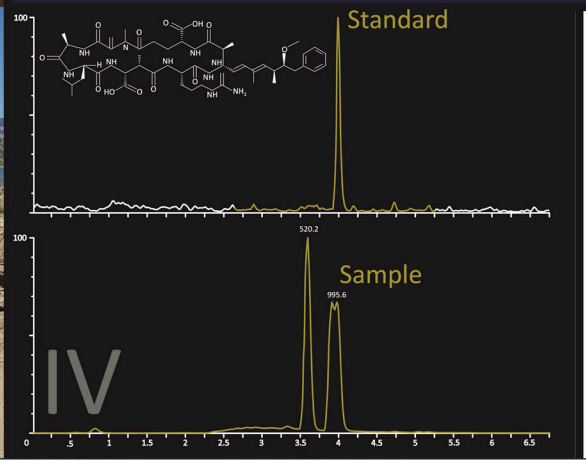
Assessment of the cyanobacterial Harmful Algal Blooms (cHABs) and toxins in the blooming water bodies of New Mexico

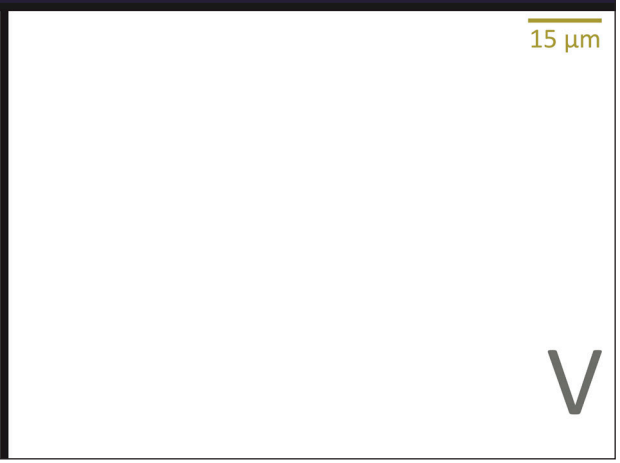
Sergei Shalygin, F. Omar Holguin, and Peter Cooke

Cyanobacterial Harmful Algal Blooms (cHABs) are the cause of many environmental problems World Wide. Once established in the water body, cHABs persist for many years. Many cyanobacterial species form and release dreadful toxins into the water. CHABs are progressing in the world and in USA due to nitrogen/phosphorus pollution and climate change/tempreture increase. Some cyanobacterial species have specific nitrogen fixing cells, making them independent from inorganic nitrogen. Prior to this research there were only disintegrated information about cHABs on the territory of New Mexico.

In the attemt to assess cHABs, several scientific methodics were implemented. To determine taxomonic affiliation of the major bloom taxa, LIGHT MICROSCOPY was used. In order to confirm viability and pigments distribution in the cells CONFOCAL MICROSCOPY was applied. TANDEM MASS SPECTROMETRY coupled with ULTRA PERFORMANCE LIQUID CHROMATOGRAPHY was used to identify 10 major cyanobacterial toxins. Standard solution of Microcystin-LR was run with the toxin samples extracted from water and biomass. MRM (Multiple Reaction Method) with two daughter fragments was used for reliable identification of the toxins. Due to COVID-19 quarantine quantification of the toxins was postoned.

According to the morphological analysis, species composition of 3 lakes under study (I, II, III) was quite diverse. Caballo Lake had *Dolichospermum spiroides* (I) as a major bloom contributor. In contrary, *Aphanizomenon flos-aquae* (II, III) was a dominant species in Snow Lake and Abiquiu Lake. There was transition in species composition from summer to fall, to the communities with multiple *Microcystis* species in Snow Lake and Abiquiu. Caballo Lake did not sustain massive bloom in the fall season. In order, to evaluate community structure, Next-Generation sequencing will be applied in future. Confocal imaging showed clear Chlorophyll distribution within the *Aphanizomenon flos-aquae* cells (V), indicating viability of populations. It also showed empty volume in the terminal cells which promotes efficient buoyancy of a population. Mass spectrometry identified 3 cyanobacterial toxins in the summer waters of 2 lakes: Caballo and Abiquiu (IV). In the fall, major toxins were found in the Snow Lake only, where community structure shifted to the *Microcystis* spp. dominated. Similar trend was observed in the Abiquiu Lake, however MRM did not find any substantial toxins neither in water nor in the living biomass. This research may serve as a template for monitoring program of water bodies of New Mexico, which is missing at the time.





Abstract 26) Assessment of the Cyanobacterial Harmful Algal Blooms (cHABs) and Toxins in the Blooming Water Bodies of New Mexico (Pg.131)

The New Mexico Produced Water Database 2020

Martha Cather and Raven Goswick

Petroleum Recovery Research Center, a division of New Mexico Tech

The Challenge

How can we do a better job of managing produced water if we don't know much about it?

- Do we know where the water comes from, how much of it is there, how much is brought in from outside the system, how much is disposed or recycled, and how much quantity or quality can vary in time and/or space?
- The primary objective of this research was to build a geospatial database of oilfield water volume information that can be linked to the existing produced water quality databases.
- A second objective was to survey people involved in produced water management in the industry to get more information on usage practices.
- Data from several sources was compiled into a database that allows users to conduct temporospatial and stratigraphic analysis, to better visualize locations, important formations, and volumes of water production and injection and in doing so to have a better understanding of the overall "budget" for oilfield waters in New Mexico. The database is linked to two pre-existing water quality databases.

It's *hard* to make a database look **EXCITING!!!!**



But with this database, we've answered some of our most frequent user requests. We have:

- Combined volume data for water, oil, and gas production along with injection data for 1995 to midway through 2020
- Kept granularity - Volume data is on the level of well and pool by month and year
- Provided aggregations of data such as annual cumulative totals, totals by well, and information to allow aggregation by pool, formation, county, or other parameters
- Added produced water quality data from both the 2016 NM Produced water database and the USGS produced water database
- Combined the best of the NM OCD well information with some of our legacy data for better identification of historical wells, added some
- Cleaned up well identifications, locations, and formations for the USGS produced water database
- Database is in Microsoft Access, but has spatial data and identifiers to allow use with GIS programs

So What?

Our next panels will show you how our database can be used to answer typical questions such as:

- How much water is produced or injected in New Mexico?
- What region (county, township, well) has the most production? Injection?
- Can we distinguish water production or injection versus water that is recycled through EOR projects?
- What formations or pools produce the most water? Which take the most disposed water?
- Where's the highest quality produced water in the state? How about the worst?
- How do water/oil ratios change through time?

Abstract 27) The New Mexico Produced Water Database 2020 (Pg. 132)

Hydrogeochemical Analysis of Springs in the Cibola National Forest: Implications for Springs/Wetlands Sustainability & Geochemical Response to Forest Fire

[1]Naomi T. DeLay, [1]Laura J. Crossey, and [2]Livia Crowley

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Introduction

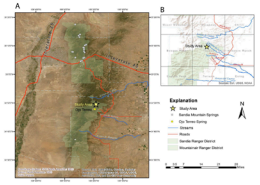


Figure 1: A- Larger map with aerial imagery shows Ranger Districts, major hydrology, roads, and location of the study area that includes Ojo del Rancho del Medio and Ojo del Rancho del Medio West. B- Close-up terrain map shows important roads and hydrology as well as USGS quadrangles of the study area. The star indicates the location of the focus study springs.

Aridland springs of the Southwest provide habitat for many species and important resources for local communities. Ojo del Rancho del Medio (RDM) and Ojo del Rancho del Medio West (RDMW) springs within the Mountainair District of the Cibola National Forest located in the Manzano Mountains are the focus of this study (shown in Fig 1). This work builds on recent regional springs assessments in the Cibola National Forest by the USFS. During this study, seasonal monitoring is proposed to continue beginning in summer of 2019 until spring/summer of 2021.

Research goals of the study:

(i) use geochemical tools to characterize water quality and understand sustainability in selected springs of the Manzano Mountains

(ii) characterize the hydrologic flow paths and spring-flow regions of the Manzano spring waters

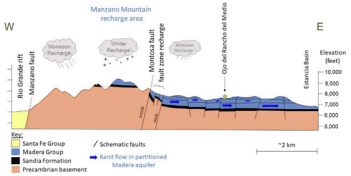


Figure 2: Local schematic cross section of the Manzano Mountains. Modified from Kietzstron et al. (1999) and Allen (2002). Schematic cross section shows the major faults and stratigraphy of the USGS Tajique and Bosque Peak and quadrangles through the study area (Ojo del Rancho del Medio Spring). Includes blue arrows showing karst flow through the Madera Group and recharge mechanisms through monsoonal and winter recharge.

Methods





Figure 3 & 4: Top image- Photo of Confluence of Ojo del Rancho del Medio and Ojo del Rancho del Medio West. Bottom image- Installation of CDT sensor downstream of springs.

Monitoring of springs: By collecting the seasonal physico-chemical parameters, water samples, and additionally the deployment of continuous sensors (CDT- Conductance Depth Temperature sensors and barometer) from August to November of 2020 (shown in Fig 4)

Sample Water Analysis:
Major and trace ion chemistry analysis using Ion Chromatography (IC), Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES), and Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) (Analytical Geochemistry Laboratory at UNM EPS)

Isotope Analysis: Analyze water samples for the isotopic values of deuterium and oxygen (δD and $\delta^{18}O$) using Picarro cavity ring-down spectroscopy (Center for Stable Isotopes at UNM)

Results & Conclusions

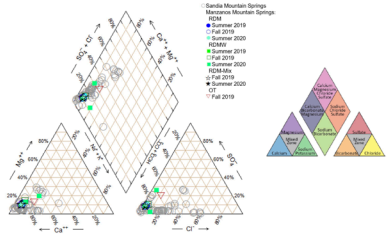


Figure 5: Major-ion chemistry analyses are shown using a Piper Diagram (Tumejag). Piper includes previous samples of Sandia Mountain springs and pdata from this study's sampling sites including Ojo del Rancho del Medio Spring (RDM), Ojo del Rancho del Medio West Spring (RDMW), Ojo Ternes Spring (OT), and the Confluence of Ojo del Rancho del Medio and Ojo del Rancho del Medio West Springs (RDM-Mixed) for different seasons between 2019 and 2020. The hydrochemical facies in right hand Piper diagram from Frus (2016).

- Major ion geochemical analyses show these springs are consistent with other Sandia mountain springs issuing from the Madera Group carbonates.
- These waters plot in the calcium, bicarbonate, and the calcium bicarbonate magnesium dominant hydrochemical facies (Frus, 2016) of the Piper diagram (Fig 5) indicating the similar major chemistry.

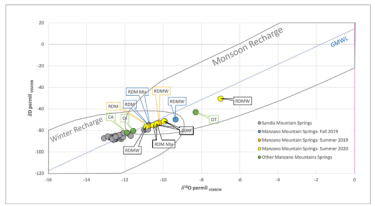


Figure 6: The stable isotope values of O and H are plotted relative to the Global Meteoric Water Line. The GMWL shows the linear relationship (slope of 8) of surface waters across the globe (Craig, 1961). Parabolas show the different recharge mechanisms (monsoonal and winter recharge) based on the work by Sharp, 2017 and Frus, 2016. This plot includes results from this study in the Manzano Mountains and previous analyses in the Sandia Mountains (Griego et al., 2018). Spring acronyms: OT-Ojo Ternes, OI-Ojo del Indio, CA-Capilla Spring. See Fig 5 for remaining acronyms.

- Analyses in show isotopologues (δD and $\delta^{18}O$) of the study springs are within the range of observed values for the nearby Sandia mountains consistent with winter recharge mechanisms (shown in Fig 6).
- Isotopologues of these waters indicate recharge from high elevation in the mountains.

