59th Annual New Mexico Water Conference Poster Abstracts

Assessing the Quality of Groundwater Used for Public Supply in the Rio Grande Aquifer System

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Poster Abstract 1

In May through October 2014, the National Water-Quality Assessment Program (NAWQA) of the U.S. Geological Survey sampled 60 public-supply wells in the Rio Grande aquifer system as part of a 10-year assessment of the quality of groundwater used for public supply in principal aquifers across the United States. The Rio Grande aquifer system consists of hydraulically interconnected basin-fill aquifers extending across about 70,000 square miles of southern Colorado, central New Mexico, and western Texas. Wells were selected for sampling under a nationally consistent design using equal-area grids to achieve a spatially unbiased dataset that allows for comparison of water quality among principal aquifers. The study area for the Rio Grande aquifer system was defined as the area that contained at least 1 known public-supply well within a 5 kilometer radius. The 60 selected wells (45 in New Mexico) were sampled for a comprehensive suite of analytes to characterize the occurrence of contaminants of concern for human health and to improve our understanding of groundwater processes that are important to the management of water resources. Analytes included nutrients, volatile organic compounds, pharmaceuticals, hormones, pesticides, major elements, trace elements, radionuclides, microbial indicators, and tracers of groundwater age. The poster presents selected preliminary results from the Rio Grande aquifer system assessment and compares them with results of the 2013 NAWQA assessment of groundwater used for public supply in the Basin and Range basin-fill aquifers of Arizona, California, Nevada, and Utah.

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Temporal Analysis of Non-Snow Fed Streams in New Mexico

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Poster Abstract 2

The impact of climate change on the hydrological cycle is an area that requires more detailed analysis and research. While climate models agree that global temperatures will rise due to anthropogenic climate change, the impact on precipitation is less well understood. Changes in precipitation will directly impact the streamflow of all streams and rivers along with stream variability. Large snow fed rivers such as the Gila River and the Rio Grande have received extensive study due to the impact they have on water availability in major cities, but headwater, intermittent, and ephemeral streams have largely been ignored.

The objective of this study is to identify, define, and analyze non-snow fed streams in New Mexico in order to determine what impact climate change is having on hydrological trends and variability using the Rio Penasco as an illustration. This study seeks to discover if there are any temporal trends in streamflow data including interannual and decadal variability. It also seeks to find patterns in streamflow variability by examining peak flows, floods, and droughts. All data will be tested for trends and the trends will subsequently be tested for significance. A flood analysis will be run on all streams in order to determine if any floods occur, the magnitude of the floods, and if there are any temporal trends in the flood series. Interannual variability of flow statistics will be compared to known climatic drivers such as the El Niño-Southern Oscillation.

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Underground Storage & Recovery in New Mexico

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Poster Abstract 3

Surface storage of water in the high desert of New Mexico results in considerable loss of stored water to evaporation. Research has indicated pan evaporation rates in New Mexico range from approximately 30 inches to over 80 inches per year. There is no guarantee that nature will return this significant amount of precious water for beneficial use in our state. Other ways (not open surface storage) to keep this water available for use in the state is to store it in huge above ground tanks which are costly to construct, require a large land footprint, and are not aesthetically pleasing. According to 2010 data provided by the OSE Water Use and Conservation Bureau, approximately 46% of all water withdrawals in NM in 2010, were from surface water. Surface reservoir evaporation accounted for an approximate 7% loss of available water. According to the same report (New Mexico Water Use by Categories 2010), all of this evaporative loss is from surface water. There are currently five active Underground Storage and Recovery (USR) projects in NM, at various stages of development and permitting. This poster summarizes the status of these projects undertaken by the Albuquerque Bernalillo County Water Utility Authority (ABCWUA), the City of Rio Rancho, and the City of Las Vegas. Contractor Daniel B. Stephens & Associates, Inc. of Albuquerque is providing technical and administrative support for all of these projects. The Office of the State Engineer (OSE) and the New Mexico Environment Department (NMED) are responsible for the permitting.

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21st Century Streamflow Projections for the Upper Gila River

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Poster Abstract 4

Median snowmelt-runoff driven flows in the upper Gila River are projected to decrease by mid-century, with a best estimate of about 8% less total flow, based on projections derived from global climate change models that predict a continuation of current warming trends in coming decades. We have compared dynamical projections of changing flow in the upper Gila generated by the Bureau of Reclamation's West-Wide Climate Risk Assessment, with a statistical projection derived from a regression of observed precipitation and temperature onto historical flows, assuming stationarity statistics of interannual variability. The stationarity assumption will be violated by mid-century but is defensible for the next several decades. Possible changes in summer flows driven by monsoonal precipitation are very difficult to project.