Future Work & Broader Implications

Future Work:
- Tritium water sampling
- Analysis of continuous sensor data

Broader Implications:
- This study will provide the first baseline of the seasonal hydrochemistry in the Manzano Mountains.
- Based on the outcome of this study, understanding the dynamics and interactions of the springs will help us to better understand the sustainability of these springs to aid in management decisions.
- Monitoring of the water quality of these springs will assist in understanding how these springs are being affected by land management decisions.
  - For example, the conclusion of the survey by the Springs Stewardship Institute in the summer of 2019 confirmed that livestock are affecting the springs.
  - This study may bolster those recommendations.

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Acknowledgements

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Abstract 28) Hydrogeochemical Analysis of Springs in the Cibola National Forest: Implications For Springs/Wetlands Sustainability & Geochemical Response to Forest Fire (Pg. 132)

Phycoremediation of Contaminated Groundwater With Microalgae for Simultaneous Water Treatment and Biofuel Production at a Legacy Uranium Mining Site.

Zachary DeLay1, Annie Padilla2, Ondine Frauenglass3, Luke Spangenburg4, Stephen Gómez5

History of site

- From 1958 to 1963 3 million tons of uranium ore were processed at the Ambrosia lake facility.
- Philips petroleum built original mill in 1957 and operated the site until 1963.
- United Nuclear Corporation operated the mill from 1970 to 1982 operating an Ion exchange system to extract uranium from mine water.

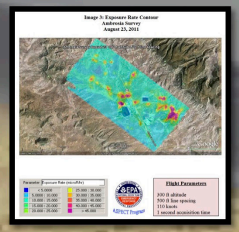




SFCC Technicians growing algae collected from Ambrosia Lake site

Current scope of work



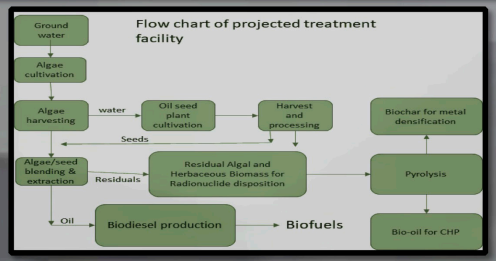


- Site now considered a legacy/superfund site owned by BHP



Multiple polyculture samples were cultured and scaled up into 2L PBRs which were used as inoculant for later experiments.

Phytoremediation and Biomass production



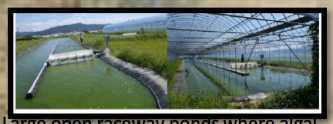
- Phytoremediation of water sources has been implemented in various methods to remediate multiple sources.
- Heavy metal removal can be accomplished with microalgae polycultures which utilize a variety of algal species which are used to increase absorption rates and target specific metals.
- The use of microalgae in wastewater treatment to eliminate excess nutrients within solution has been practiced for many years.
- Biomass will be collected from algae and crops to create biofuels which can then be used to power a process within the system.

Collaborators

- New Mexico State University(NMSU) is researching terrestrial plants which absorb contaminants and heavy metals still present in the soil.
- Remediated water produced from phytoremediation through SFCC processes will be used to grow crops and further clean water and soil.
- Oregon State University is researching phytoremediation properties of native grasses and potential uses
- National Renewable Energy Laboratory (NREL) has been offering oversight, data research/analysis and leadership.

Future

- BHP owns the site currently and will be operating Greenhouses that will be constructed on site to create and grow algae polycultures used to remediate water.



- Large open raceway ponds where algal biomass can be harvested after reaching desired density.



Abstract 30) Phycoremediation of Contaminated Groundwater with Microalgae for Simultaneous Water Treatment and Biofuel Production at a Legacy Uranium Mining Site (Pg. 133)

A Critical Review of Reclamation's Water Yield Modeling for the New Mexico Unit of the Central Arizona Project

Norm Gaume, P.E. (ret.) and Peter Coha

Retired water engineer/manager/consultant for public water agencies and retired Intel principal engineer

Problem Statement

Determine Reclamation's water yield model simulation bases for Reclamation's project performance summary metrics published in the draft Environmental Impact Statement (DEIS) for the New Mexico Unit of the Central Arizona Project, aka **Gila Diversion and Storage Project**, 2004 Arizona Water Settlements Act.

- Net yield of project water
- Reliability of project water yield
- Cost of project water
- Losses
- Impacts of the lowest seniority on the river of the NM Unit's Gila River diversion right

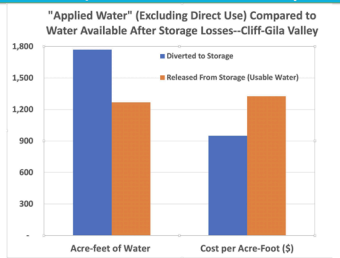
Objective & Methods

Objective: Provide Informed public comment regarding draft Environmental Impact Statement

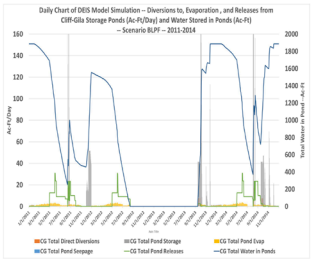
- Reviewed DEIS including appendices and associated technical memoranda
- Identified Reclamation project performance descriptions and conclusions that seemed wrong and which were unsupported by information in the DEIS and technical memoranda
- Obtained Reclamation's Excel workbook yield model from Reclamation
- Asked questions of Reclamation and received written responses
- Determined the details of model structure and operation, including macros that generated scenario simulations. One scenario matched the DEIS preferred alternative "BLPF" (Alternative B, low ditch losses, pecans in crop mix, flood irrigation)
- Compared model simulations with DEIS representations by generating daily, annual, and overall mean and median simulation graphics and data using Excel PivotTable functionality



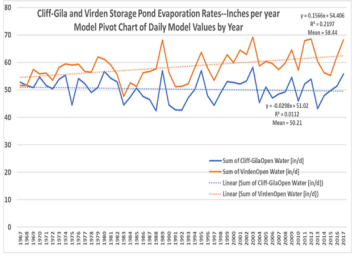
Results (details on subsequent pages) and conclusions



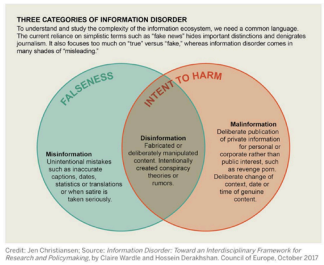
Project water yield and unit costs described in the DEIS as "applied water" included evaporation losses, overstating the yield and understating farm delivery water cost



Reclamation model shows 396 consecutive dry days 2012-13, indicating project unsuited to irrigate pecan orchards



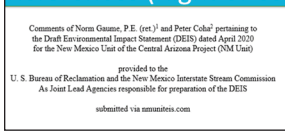
Project evaluation disregarded climate change; model simulations improperly calculated evaporation rates (note negative annual trend)



The DEIS and its water yield model are an example of information disorder.
Graphic from *Scientific American* Sept. 2019

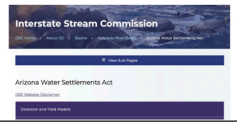
Conclusion:
Reclamation's draft EIS and technical memoranda withheld or misrepresented pertinent modeling results, violating scientific integrity and information integrity essential to democracy and NEPA compliance.

References (Right or control click for hyperlinked documents or websites)















Acknowledgements

GILA CONSERVATION COALITION

NEW MEXICO OPEN MEETINGS ACT

NEW MEXICO INSPECTION OF PUBLIC RECORDS ACT COMPLIANCE GUIDE

nmfog FOUNDATION FOR OPEN GOVERNMENT

Abatement of Lead and Uranium by Fired Natural Clays to Produce Potable Water

Author: Jeremy Jones, Sarah Bockisch, Moticha Franklin, Dr. Antonio S. Lara
Department of Chemistry and Biochemistry, New Mexico State University, Las Cruces, NM, 88003,

Abstract

- Lead and uranium in drinking water are serious threats to human health
- Modern technology is not viable for most people affected
- Clay is a viable option but is difficult to manage
- Fired clay pellets offer an appropriate solution
- Pellets from New Mexico and Arizona reduced the concentration of uranium and lead below EPA MCL

Introduction

- Drinking water contaminated by uranium and/or lead is a serious issue affecting many parts of the world
  - Examples: Navajo Nation, Flint, MI
- Uranium (U) & Lead (Pb)
  - Toxic Heavy Metals (in trace quantities)
  - EPA MCL; U – 30 ppb, Pb – 15 ppb
  - Renal failure, liver damage, & PNS damage
  - U – Cancer
  - Pb – Developmental disorders
- Need an expeditious and economically viable solution
  - Water treatment, reverse osmosis, ultrafiltration, etc.
- Clay economically viable solution
  - Ubiquitous
  - Readily available
  - Abates uranium and lead from aqueous environments
- Clay drawback
  - Clay is difficult to manage when wet
- Solution to mud manageability
  - Fired Clay Pellets
- Two Clay were chosen for this study
  - New Mexico (NM) & Arizona (AZ)
    - Adjacent to the Navajo Nation



Hypothesis

- Both NM and AZ fired clay pellets can abate ppb concentrations of U and Pb to below EPA MCL.
  - Objective
    - Determine the efficacy of fired clay pellet in the sequestration of uranium and lead from aqueous environments.

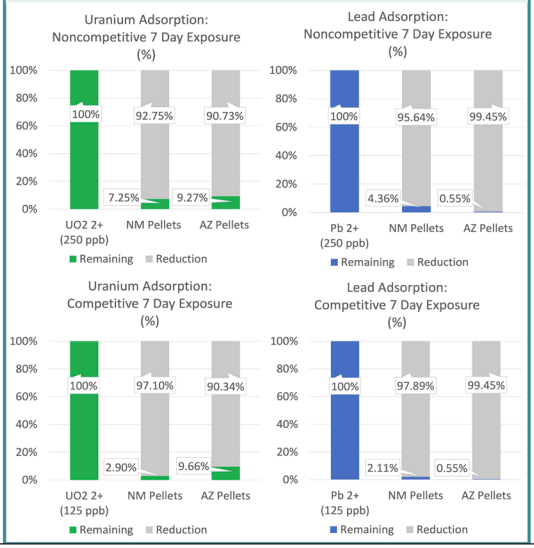
Methods

Non-Competitive & Competitive

- All samples (experimental controls in place)
  - In triplicate; n = 3
  - Five Pellets exposed for seven days with agitation
- Non-competitive
  - Separately, each clay was exposed to 50 mL of 250 ppb U or Pb
- Competitive
  - Simultaneously, each clay was exposed to a 50 mL mixture of 125 ppb U & 125 ppb Pb
  - Chemical adsorption potential
- Sample analysis; ICP-MS; EPA Method 200.8
- Data analysis software: Microsoft Excel

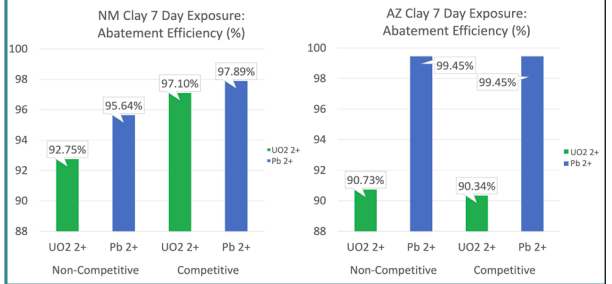
Results

Type of Clay	Non-Competitive (250 ppb)		Competitive (125 ppb)	
	Uranium (ppb)	Lead (ppb)	Uranium (ppb)	Lead (ppb)
NM Pellets (5)	18.12 ± 7.25	10.90 ± 2.73	3.62 ± 0.45	2.64 ± 0.34
AZ Pellets (5)	23.17 ± 0.76	1.37 ± 0.76	12.07 ± 0.86	1.13 ± 0.31



Results

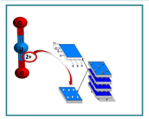
Heavy Metal Cation	NM Clay Pellets (5 ea)		AZ Clay Pellets (5 ea)	
	Non-Competitive (250 ppb)	Competitive (125 ppb)	Non-Competitive (250 ppb)	Competitive (125 ppb)
Uranium (ppb)	18.12 ± 7.25	3.62 ± 0.45	23.17 ± 0.76	12.07 ± 0.86
Lead (ppb)	10.90 ± 2.73	2.64 ± 0.34	1.37 ± 0.76	1.13 ± 0.31



Conclusion

- Results discussion
  - Change in concentration
    - (%) Remaining and Reduction
  - Abatement efficiency
    - Clays
      - Heavy metals
- Both fired clay pellets, NM & AZ, reduced U and Pb to below EPA MCL
- Both clays appear to have a higher affinity for lead
  - AZ abates more lead than NM
  - NM abates more uranium than AZ
- Fired clay pellets offer a prompt and viable solution







Future Directions

- Capacity, kinetics, and thermodynamics
- Compare 3 other clays

Acknowledgements

- New Mexico State Legislature NMWRRI2017-18, administered by the New Mexico Water Resources Research Institute
- National Institutes of General Medical Health MBRS R25GM061222 **R**esearch **I**nitiative for **S**cientific **E**nhancement
- College of Engineering New Mexico State University
  Freeport-McMoRan Water Quality Lab
  Mark Chidester



Contact Info: Jeremy Jones; odinseye@nmsu.edu

Abstract 37) Abatement of Lead and Uranium by Fired Natural Clays to Produce Potable Water (Pg. 135)

The Solution to Pollution is Diminution: Use Only Enough

Cecilia V. López

SFCC WTR 111 Prof. Rodke

Introduction

- Algae blooms (HABs) are photosynthesizing, microscopic bacteria that live in slow-moving waters.
- They create toxins harmful to humans, pets, fish and ecosystems.
- Algal blooms are cause by hot temperatures, climate change, upstream pollution, waste water from treatment plants, and **runoff from farms**.

Methods & Objectives

- Not realistic to kill off bacteria in lakes and reservoirs as treatments can kill fish and harm the ecosystem.
- Reduce nutrients like phosphorus and nitrogen from getting into rivers and runoffs that feed into lakes by working with New Mexican farmers and educating them on what they can do to help prevent HABs.
  - Only use what you need: Nutrients found in fertilizers (nitrogen and phosphorus) cause HABs. Educate farmers on the cost effectiveness of only using what they need for fertilizing crops.
  - More doesn't mean better: Educate farmers on the negative impacts of over-fertilizing i.e. crop tissue and soil nutrients.
  - Dry Farming: Dry farming has existed in NM Pueblos for centuries. Teach NM farmers alternative farming methods and give them tax incentives when implementing said methods to help prevent HABs.

Less Fertilizer

- leads to less nutrient rich runoff feeding into lakes and reservoirs causing HABs.
- more money in farmers' pockets.
- less over-fertilized/diseased crops and soils.

Dry Farming

- Ancestral Pueblo people successfully grew crops with dry farming. Giving farmers tax incentives to implement the same methods will directly impact HABs by using little to no water with dry farming.

Did you know?

- Pumice Soil and Farming in the Jemez Mountains—archeological findings have shown that dry farming was used and relied on only precipitation and pumice soil for successful harvests.

Conclusions

Cleaner runoffs:
1.Reduce the amount of fertilizer used on crops.
2. Implementing alternative farming methods that use little to no water.

References & Acknowledgements

New Mexico Geological Society
New Mexico National Park Service
Maria López, Environmental Scientist, Idaho EPA

Abstract 38) The Solution to Pollution is Diminution: Only Use Enough (Pg. 135)

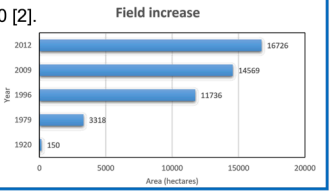
Comparison of Water Movement in Pecan Fields Under Different Irrigation Scenarios; Implications to the Water Cycle

United States Department of Agriculture
National Institute of Food and Agriculture

Jorge Preciado, Alexander "Sam" Fernald, Richard Heerema,
Salim Bawazir, Manoj Shukla, Curt Pierce
NM Water Resources Research Institute
New Mexico State University, Las Cruces, NM 88003

Introduction

- Agriculture in arid and semi-arid regions can consume more than 80% of the available water [1].
- Pecan production in New Mexico has increase since 1920 [2].
- As of 2017, 13,888 ha of pecans have been planted in Doña Ana County [4].
- Compared with other crops grown in the Lower Rio Grande Basin, pecan trees have the highest consumptive water use [3].



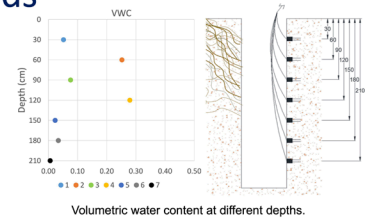
Objectives

1. Estimate recharge and model water flow through the soil in a drip irrigated pecan orchard to better understand surface water/groundwater interactions for improved river basin water management.
2. Quantify water stored in the soil and lost through evapotranspiration.
3. Monitor water table to assess groundwater level fluctuations and quantify water consumption.

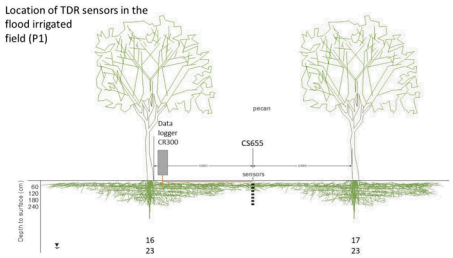
Methods

The study site is located at Leyendecker Plant Science Center, 14 km south of Las Cruces, New Mexico. The field area is 0.04 km^2, with approximately 460 trees with a square spacing of 9 m, trees are approximately 10 years old with an average trunk diameter of 0.20 m.

The soil water content is measure at three different locations using time domain reflectometry (TDR) probes (CS655 12 cm. Campbell Scientific) installed at different depths intervals (30, 60, 90, 120, 150, 180, 210 cm). And the data are stored in a Campbell Scientific data logger CR300.



Volumetric water content at different depths.



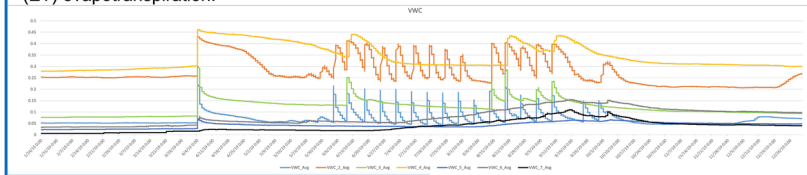
Results

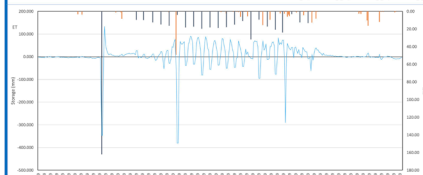
This study is estimating the amount of deep percolation in drip irrigated pecan orchard in the Mesilla Valley, using the commonly used water balance equation [5]

$$DP = IR + R - \Delta S - RO - ET$$

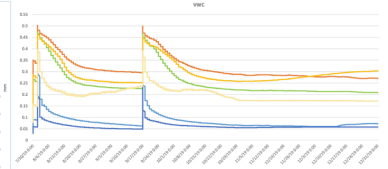
IR: Flow meter (Bigfoot); R: Rain gage; ΔS: CS 655; RO: —; ET: Leyendecker weather station

Where, (DP) deep percolation, (IR) irrigation, (R) precipitation, (ΔS) change in storage, (RO) runoff, (ET) evapotranspiration.

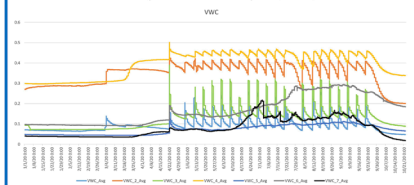




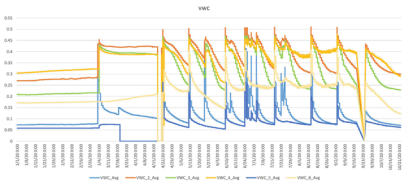
Estimated recharge and water lost through evapotranspiration.



Change in volumetric water content at different depths, highest water content 30% at 1.20 m followed by 25% at .60 m, with an increase in water table in June.



Change in volumetric water content in the drip field.



Change in volumetric water content in the flood field.

Conclusions

The amount of water in 2019 below the root zone was 2659 mm this water is mainly coming from the Rio Grande river, Irrigation amount in the drip field was 492 mm and rainfall was 126 mm in 2019 show that may be some capillary rise in the field that may affect the water movement down in the field.

References:
1. Olivera-Guerra, Merlin, Er-Raki, Khabba, & Escorihuela, 2018
2. Sammis, Shukla, Mexal, Wang, & Miller, 2013
3. Kallestad, Mexal, Sammis, & Heerema, 2008
4. USDA 2017. Census of Agriculture Las Cruces. National Agricultural Statistics Service
5. Shukla, 2014

Funding for this project is provided by USDA to Project No. 2017-68007-26318, through the National Institute for Food and Agricultural's Agriculture and Food Research Initiative, Water for Agricultural Challenge Area

Abstract 39) Comparison of Water Movement in Pecan Fields Under Different Irrigation Scenarios; Implications to the Water Cycle (Pg. 135)

Sustainability in a human-dominated region: the agricultural use of natural capital

Yining Bai, Saeed P. Langarudi, Sam Fernald
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What is Natural Capital ?

Natural capital is a stock that yields a flow of ecosystem service and valuable goods for supporting human activities into the future based on the traditional definition of capital. Sustainability depends on the maintenance of the total stock of capital, including natural capital, out of various parts of the total stock of capital, is non-substitutable.

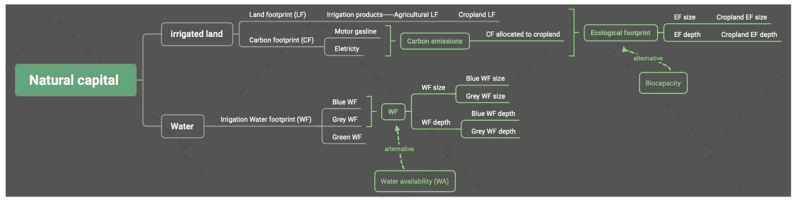
Lighten policy through natural capital

In order to fully deliver nature valuing, the ecological footprint (EF) model is a mature approach for quantitatively measuring the effect of human occupation on natural capital. The 3D ecological footprint (3D EF) model not only depicts stock consumption but also flow occupancy. A System Dynamic model using the STELLA platform is built to simulate how complex systems change over time and to capture realistic dynamic behavior between variables, including feedback loops, delays, and nonlinear relations. This model is appropriate for modeling complex relations among social, economic, and physical components coupled with interdependencies between natural capital and water system.