Dynamical and statistical approaches yield consistent projections of declining average snowmelt runoff on the upper Gila for the period 2021-2050 if, and only if, a long historical period is chosen to represent baseline "average" flow. An averaging period much longer than the 30 year "climate normal" used by meteorologists is needed to establish a representative "average" flow to use as the basis for assessing century-scale climate change. Detecting the incipient effects of long-term warming trends on streamflow requires development of flow metrics that separate temperature-driven change from interannual and decadal precipitation variability.

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Water Right Systems to Protect Food Security in the Lower Tigris Euphrates

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Poster Abstract 5

In arid regions where irrigation is important, food security is tied to the supply and efficient use of water. Ongoing climate change and variability is raising the importance of science-informed water management to protect food security in irrigated areas. Much research has examined climate-related impacts on food security, but little has work has systematically examined alternative water right systems for protecting food security. This research addresses that gap by examining water right systems based on water allocation rules that protect food security while adapting to ongoing water supply fluctuations. It is based on a case study of water supply shortages in Iraq, where food grain shortages have been experienced periodically over a long history as a consequence of those shortages. It examines two alternative water allocation rules for adapting to drought while protecting food grain security in the Lower Tigris-Euphrates Basin, Iraq. The most widespread method for sharing water shortages when they occur in Iraq is an upstream priority allocation system. An alternative method for addressing reduced supplies is a proportional sharing of shortfalls. These two water shortage sharing systems are reviewed for their performance for sustaining domestic grain food security. Surprisingly, a proportional sharing of shortages outperforms the upstream priority system. Results point to the importance of carefully designed rules for allocating water shortages to ensure food grain security in the world's important irrigated regions.

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Effects of Forest Fire on Submerged Aquatic Macrophytes

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Poster Abstract 6

Surface water systems are increasingly critical for human water supply, and submerged aquatic macrophytes (SAMs) can strongly influence these ecosystems. High elevation headwater areas, such as the East Fork Jemez River (EFJR) in the Jemez Mountains of northern New Mexico, are a key component of these surface water networks. The EFJR, in the Valles Caldera National Preserve (VCNP), is a low gradient grassland stream with very high primary productivity driven throughout the growing season by four main aquatic plant species: Elodea canadensis, Ranunculus aquatilis, Potamogeton richardsonii, and Stuckenia pectinata. The Las Conchas fire, which burned over 157,000 acres of forest and grassland in June and July of 2011 including 36% of the East Fork Jemez watershed, created an excellent opportunity to study the effects of a catastrophic forest fire on SAMs both as individual species and as a dominant community for primary production. SAMs extract nutrients from both the water column and the sediment. Fire increases both dissolved nutrients and the transport of nutrient rich particles to streams. Plant tissue samples collected before and after the Las Conchas fire are being analyzed for percent carbon (C), percent nitrogen (N) and percent phosphorous (P) to see if the elemental stoichiometry of the tissues in the SAMs has responded to the nutrient enrichment. Understanding the effects of catastrophic forest fires on the growth and composition of SAMs will provide valuable new information on the recovery of these key components of aquatic primary production in mountain headwater streams throughout New Mexico.

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Application of HydroGeoSphere to Model Complex Hydrological Processes in Valles Caldera, New Mexico

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Poster Abstract 7

Climate change is expected to reduce streamflow in the southwestern USA due to reduction in precipitation and increases in evaporative demand. Understanding the effects of climate change in this region is particularly important for mountainous areas since these are primary sources of recharge in arid and semi-arid environments. Therefore we undertook to model effects of climate change on the hydrological processes in Valles Caldera (448 km2), located in the Jemez Mountains of northern New Mexico.

In Valles Caldera modeling the surficial, hydrogeological, and geothermal processes that influence hydrologic fluxes each present challenges. The surficial dynamics of evaporative demand and snowmelt both serve to control recharge dynamics, but are complicated by the complex topography and spatiotemporal vegetation dynamics. Complex factors affecting evaporative demand include leaf area index, temperature, albedo, and radiation affected by topographic shading; all of these factors vary in space and time. Snowmelt processes interact with evaporative demand and geology to serve as an important control on streamflow generation, but modeling the effects of spatiotemporal snow distributions on streamflow generation remains a challenge. The complexity of Valles Caldera's geology—and its associated hydraulic properties—rivals that of its surficial hydrologic forcings. Hydrologically important geologic features that have formed in the Valles Caldera are three-dimensionally intricate and include a dense system of faults, alluvium, landslides, lake deposits, and features associated with the eruption and collapse of this super volcano. Coupling geothermally-driven convection to the hydrologic cycle in this still-active geothermal system presents yet an additional challenge in modeling Valles Caldera.