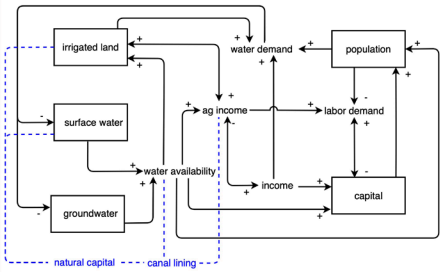
- clarify the value of natural capital
- how the value served in the sustainable management of agricultural water

Contact information:
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Sam Fernald afernald@nmsu.edu

Accounting Natural capital in form of irrigated land and water

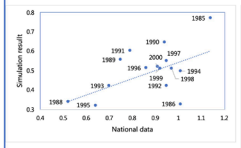


Causal structure of the model

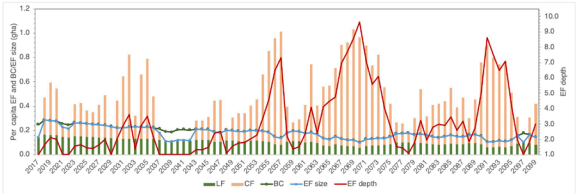


- Irrigated land contributes land footprint
- Groundwater pumping for irrigation contributes carbon footprint
- Blue WF and Grey WF contributes natural capital flow
- The cost of canal lining impacts water supply and agricultural income
- Depletion of natural capital affect the pace of canal lining

Sustainability in the light of natural capital

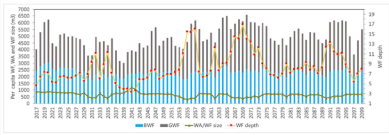


Correlation coefficient is 0.51



- CF dominates EF in the future
- BC declines as irrigated land shrinks in the future
- BC is less than the sum of CF and LF indicating the depletion of productivity in irrigated land
- EF depth accumulates to 9.6 until 2069 implying number of years to generate land sources consumed

Sustainability in the light of natural capital cont.

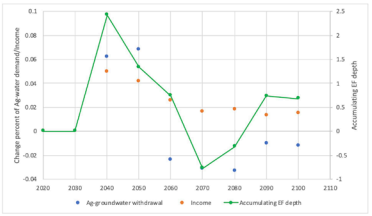


- WA < WF size: limited water availability
- The proportion of GWF increases over time
- Overdraft groundwater increases the risk of pollution
- WF depth climbs

Natural capital as indicator in policy implementation

Decoupling Index (DI) : the declining quantity of natural capital for producing per capita of income

- DI ≥ 1 (strong decoupling): natural capital consumption decrease as income grows.
- 0 < DI < 1 (weak decoupling): natural capital consumption grows simultaneously with income, with the income growing at a faster rate.
- DI ≤ 0 (coupling): natural capital consumption grows together with income, but natural capital consumption grows faster.



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Abstract 41) Sustainability in a Human-dominated Region: Agricultural use of Natural Capital (Pg. 136)

ZiaMet, The New Mexico Mesonet

David DuBois[1], Stanley Engle[1]
Deptartment of Plant and Environmental Sciences, NMSU[1]

Presented at the 65th Annual New Mexico Water Conference October 28th, 2020

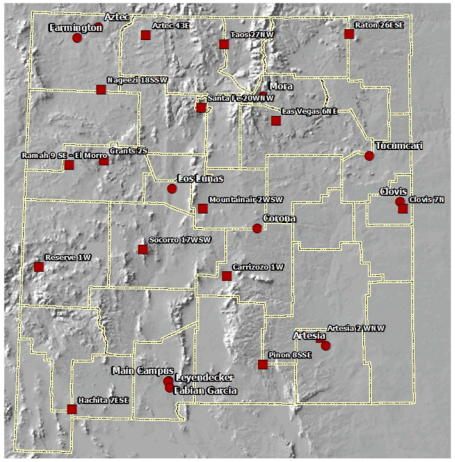
Introduction

The New Mexico Climate Center (NMCC), through New Mexico State University (NMSU), has been maintaining a modest mesonet since 1985 which has provided weather data for agricultural research as well as for dissemination of data to the general public. Since 2015, this mesonet has been re-branded the ZiaMet Network and the network is a member of the National Mesonet Program, providing data via http://weather.nmsu.edu and http://mesowest.utah.edu.

ZiaMet currently operates 10 automated agricultural weather stations usually located at NMSU science centers and 16 former federal climate reference automated stations installed in remote locations across New Mexico. ZiaMet continues to help support agricultural research while also providing data points that fill in temporal and spatial gaps that are not provided by other weather station networks such as the federally-owned Automated Surface Observing System. By working to fill these gaps, ZiaMet is helping to provide decision support to economic sectors, both public and private.

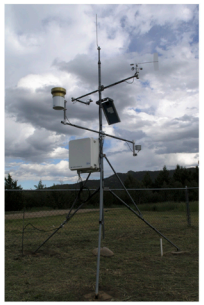
This paper will discuss the current operational status of ZiaMet, the data provided by the program, and plans for future growth.

Weather Station Locations



Agricultural Stations

- Sensors
  - Wind speed/direction at 3 meters above ground (AG)
  - Solar Radiation between 2 to 3 meters AG
  - Tipping-bucket rain gauge between 2 to 3 meters AG
  - Air Temperature/RH sensor at 2 meters AG
  - Soil temperature at 10 cm below ground
- Data Collection/Transmission
  - Collects data at 5 minute intervals
  - Transmits at near-real time via short range radio + NMSU network

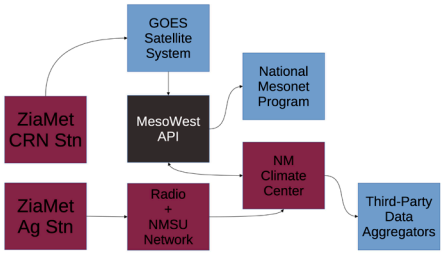




Climate Stations

- Sensors
  - Triple redundant air temperature sensors enclosed in an aspirating solar radiation shield mounted at 1.5 meters AG
  - Weighing rain gauge using triple redundant vibrating wire sensors
- Data Collection/Transmission
  - Data is collected at 5 minute intervals
  - Transmits hourly via GOES satellite data channel

Flow of Data



Operational Assets

Aside from the physical weather station infrastructure, the ZiaMet network consists of personnel and computational assets that maintain the infrastructure and provide data access.

- Personnel
  - Two full time employees
  - One undergraduate student
- Computational assets
  - Main website server accessed via http://weather.nmsu.edu
  - Multiple fully replicated database servers
  - Multiple data acquisition and processing servers

Data Products

Most ZiaMet data is provided through the NM Climate Center website. Custom data requests are handled manually. Data collection external to the ZiaMet network is available and the NMCC can also help provide weather data collection for external projects.

- Penman-Monteith Short/Tall canopy reference ET
- Hargreaves-Samani reference ET
- Pecan ET
- Growing Degree Days
- Data Summaries

Database Statistics

- 4.2 GB of data
- Since 2013, 4.35 million data reports from ZiaMet agricultural stations
- Since 2018, 2.25 million data reports from ZiaMet climate stations
- From 1985 to 2019, 1.6 million hourly data reports from the original ZiaMet agricultural weather stations

Future Work

- Currently only one Ag station has multiple soil temperature sensors. Add soil temperature and soil moisture sensors at multiple depths.
- Add 10 meter wind speed/direction sensors to assist in forecasting.
- Supplement precipitation monitoring by adding weighing precipitation gauges at every site.
- Expand network so that every NM county contains at least one station. 13 counties do not.

Contact Info

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NM Climate Center
http://weather.nmsu.edu

Abstract 42) ZiaMet, the New Mexico Mesonet (Pg. 136)

Nitrogen, Carbon Dioxide and Argon Adsorption for Surface Area of an Unknown New Mexico Clay in order to Elucidate Uranium Abatement

Moticha M. Franklin , Jeremy Jones, Dr. Antonio S. Lara
Department of Chemistry and Biochemistry, New Mexico State University, Las Cruces, NM, 88003

Introduction:

- Heavy metals, especially Uranium, contaminate the Navajo Nations water source (Figure 3)
  - Health problems, sometimes death, occur from drinking contaminated water
- **Uranium abatement** occurs for all regional and reference clays that have been tested (Figure 2)
- Muddy suspensions are difficult to manage
  - Dirt ceramic pellets fabricated from clays to sorb uranium
- **Surface area is directly related to uranium abatement**

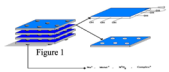
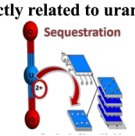


Figure 1
Clay: aluminophylosilicate sorbent, cation exchange





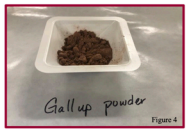
Justification/Objective:

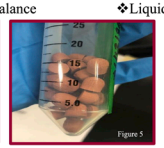
Hypothesis: Clay pellets, relative to clay powder decreases available surface area.

- Analyze surface area of clay powder and clay pellet (benchmark)
  - Compare surface area between powder and pellet
- Compare surface area between the different sorbates
  - N_2 is a standard, Ar is spherical and CO_2 to 'mimic' UO_2^{2+}

Materials:

- Gallup, NM clay powder (Figure 4) and pellet (Figure 5)
- Double Deionized water
- Silicone molds
- Precision Thelco Model 16 Laboratory Oven
- Thermolyne 10500 Furnace
- Mettler AJ100 electronic balance
- ASAP 2050 Extended Pressure Adsorption Analyzer (Figure 6)
- Liquid Nitrogen
- Gaseous Nitrogen
- Gaseous CO_2
- CO_2 Climate Control Chiller
- Gaseous Argon
- Liquid Argon

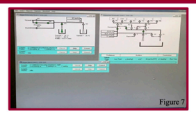






Methods:

1. Clay preparation from raw material
   - A. Grind raw material to a powder
   - B. Sieve powdered material to ~100 mesh
2. Pellet Fabrication
   - A. Clay to Water ratio
   - B. Mold casting for pellet
   - C. Dry pellet
   - D. Fire pellet
3. Surface Area
   - A. Weigh ~3g of powder and pellets
   - B. Load sample for degassing
   - C. Degas for 48-96 hrs. (Figure 7)
   - D. Transfer sample to ASAP 2050 adsorption port (Figure 6)
   - E. 24-48 hrs. to sorb and desorb (Figure 8)
   - F. Weigh final sample

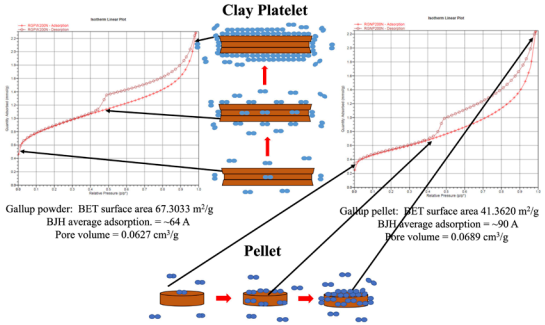




Isotherm Results:

Nitrogen Isotherm

Gallup Powder | Gallup Pellet

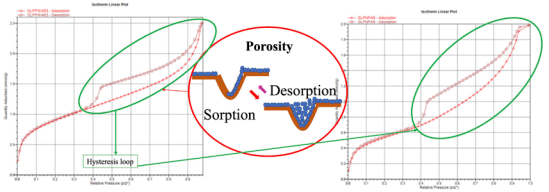


Gallup powder: BET surface area 67.3033 m^2/g
BJH average adsorption. = ~64 A
Pore volume = 0.0627 cm^3/g

Gallup pellet: BET surface area 41.3620 m^2/g
BJH average adsorption = ~90 A
Pore volume = 0.0689 cm^3/g

Argon Isotherm

Gallup Powder | Gallup Pellet

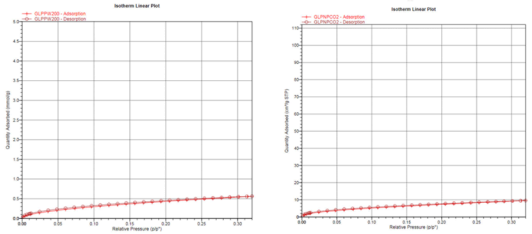


Gallup powder BET surface area 63.0481 m^2/g
BJH average adsorption. = ~69A
Pore volume = 0.0557 cm^3/g

Gallup pellet BET surface area 38.2939 m^2/g
BJH average adsorption. = ~73 A
Pore volume = 0.04948 cm^3/g

Carbon Dioxide Isotherm

Gallup Powder | Gallup Pellet



Gallup powder: BET surface area 42.2562 m^2/g
BJH average adsorption = In Progress
Pore volume = In Progress