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Modeled Impacts of Conventional Uranium Mining on Groundwater in the San Juan Basin, New Mexico

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Poster Abstract 8

With few exceptions, all conventional sources of electric power are associated with large volumes of water to produce the fuel and/or generate the electricity. Growing electric power demands thus result in increasing impacts on water resources, especially in the arid southwest. Electricity production from nuclear power provides 19% of total US energy demand, but more than 83% of the required uranium is currently imported. It is estimated that uranium reserves in the San Juan Basin in northwestern New Mexico contains nearly 600 million pounds of ore, primarily in the Morrison Formation, leading to renewed interest uranium mining in the basin. However, most of these reserves are located in high quality and productive aquifers consequently future underground development would have large impacts on an already limited resource. This paper describes a modeling study to explore the relationship between uranium development and water resources in the region. The basin was divided into nearly 300 interconnected cells to account for geologic and hydrologic variability and a spatial-compartmental (Roach & Tidwell, 2009) or mixing cell approach within a system dynamics framework was applied to model groundwater flow and the impacts of uranium mining on groundwater resources in the Morrison Formation. Results from the model simulations show storage loss in cells in the vicinity of potential mines, very large cones of depression and extraction of large volumes of water associated with mining. The model suggests that the impacts of uranium mining on groundwater vary largely as a function of sub-regional geology and groundwater hydrology.

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Native American Water Rights Settlements Repository

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Poster Abstract 9

The Native American Water Rights Settlement project is a repository of legal documents that are related to Native American water rights. The repository includes rich metadata documenting the content and classification of the documents to facilitate search and access to the documents.

The text-based search supported by the documentation in the repository is complemented by a map-based search tool that uses geographic locations associated with the documents to enable discovery by location.

The repository arranges by documents by water rights agreement (settlement). The map search-tool allows for searches by reservation/Tribe, by state, by hydrological unit and by document type.

In the map interface red boundaries indicate reservations, green-fill with red boundaries indicate reservations with documents, dotted boundaries indicate states and blue boundaries indicate hydrological units. Access to documents is provided through either text-based or map-based search, with both processes taking the user to the scanned documents for download and use.

While the current application focuses on documents related to Tribal water rights settlements, the general model may be expanded to any document and/or data collection for which there is a defining location component.

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Development of a Bio-indicator to Assess Water Quality in Ephemeral Ponds

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Poster Abstract 10

Ephemeral ponds are unique to arid regions and have been identified as one of the ten key aquatic habitats in New Mexico because they constitute a large proportion of the overall water resources in the state. These critical water resources recharge ground waters and provide habitat for waterbirds and species of crustaceans such as the tadpole shrimp (Notostraca: Triops). Modifications are frequently made to ephemeral ponds to benefit livestock management or as catchment basins for flood or wastewater produced by oil and natural gas operations. These anthropogenic inputs can influence both the physical and chemical nature of the water and sediments causing water chemistry changes. My previous research indicates that water quality differences can alter species occurrence of tadpole shrimp within ephemeral ponds in southwestern NM, a region dominated by urban and ranching impacts. The tadpole shrimp Triops newberryi appears more tolerant of anthropogenically modified ponds whereas T. longicaudatus "short" does not occur in ponds with increased levels of nitrates and ammonia. The Otero Mesa region in the south central portion of NM that is one of the last intact grasslands of the Chihuahuan Desert, has no urban impacts, and contains a third, undescribed species of tadpole shrimp. I will be testing the water chemistry of ponds on the Otero Mesa, comparing them to ponds in southeastern NM and determining if species occurrence directly corresponds to water quality. With this information, tadpole shrimp can be used as a bio-indicator species to assess water quality within ephemeral ponds.

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Pore Clogging Due to Irrigation with RO Concentrate

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Poster Abstract 11

In the southwestern United States, water is a scarce resource because of arid climate with low rainfall and high evaporation. Problem is exacerbated by low quality groundwater and dwindling surface water. There is a growing need for use of alternate water sources for agricultural use. About 75% of available groundwater in New Mexico is saline (EC > 3 dS/m). Brackish Groundwater National Desalination Research Facility in Alamogordo, NM uses reverse osmosis for desalinization of groundwater. This process results in a highly concentrated saline solution which must be managed in an environmentally sound way. One proposed way to dispose of this concentrate is land application for irrigation of salt tolerant plants. However, its impact on soil porosity is unknown. The objective of this study was to evaluate the effect of irrigation with RO wastewater concentrate on soil hydraulic conductivity. Two soils, clay and silica sand, were repacked and saturated with concentrate and one pore volume of concentrate (EC ~ 9.5 dS/m) was applied to the soil once a week. The samples were allowed to dry for one week at temperatures simulating southern NM weather between concentrate applications and the cycle was continued for 22 weeks. The hydraulic conductivity and bulk density of the samples were measured at 4 week intervals. Results from experiments showed reductions in hydraulic conductivity with concentrate application likely due to the precipitation of chemicals from wastewater resulting in pore clogging. Concentrate disposal on soil could aid in the implementation of inland groundwater desalination in the southwestern U.S.