Gallup pellet: BET surface area 31.4721 m^2/g
BJH average adsorption. = In Progress
Pore volume = In Progress

Surface Area and Porosity Results:

BET Surface Area — Table 1

Gas	Powder (m^2/g)	Pellet (m^2/g)	% loss from powder to pellet
Ar	63.0481	38.2939	39.2624
N_2	67.3033	41.362	38.5439
CO_2	42.2562	31.4721	25.5208

BJH Pore Size/Volume — Table 2

Gas	State	Size (Å)	% gained from powder to pellet	Volume (cm^3/g)
Ar	Powder	69.530	4.700129441	0.055732
	Pellet	72.798		0.049480
N_2	Powder	64.484	40.09986974	0.062716
	Pellet	90.342		0.068906
CO_2	Powder	In Progress	In Progress	In Progress
	Pellet			

Conclusion:

- Same clay was analyzed with the three different sorbates
  - BET Surface Area measurements for the three sorbates are different (Table 1)
  - Pore size of a pellet can indicate we are creating larger pores when being fabricated (Table 2)
  - Pore volume is the same for powder and pellet (Table 2)
- Hysteresis loop suggests micro-porosity within the powder and pellet
- N_2 and Argon penetrates the micropores of the clay in its various states (Figure 9)
  - it is easier for the smaller gases to channel their way onto the clay and its micropores.
- Pellet fabrication process reduces the surface area (Table 1)
  - not enough to suppress the uranium sorption significantly (data from other research in our laboratory)

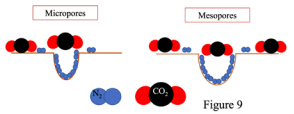


Figure 9

Future Research:

- Surface analysis for other reference and regional clays
  - Test clay from the Navajo Nation and surrounding areas
  - Test parameters for induced macroporous pellets
  - Find an ASTM or procedure for CO_2 pore size and distribution
    - Test CO_2 at a different temperature

Acknowledgements:

New Mexico State Legislature NMWRRI2018-19, administered by the New Mexico Water Resources Research Institute; Water Resources Research Institute FY19 Student Water Research Grant NMWRRI-SG-2019 and Mark Chisdester, Laboratory Research Manager, NMSU Freeport-McMoRan Water Quality Laboratory.

Contact Information: Moticha Franklin, email: moticha@nmsu.edu

Abstract 43) Nitrogen, Carbon Dioxide and Argon Adsorption for Surface Area of an Unknown New Mexico Clay in Order to Elucidate Uranium Abatement (Pg. 136)

Aquaponics Cuts Path to Water-Neutral Agriculture in NM

R. Charlie Shultz Lead Faculty at Controlled Environment Agriculture (CEA) Department, SFCC • **Nate Downey** President at Lettuce, Etc llc, SFCC intern, author *Roof-Reliant Landscaping*

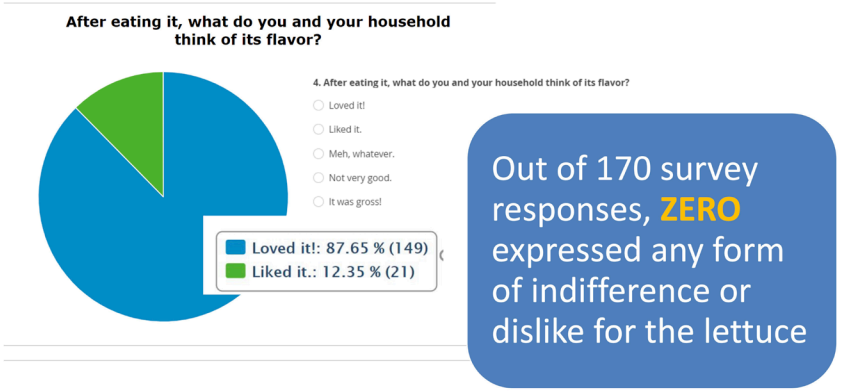
Background

With 12” of annual rainfall, an aquaponics farm could generate enough water for its crops from roof catchment alone. Two barriers to a roof-reliant revolution in agriculture led by aquaponics are the low profit margins generally associated with farming and the costly facilities associated with growing fish and plants in controlled environments. If, however, aquaponics farmers could sell crops at retail prices using a farm-to-door, direct-to-consumer business model, retail prices and delivery fees would be attainable.

Hypothesis

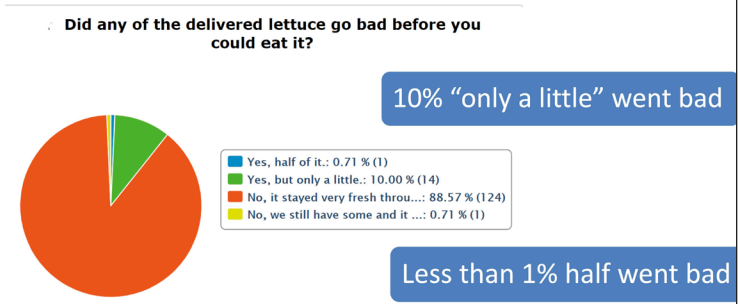
Would a farm-to-home delivery model from an aquaponics facility generate significant profits in Santa Fe, NM?

Much-Loved Lettuce



Out of 170 survey responses, **ZERO** expressed any form of indifference or dislike for the lettuce

Lettuce with a Formidable Shelf Life



10% “only a little” went bad

Less than 1% half went bad

Nine out of ten say NONE went bad.

Abstract 44) Aquaponics Cuts Path Toward Water-Neutral Agriculture in NM (Pg. 137)

Effect of Chloride Salt Solutions on the Unconfined Compressive Strength of Heat-Treated Clay Pellets Made for the Abatement of Uranium in Contaminated Water

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Abstract

Uranium contamination in drinking water is an ongoing crisis for citizens of the Navajo Nation. This problem can be mitigated with locally produced clay pellets known to abate uranium, but parameters that effect the robustness of these pellets must be understood before they are utilized. It is known that chloride salt solutions affect the plasticity and liquid limit of clays, but there is little study on how these solutions alter the robustness of a clay, especially after heat-treatment. This is surprising given how cations affect clay platelet coordination, such as with potassium in illite clays. To better understand this effect, chloride salt solutions were mixed into two clays, a sodium-bentonite clay and a local illite-smectite clay, at specific weight ratios during the pellet fabrication process. The chloride salt solutions used were LiCl, NaCl, and KCl with each at a concentration of 0.8M. The robustness of each set of pellets was quantified by the maximum compressive force (MCF) measured during unconfined compression testing. The addition of NaCl had little to no effect on the pellet robustness. The bentonite pellets maintained a MCF of 700±100 ftlb (n=15) while the illite-smectite pellets' MCF slightly decreased from 2300±200 ftlb (n=15) to 2000±300 ftlb (n=15). The addition of the other chloride salts, however, has preliminarily shown to increase pellet robustness. The bentonite pellets' MCF increased to 900±100 ftlb (n=5) when using LiCl and 1300±300 ftlb (n=5) when using KCl. This finding suggests that externally added cations can have a significant effect on heat-treated pellet robustness.

Introduction

- The Navajo Nation is facing health threats due to uranium contamination in drinking water aquifers.
- Solutions are available, but expensive to implement (reverse osmosis)
  - Clays sorb heavy metal ions while being ubiquitous and cost-effective. Easiest to manage when in pelletized form.
- Some clays are more robust than others; a local illite-smectite clay from Gallup, NM, creates robust pellets and a standard bentonite clay creates non-robust pellets [Fig 1].
  - Difference in chemical composition can explain these disparities [Table 1]; note the differences in interlayer cations (K, Ca, Na).

Formula (moles)	Bentonite	Gallup
Al	1.46	1.57
Ti	0.01	0.04
Fe (III)	0.17	0.33
Fe(II)	0.01	N/A
Mg	0.28	0.33
K	0.04	0.25
Ca	0.12	0.32
Na	0.19	0.04

Table 1: Bentonite composition determined by Clay Mineral Society with X-ray fluorescence; Gallup composition found by means of inductively coupled plasma mass spectrometry.



Figure 1: Example of robust Gallup pellet (left) and cracked bentonite pellet (right)

- Interlayer cations can be increased by means of inorganic salt solutions
  - These cations are known to affect clay properties; zeta potential, liquid limits. Little has been done to study cation's affect on robustness, however.
- The lack of research in this area is surprising, given how interlayer cations affect clay coordination, such as with potassium in illite clays [Fig 2]

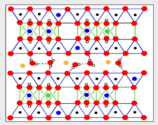


Figure 2: Example of general clay structure; sorption takes place between clay platelets

Hypothesis

•Inorganic salt solutions can alter pellet robustness and may offer an uncomplicated way to increase pellet robustness for areas with non-ideal clays

Materials and Methods

- Samples of bentonite and Gallup clay were ground and sieved to a 100 mesh (149 micron) powder.
  - This included a batch of bentonite clay which had its excess salts removed by repeated suspension in deionized water followed by centrifugation and decanting of the supernatant fluid.
    - ► Referred to as 'washed' bentonite
- Clay was mixed with inorganic salt solution in a Ziplock bag at a specific weight ratio [Fig 3.1]
  - Ratios: (clay wt% / solution wt%) : 30/70 and 50/50 for bentonite, 65/35 for Gallup
  - Inorganic salt solutions: Lithium Chloride, Sodium Chloride, and Potassium Chloride.
- Ratio allowed to equilibrate for a period of 24 hours
- Ratio then cast into silicone pellet mold and allowed to dehydrate [Fig 3.2]
  - Ambiently dehydrated on bench top until ~10% water by mass [Fig 3.3]
    - ► Mass monitored every 24 hours until reaching this point.
- Produced pellets are heat-treated in a Sybron F-A1638 Furnace [Fig 3.4]
- Heat-treated pellets were sanded until their faces were parallel, then measurements of average diameter and height were made using calipers
- Robustness of each set of pellets was quantified by means of the maximum compressive force (MCF) measured using the Instron Model 5882 Compression Tester, with n=15 samples in a complete data set*.

Pellet Fabrication Process

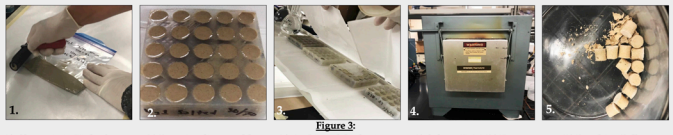
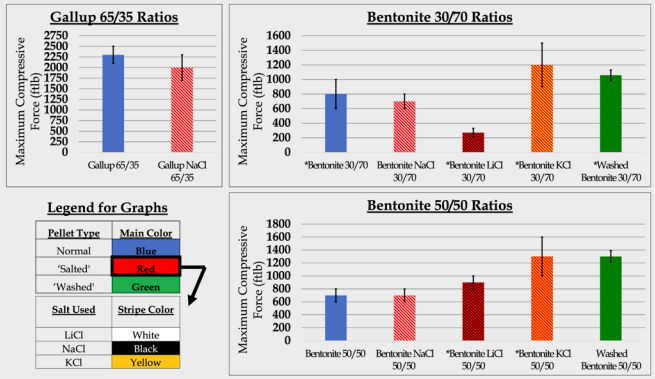


Figure 3:
1.) Clay ratio in Ziploc bag 2.) Ratio in silicon mold 3.) Ambient dehydration 4.) Sybron F-A1638 Furnace 5.) Resulting Pellets

Results



*= number of samples is n=5 instead of n=15

Discussion & Conclusion

- The normal clays without added inorganic salt solutions served as a control.
  - The normal bentonite clay had an average maximum compressive force (MCF) of 800±100 ftlb for the 30/70 ratio and 700±100 ftlb for the 50/50 ratio
    - ►NOTE: 30/70 ratios often fractured during heat-treatment. Thus their sample size remained small.
  - The Gallup clay had an average MCF of 2300±200 ftlb
- NaCl solutions did not greatly alter the MCF in either clay.
  - The bentonite clay remained at ~700±100 ftlb for both ratios
  - The Gallup clay only slightly decreased to 2000±300 ftlb
    - ► May be explained by binding affinity and relative abundance; Gallup clay likely has little binding affinity to sodium considering it already has coordinated potassium and calcium, meanwhile the bentonite clay has a large abundance of natural sodium
- LiCl affected each bentonite ratio's MCF differently
  - 30/70 ratio greatly weakened, at 270±60 ftlb while the 50/50 ratio was strengthened to 900±100ftlb
    - ► Noticeable cracks formed on the 30/70 pellets whereas the 50/50 pellets remained intact; likely cause for MCF difference
    - ► Lithium ions have high charge density and may attract surrounding clay platelets with coulombic forces. These same forces influence ion hydration, however, and could lead to presence of many coordinated water molecules which cause fracturing upon heat-treatment (evaporation), as with the 30/70 ratio.
- KCl doubled the MCF in both bentonite ratios, but increased deviation
  - 30/70 ratio increased to 1200±300 ftlb and the 50/50 ratio increased to 1300±300 ftlb
    - ► Illite structure known for interlayer potassium, which interlinks clay platelets. This is likely the cause of the increased robustness
  - Large deviation may partially be attributed to small sample size (n=5 compared to n=15)
- Removing excess salts in the bentonite clay also increased the MCF of both ratios, and reduced deviation
  - 30/70 ratio increased to 1060±70 ftlb, while the 50/50 ratio increased to 1300±90 ftlb
    - ►The ions which remained in the clay matrix would be only the ones necessary to negate the clay platelet's charge. The void space and coulombic repulsion caused by excess salts upon solvation would not be present, and thus the overall coordination would be maximized.
- Preliminary results; inorganic salt solutions can directly alter pellet robustness, and offer an affordable and effective way to increase pellet strength
  - KCl is the most viable and health conscience choice in this matter, since it is a non-harmful food additive and does not affect brain chemistry like LiCl.
    - ►Also less time intensive than repeated 'washing' of clay

Future Directions

- X-ray diffraction to determine changes in platelet coordination; A pellet with higher coordination in basal spacing would give reason for an increased MCF.
- Study salt's effects on sorption capacity; likely tradeoff between strength and cation exchange

Acknowledgements

A special thanks to Mary Jo Ruthven, Dr. Michael Johnson, Dr. Graciela Unguez, and Dr. Ivette Guzman for their support through the Maximizing Access to Research Careers (MARC) Program, Kenny Stevens and Eduardo Gamillo for the use of their compression tester, the Research Initiative for Scientific Enhancement (RISE) Program.

This research was supported by New Mexico State Legislature NMWRRI2018-19, administered by the New Mexico Water Resources Research Institute; National Institutes of General Medical Health MBRS R25GM061222; National Institutes of Health GM07667.

Abstract 45) Examination of Chloride Salts' (XCl, X=Li, Na, K) Effect on the Robustness of Clay Pellets made for Uranium Abatement (Pg. 137)

Multilevel Assessments of Contribution of Livestock Manure to Nitrogen Budget in Arid-land Ecosystems: The Case of Dairies in New Mexico

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University of New Mexico, Department of Economics

Introduction & Objective

- New Mexico leads the country in terms of the average number of cows per large dairy farms.
- Most of the dairy farms are concentrated in the five counties – Chaves, Curry, Roosevelt, Dona Ana, and Lea
- This study aims to quantify the contribution of large dairy farms towards the N budget of the arid land ecosystem with 3 levels of assessments: county, water basin and farm level .
- In the face of an ever-increasing intensification of dairy farms, this study also brings to light the potential benefits of recoupling the crop-livestock system.

Methods

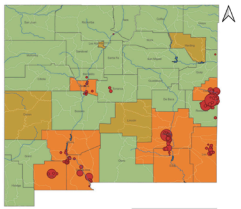
- Nitrogen budget is calculated as the difference between livestock manure N loadings and crop N requirements at various levels.
- Farm-level assessment: Circles corresponding to the application acreage of farms were drawn and land cover data was used to calculate total N utilization by crops.
- County-level assessment: County totals were obtained by aggregating over livestock farms and croplands/grasslands in a county. Based on the location of individual farms, farm-level data was added to get N excretion data for each county.
- Watershed-level assessment: Watersheds totals for potential N-vulnerable watershed were obtained by aggregating over livestock farms and croplands/grasslands in a watershed.
- Sensitivity Analysis: N budgets of watersheds at 4 different levels (20, 40, 60 & 80%) of manure acceptance rates for the grasslands were calculated.

Data

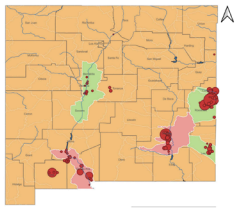
- Farm-level data (location, # of cows etc.) – NMED
- Remote sensing data of the land cover – NLCD
- Watershed data – USGS
- N excretion parameters – Todd et al (2015)
- Crop N requirement – various studies

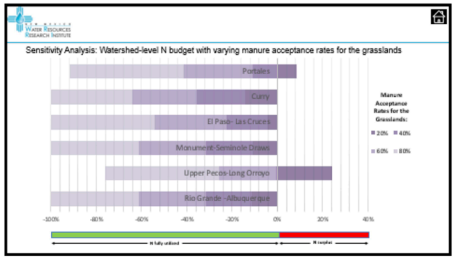
Results

County level Analysis



Watershed-level Analysis





Conclusions

- Farm-level assessment showed that all the farms in our study produced excess N that was beyond the assimilative capacity of onsite croplands.
- Eight counties were identified as having excess N.
- Out of the six watersheds, two watershed were identified as hotspot regions.

Discussions

- Sensitivity analysis showed the possibility of total assimilation of N if the grasslands accept manure at the rate of 40% or more .
- Use of manure as a soil amendment has twofold benefits:
  1. It can provide vital nutrients and organic matter to the plants, reducing the need for commercial fertilizers.
  2. Widespread disbursement of manure reduces the pollutant load in the hotspot regions.

Abstract 46) Multilevel Assessments of Contribution of Livestock Manure to Nitrogen Budget in Arid-land Ecosystems: The Case of Dairies in New Mexico (Pg. 137)

Improving Green Water Use Proportion by Circular Buffer Strips of Perennial Grasses

Paramveer Singh[1], Sangu Angadi[1], Sultan Begna[1], Dave Dubois[2], Rajan Ghimre[1] and John Idowu[2]
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[2]Department of Plant and Environmental Sciences, New Mexico State University, Las Cruces, NM

Background

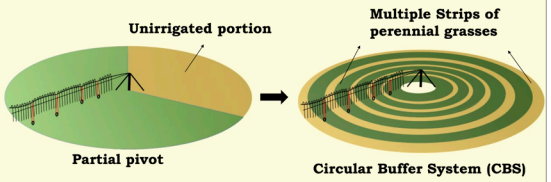
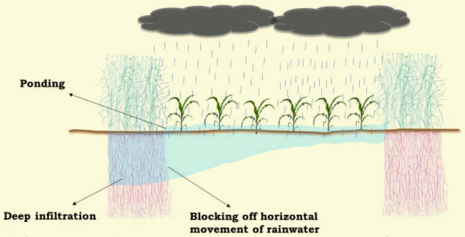


Fig. 1. Due to decline in irrigation capacities, farmers keep a section of the pivot circle dryland since they cannot follow full irrigation management on the entire circle. Rearranging the unirrigated portion of such partial pivot into circular perennial grass strips can improve conservation high intense rainfalls in the SHP of US.

- A simple modification of pivot circles using native perennial grasses in the form of circular strips can improve rainwater conservation and use by agriculture production systems in the region.

Rationale



- With CBS acting as multiple barriers to surface runoff, and horizontal water movement below soil surface will increases infiltration of rainwater and wind moderation effect of grass strips will reduce evaporation loss.

Objective

- Assess and compare rainwater storage and extraction by corn with and without grass strips.

Material & Methods

- **Location:** Agriculture Science Center, Clovis, NM.
- **CBS: :** 5 grass strips of 30 feet width arranged alternately with 5 crop strips of 60 ft width (Fig. 2).
- **Observations:** Neutron probe measurements, leaf water potential and biomass before and after a 44 mm of rain event on 07/04 and 07/05/2020.

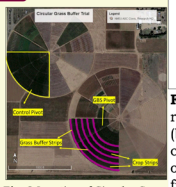


Fig. 2 Location of Circular Grass Buffer System (CBS) and control pivot (CT) at ASC, Clovis NM.

Results

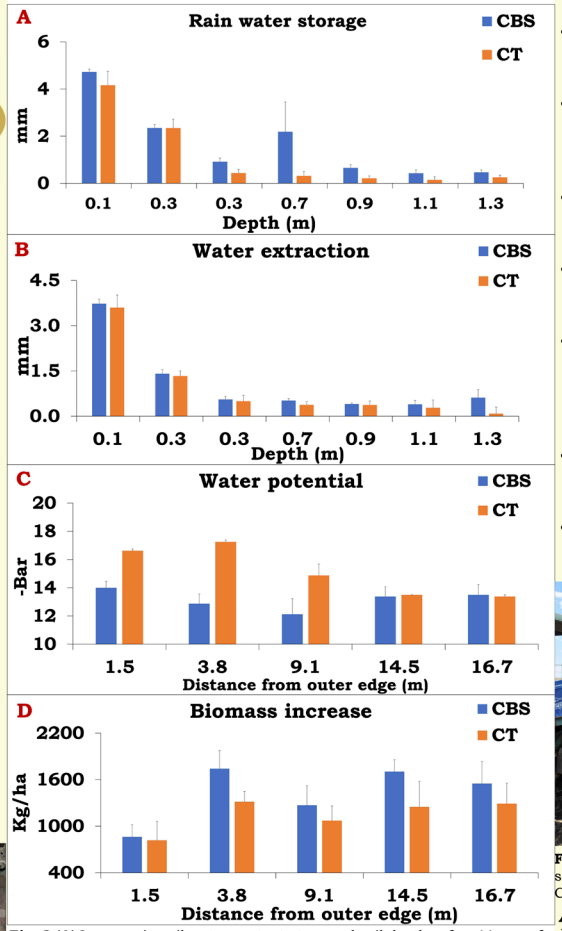


Fig. 3 (A) Increase in soil water content at several soil depths after 44 mm of rainfall was calculated by subtracting moisture measurements of 07/01 (before) from 07/07/2020 (after) in CBS and CT. **(B)** Soil water extraction was calculated by subtracting moisture measurements of 07/10/2020 from the one taken on 07/07/2020. **(C)** Corn leaf water potential at different distances from outer edge in CBS and CT on 07/10/2020. **(D)** Increase in biomass over 10 days (07/01/2020 to 07/10/2020) at various distances from the outer border in CBS (with circular grass buffer strip) and CT (control).

Discussion

- Due to slightly higher rainwater storage and water use in CBS decreased water stress levels and improved crop growth.
- Thus, results indicate that integration of native perennial grasses in the form of alternating circular strips has potential to improve conservation and use of rainwater by irrigated agriculture.
- This will encourage farmers to reduce irrigation inputs as additional water from rain will mitigate the impact of water stress on crop growth and yield.
- Further reduction in irrigation capacities are predicted, as a result most of the irrigated land will either be minimally irrigated or convert to dryland agriculture in near future.
- Improvement in rainwater use by CBS may prove valuable for dryland production system in the region.

Future Plan

- The stable isotope analysis has been successfully used to determine rainwater use by crops under center pivot irrigated system in SHP (Goebel and Lascano, 2019).
- We propose to use isotope signatures to assess improvement in rainwater use by CBS.



Fig. 4. Installing neutron access tubes for measuring water content of the soil profile (left). A scattered thunderstorm bearing down at NMSU ASC, Clovis on 25th June 2020 (right)

Acknowledgement: *We are thankful to New Mexico Water Resource Research Institute for providing funds to carry out this objective of a larger project. USDA-NIFA- Ecosystem Services and Agricultural Science Center, Clovis, NM for financial assistance. We also thank Aaron Scott and his crew member for their technical help. Also, thankful to Jagdeep, David and Jaden for their help.*

References:
Goebel, T.S., and R.J. Lascano. 2019. Rainwater use by cotton under subsurface drip and center pivot irrigation. Agric. Water Manag. 215(September 2018): 1–7. doi: 10.1016/j.agwat.2018.12.027.

Abstract 48) Improving Green Water Use Proportion in a Center Pivot Irrigation System by Using Circular Grass Buffer Strips (Pg. 138)

Sedimentology and Topography of the Confluence Outlet of an Ephemeral Tributary to the Mid Rio Grande – Arroyo de los Pinos

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Introduction

Ephemeral tributary streams are common throughout the American Southwest and deliver high loads of sediment downstream during flooding. River confluences are zones of morphodynamic importance that influence the scale and scope of channel morphology and sedimentology of the mainstem river and tributary. Quantitative relationships have been established (e.g., Best, 1987; Leite Ribeiro et al., 2012) between flow planform, junction angle, bed discordance, sediment type and discharge ratios between the tributary and the mainstem to characterize confluence morphology. These hydrodynamic characterization efforts, however, are mainly concentrated in the trunk stream, with limited information on the effects of the confluence upstream in the tributary proper. The morphology and sedimentologic character of ephemeral tributary outlets are further complicated by the disconnected, episodic nature of flooding.

In this study we apply Structure from Motion (SfM) photogrammetry and Digital Elevation Models (DEMs) of Difference (DoDs) to monitor the confluence topography and roughness of an ephemeral tributary to the Rio Grande in central New Mexico. The morphologic data are combined with sedimentologic information obtained from a trenched tributary-mouth sandbar to categorize seasonal deposition and erosional features.



Location map of basins of interest and the planform geometry of the confluence. The arrows indicate flow.

Questions:

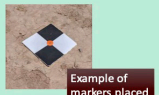
- What morphological changes and surface grain size changes can be observed in the field?
- How does the mainstem river rework arroyo-delivered sediment?
- How does the tributary rework mainstem-delivered sediment?

SfM Workflow

Image processing using Agisoft Metashape Professional :

1. Field work placing ground control point markers and aerial photography.
2. Assess photo quality and data post processing[1]
3. Create a sparse cloud and GCPs placement and control points to establish RMSE.
4. Process dense point cloud
5. Create DEM and Orthomosaics


DJI Phantom 4 Drone


Example of markers placed and surveyed

References: (1) USGS National UAS Project Office. (2017). *Unmanned Aircraft Systems Data Post-Processing Structure-from-Motion Photogrammetry*. Retrieved from https://uas.usgs.gov/nupo/pdf/PhotoScanProcessingDSLRMar2017.pdf
(2) Wheaton, J. M., Brasington, J., Darby, S. E., & Sear, D. A. (2010). Accounting for uncertainty in DEMs from repeat topographic surveys: Improved sediment budgets. *Earth Surface Processes and Landforms*, 35(2), 136–156. https://doi.org/10.1002/esp.1886

Digital Elevation Models

Agisoft Metashape produces DEMs. Applying a free geomorphic change detection software (Wheaton et al., 2010), DEMs of Differences (DoD) can be created to determine the temporal morphological responses at each juncture due to the variability of sediment supply and local runoff events.

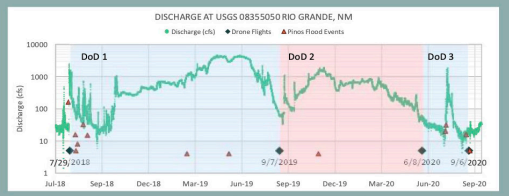


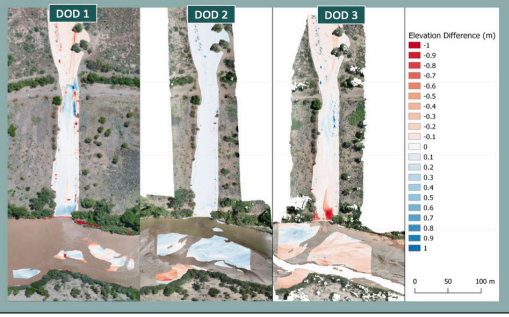
Volumetric Change at the Confluence

$$DEM_{new} - DEM_{old} = DoD$$

Three unthresholded DoDs were based on the four DEMs.

- First DoD: Flow events in August 2018 lowered the tributary bed in the north end of the study reach and deposited sediment just below a man-made ditch crossing. During spring 2019 the Rio Grande experienced abnormally high, sustained discharges, which allowed for the deposition of a large tributary mouth bar.
- Second DoD: Late autumn and winter are usually associated with a few small tributary flow events leading to thin deposition within the tributary in 2019. Poor 2020 snowmelt led to low Rio Grande levels preventing additional deposition at the mouth. Aeolian redistribution reduced the height of the mouth bar and raised elevations just upstream in the tributary.
- Third DoD: Summer is characterized by locally intense rainstorms and sediment delivery to the Rio Grande via flood-driven ephemeral tributaries. In summer 2020, three flood events were observed leading to erosion upstream of the ditch-crossing, deposition just downstream of it, and deep gullying and headward erosion at the mouth bar.



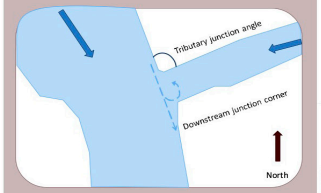


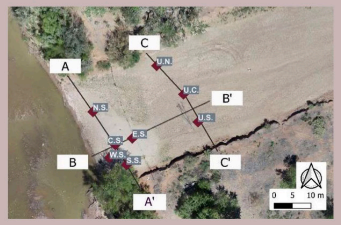
Trenching and Stratification

During the spring of 2019, the Rio Grande experienced abnormal snowmelt runoff which produced peak discharge greater than 113, m^3/s (4000 cfs). During such time, no flow events (> 5cm water depth) occurred in the Pinos, but back flooding from the Rio Grande deposited an asymmetric tributary mouth bar.

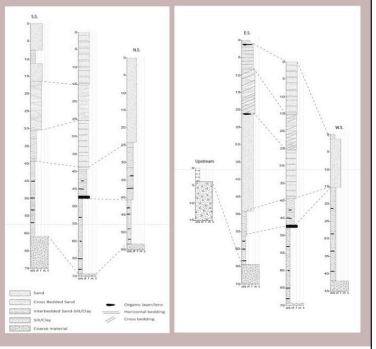


Based on previous work related to the confluence planform symmetry and discharge ratios, it is suggested that the flow structure at the junction angle would create a zone of flow stagnation that would favor the tributary corner outlet. However, because the Rio Grande was at peak discharge, the river did not experience a zone of stagnation at the junction corner. Instead, a zone of flow separation occurred at the downstream junction corner. This created a recirculating eddy that dissipated and deposited the asymmetrical mouth bar.





- Sedimentary structures suggest that a tributary outlet-induced flow separation zone formed, which primarily flowed directly above the downstream junction corner;
- Lateral accretion dipping towards the southern bank and some dipping upstream towards the tributary demonstrated that the bar accreted upstream within the tributary confluence; and
- Mud drapes deposited behind the structure are slack water deposits delimiting the highest water stage of the Rio Grande



Discussion



- When there is no flow from a tributary and peak flow from the mainstem river, the tributary outlet becomes a zone of flow separation and deposits a mouth bar from the recirculating eddies at the outlet.
- Subsequent tributary flow events may dissect this bar, transporting the sand back to the mainstem, along with tributary-derived gravels.

Future Activities

- More work needs to be done to establish appropriate thresholds of propagated errors for DoDs.
- Channel bed roughness will be established from orthophotos thereby comparing changes in surface sediment type that is either eroded or deposited after flood events.
- Event-scale elevation changes in the approach reach of all three tributaries will be analyzed.
- Develop relationships between changes observed at the confluence and peak tributary discharges.

Abstract 49) Sedimentology and Topography of a Confluence Outlet of an Ephemeral Tributary to the Mid Rio Grande – Arroyo de los Pinos (Pg. 138)

The Relationship Between Firing Temperature and the Sorption Effectiveness of Fired Clay Pellets

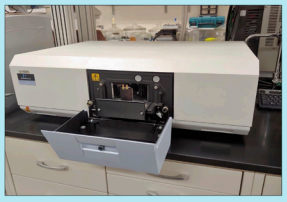
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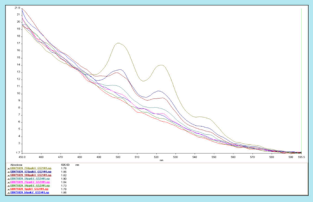
Introduction

- Uranium contaminated drinking water is a prevalent problem in the Four Corners area of the Southwest. Ingesting concentrations greater than 30 ppb causes serious long-term health effects according to the EPA.
- Usual methods for removing uranium are often expensive to maintain and therefore not a viable method for impoverished persons suffering from uranium contamination.
- Fired clay pellets offer a viable alternative to these options, as they can be easily manufactured by lay persons and are inexpensive to obtain.
- Firing clay gives it a sturdy, manageable structure while still retaining sorption properties and the clay's firing temperature affects its ability to sequester uranium.
- A cost-effective method for uranium analysis in drinking water is also necessary. Polyphosphate enhanced fluorimetry is an **inexpensive, nondestructive, and potentially portable** analysis method for both lab and field use and has the potential of being a cost effective analysis method.
  - Fluorimetry is capable of detecting uranyl in ppm concentrations. Polyphosphate compounds enhance the uranyl signal, lowering the detection limit to ppb concentrations.
- Uranyl sorption by low, medium and high temperature fired clay was tested and subsequently analyzed by polyphosphate enhanced fluorimetry and ICP-MS as an orthogonal analysis method for comparison.

Materials and Methods

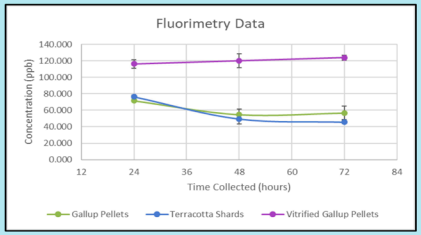
- For low temperature fired clay, fired pellets sourced from Gallup clay were provided by the laboratory.
- For mid temperature fired clay, Terracotta pots were obtained from local store and broken into regularly sized pieces by mass as determined by a Meitler-Tolledo AG 245 analytical balance.
- For high temperature fired clay, vitrified clay was obtained by vitrifying fired clay pellets from clay sourced from Gallup clay, also provided by the laboratory.
- Each sample was run in triplicate, along with uranium and water blanks.
- Samples were exposed to a 125 ppb solution.
  - Uranyl solution was made using a 1000 ppm uranyl nitrate ICP-MS standard solution.
- Samples were placed on an in-house rotator to minimize concentration gradient potential, then removed after 24, 48, and 72-hour periods.
- They were then spiked with polyphosphate solution and analyzed using a Perkin-Elmer LS 55 fluorimeter
- Samples were also acidified with 50% nitric acid and analyzed with ICP-MS

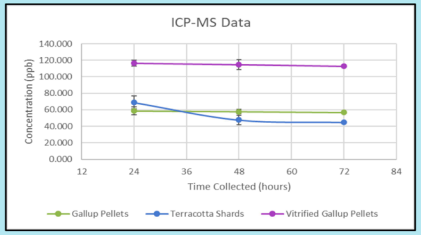




Data

		Uranyl Concentration (ppb)					
		Gallup Pellets		Terracotta Shards		Vitrified Gallup Pellets	
Time (hours)		Fluorimeter	ICP-MS	Fluorimeter	ICP-MS	Fluorimeter	ICP-MS
24	Average	71.614	58.667	76.591	68.838	116.297	116.525
	stdev	4.925	3.837	8.336	5.884	3.126	0.549
48	Average	54.826	57.813	49.421	47.680	120.183	114.824
	stdev	1.815	4.745	6.109	2.973	1.860	0.411
72	Average	56.769	56.730	45.518	44.817	123.990	112.655
	stdev	0.967	7.839	6.704	5.879	8.142	0.322





Results and Discussion

- Low-temperature fired clay and mid-temperature fired clay showed comparable sorption.
- No significant sorption was demonstrated by high-temperature fired clay.
- Similar sorption trends were shown between data obtained by pyrophosphate enhanced fluorimetry and ICP-MS

Future Directions

- Determine water accessible porosity and pore size of clay
- Determine efficacy of fluorimetry for uranium analysis as compared to ICP-MS
  - Find clay sorption relationship between ppm and ppb
- Determine sorption kinetics using polyphosphate enhanced fluorimetry for real-time analysis

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  Mark Chidester

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Biodegradable Porous Hydrogels Designed for Soil Water Retention

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Introduction

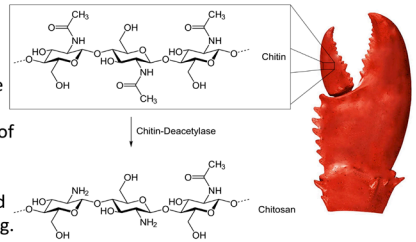
Sandy soils in arid climates have low water holding capacity and high-water loss. This leads to a decrease in plant growth and limiting organic matter content and other water holding factors.

Goals

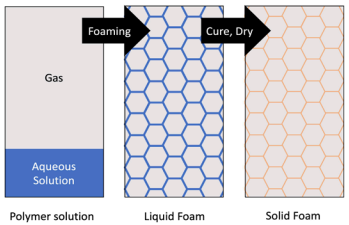
- By making the hydrogel porous save on material cost and ease access of water to plants.
- By using chitosan the hydrogel will be hydrophilic and biodegradable.
- The addition of this hydrogel to the soil will act as a water reservoir stimulating plant growth in times of water stress.

Background

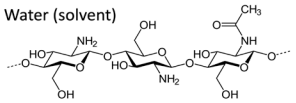
Chitosan: Chitosan is a polysaccharide made through deacetylation of chitin. Chitin derived from crustacean and insect shells e.g. shrimp, crab, cockroach.



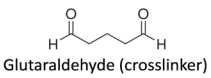
Foam templating: Foams are templated from foamed aqueous polymer solutions. The foam is cured and dried leaving behind a porous interconnected structure.

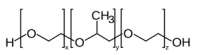


Materials



Chitosan (base material)



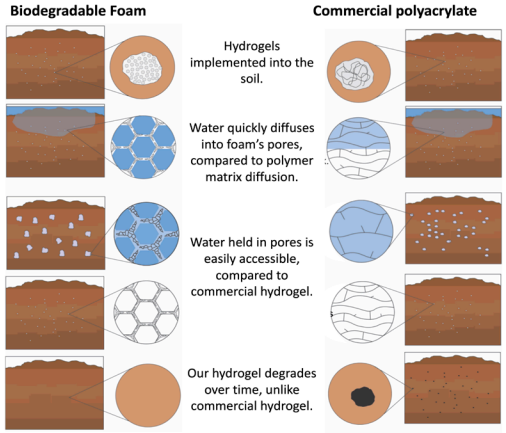


Pluronic F68 (foaming agent)

Implications in Agriculture

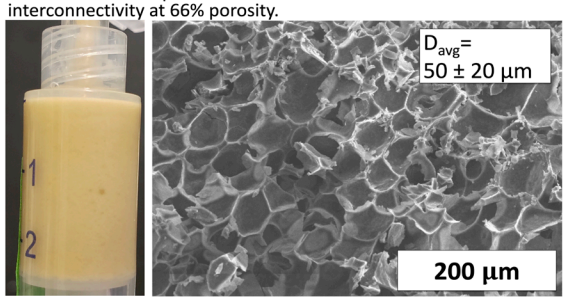
As water becomes more scarce farmers will be looking for more efficient technology to improve efficiency. These hydrogels can reduce the amount of water required for irrigation or reduce water stress between times of irrigation. This material can be implemented as a water retainer within the soil or even as a seed coating to increase likelihood of seed germination.

Comparison of Hydrogels



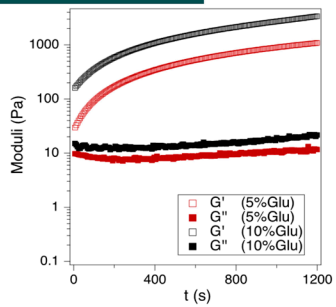
Biodegradable Foam Material

Foams cured within several minutes, and SEM imaging of the foams show a porous structure that contains some interconnectivity at 66% porosity.



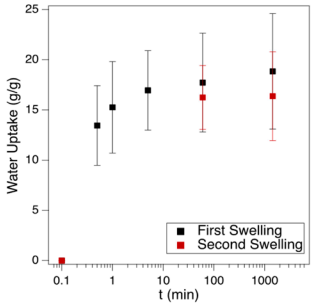
Current Results

Crosslinking study: Rheology tests show that glutaraldehyde crosslinking begins rapidly (<30 sec) as shown by G" (loss modulus) surpassing G' (storage modulus). The crosslinking occurs as quickly even when glutaraldehyde concentration is halved.



Water Uptake study: Samples show water imbibing within the first 30 seconds due to their porous nature. Water uptake is shown to be ~18 g/g for maximum water uptake for sample with 66% porosity.

Sample retained ~87% of its swelling capability after drying and reswelling.



Future Work

- Variation in foam fabrication e.g. porosity, chitosan concentrating, etc.
- Further water uptake and retention studies
- Soil-water retention curves of sandy-type soil with bio-foam amendment.
- Biodegradation studies.

References

Image of crab claw: Retrieved October 04, 2020, from https://www.amazon.com/Lobster-Weapons-Cosplay-Halloween-Costume/dp/B07JLVGGR2

Acknowledgements:

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Abstract 51) Biodegradable Porous Hydrogels Designed for Soil Water Retention (Pg. 139)

Electrical Resistivity Mapping of Rio Grande River-Groundwater Interactions

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INTRODUCTION

- Surface-groundwater interactions such as connectivity remain a challenge to characterize, especially for ephemeral rivers like the lower Rio Grande.
- This investigation used a noninvasive and spatially distributed geophysical method (i.e., time-lapse electrical resistivity tomography, or ERT) for mapping the water table below and adjacent to the Rio Grande River before, during, and after irrigation season.
- This has been validated using groundwater table monitoring well data.
- Results have shown resistivity impacts due to a coupling of both variations in water saturation and electrical conductivity (EC) or total dissolved solids (TDS) difference between resident groundwater from the previous irrigation season and the infiltrating surface water.
- This type of spatiotemporal groundwater level assessment advances our connection process characterization capabilities, and will support the sustainable conjunctive use of surface water and groundwater, especially for ephemeral systems.

METHODS

- Water arrived into the lower Rio Grande on March 17, 2020.
- ERT was used from Feb 2020 to present
- Resistivity results are the simple inverse of conductivity, and that can be correlated to water saturation.
- 84 electrodes were installed every 1 m along a cross-section of the Rio Grande, 56 of which are buried within the riverbed for repeated data collection throughout irrigation season
- Separate "snapshots" are taken with a resistivity meter and then the differences are mapped through time. The elevation of the water table is then verified using a sounder within surrounding monitoring wells, and by measuring the EC of river samples, both taken at the time of measurement.

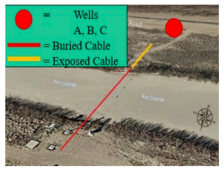


Fig. 1: Lower Rio Grande in Mesquite, NM



Fig. 2: The electrical resistivity meter taking measurements in the field, and in the lab

RESULTS

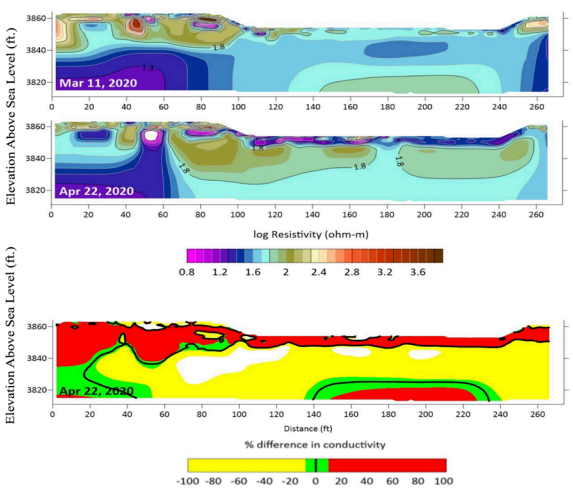


Fig. 3: Top plots: Comparisons of resistivity data from Mar 11 (before arrival of water) to Apr 22 (after arrival of water). This shows a clear decrease in resistivity (i.e. increase in conductivity) in the immediate subsurface of the riverbed associated with the increase in water saturation.

Bottom plot:: % Difference in EC from the aforementioned dates delineating this change.

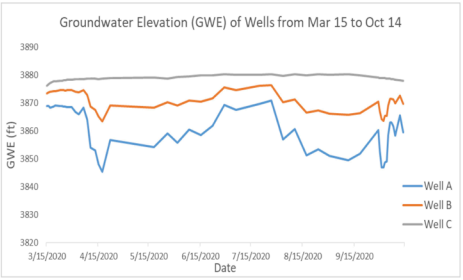


Fig 4: GWE of Neighboring Monitoring Wells from Mar 15 (before the arrival of water) to Oct 14 (after the arrival of water)

DISCUSSION

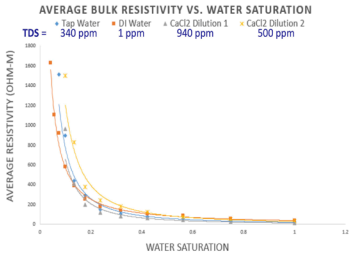


Fig. 5: Lab Testing of Bulk Resistivity vs. Water Saturation

- There is an EC or total dissolved solids (TDS) difference between the pore water from the previous irrigation season and the newly released surface water, and therefore two variables that are impacting site bulk resistivity.
- Laboratory-scale experiments were developed using site riverbed soils to determine the relationships between bulk resistivity vs. aqueous salinity, and bulk resistivity vs. water saturation
- This will be used to subtract the effects of the EC differences between waters from our resistivity results, leaving just the impact of water saturation.

SUMMARY

- We have mapped a change in riverbed hydrology pre- and post-release of water using ERT.
- The relationships between bulk resistivity versus aqueous salinity and bulk resistivity versus water saturation have been developed to evaluate the time-lapse resistivity data and characterization of surface-groundwater connectivity.
- A coupled flow and solute transport model will be used to simulate the infiltration and mixing with a prediction of the resistivity signal for comparison with the ERT measurements.
- Snapshots of resistivity will continue to be taken through March 2021 with the next annual release of water.
- Ideally, the phenomenon of partial riverbed connection will be observed, as it has never been observed at a field site nor in an experiment before, even though it can offer valuable insight for the sustainable use of conjunctive, ephemeral systems.

Acknowledgement:
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Abstract 52) Electrical Resistivity Mapping of Rio Grande River-Groundwater Interactions (Pg. 139)