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New Mexico Water Assessment: Surface-Water Inflow, Outflow, Gain, and Losses

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Poster Abstract 12

Streams are an essential source of water in the arid southwest. New Mexico's streams currently provide about 50 percent of the water used in the state. Recent studies have shown that the timing and availability of spring runoff is changing, which could substantially affect water availability and management strategies in New Mexico. Water managers have undertaken a comprehensive water assessment to quantify major components of the water budget. This study, funded the NM Water Resources Research Institute, will provide the surface-water component of the New Mexico Statewide Water Assessment.

The objectives of this project are to quantify the total volume of streamflow entering and leaving New Mexico and to generally identify areas where gains and losses of streamflow occur. Specific causes of gains and losses will not be identified initially, but could be evaluated in a future, more detailed, study. Major stream systems identified for analysis include the Rio Grande and the Canadian, Gila, Pecos, San Francisco, and San Juan Rivers. Annual and monthly mean streamflow data will be obtained from the network of streamflow gages operated by the U.S. Geological Survey (USGS), Bureau of Reclamation, and state agencies. Data will be collected from gages located near headwaters, upstream and downstream from reservoirs, and near state borders along most perennial streams within the major stream systems. Annual mean streamflow data, derivative products such as seasonal and monthly mean streamflow data, and additional supplemental data will be provided as ArcGIS files for incorporation into the Statewide Water Assessment database.

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Study on Increasing CO_2 Storage, Recovering Extracted Water for Beneficial Use

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Poster Abstract 13

Carbon capture, utilization and storage (CCUS) seeks beneficial applications for capturing and storing CO2 from fossil fuel burning. This project examines enhanced water recovery (EWR) as the primary application. Secure carbon storage requires identification of suitable geological formations possessing requisite storage volume, containment and injectivity. This pre-feasibility study evaluates the potential for removing deep, saline water to create additional storage capacity for CO2 while treating the extracted water so that it can be used for industrial and other uses. Known as active reservoir management, the process would control pressures within the formation, lessen the risk of caprock failure, and better control the movement of CO2 within the target formation. The project studied the GreenGen site in Tianjin, China where Huaneng Corporation is capturing CO2 at a coal fired IGCC power plant. This region in China is highly water-stressed because of population growth and arid conditions. Water extracted from the rocks used for CO2 storage was found to be brackish (3,000-10,000 mg/L total dissolved solids) and likely to be treatable for various applications. Treatment options and costs were then developed for the water that would be extracted, including desalination, pretreatments, transportation, and concentrate waste disposal. EWR enhanced by CO2 injection could be used to play a role in the water budget of the State of New Mexico while helping to sequester carbon, while also helping to define the costs and processes of inland brackish water desalination. This project was organized under the U.S.-China Clean Energy Research Consortium (CERC).

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Irrigation Water Balances of Agricultural Corridors in Northern New Mexico

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Poster Abstract 14

Projections of water scarcity due climate change and population growth endanger the use of the available water resources in the southwestern United States. A wide spatial and temporal analysis of surface water and groundwater dynamics is necessary to improve water planning and management. Our study was carried out to characterize surface water and groundwater interactions and to quantify the water budget components at irrigated corridors in northern New Mexico. The study sites were instrumented to collect weather data, water flows of rivers and acequias, shallow groundwater level fluctuations, soil physical properties, and irrigation and crop management practices. From one of our study sites, shallow groundwater level responses raised up to 24-38 cm, as a response of water percolation below the 1 m of soil. In another of our study sites, we found seepage values up to 16% of the main ditch flow, that support annual groundwater levels increments up to 1 m. Preliminary results in sites with low, medium and high water availability in our research area, showed deep percolation as the major component of the water budget with 43, 46 and 52% respectively. This study revealed that, water availability drives the amount of applied water and the irrigation schedule on the farms. At our study valleys it appears that traditional irrigation is an important source of groundwater recharge. From the ongoing study, we expect to get detailed information about the water distribution over larger spatial scales using field measurements and geographic information systems-based land use classification.

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In Situ Complexation and Facilitated Transport of Oxidants

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Poster Abstract 15

Naturally occurring reduced species associated with subsurface materials can impose a significant natural oxidant demand (NOD), which is the bulk consumption of oxidants by soil water, minerals, and organic matter. Although injection of oxidants has been used for chemical transformation of organic contaminants, NOD represents a challenge for the in-situ delivery of oxidants as a remediation alternative. Co-injection of complexation agents with oxidants has been proposed to facilitate the delivery of oxidants for in situ chemical oxidation remediation of contaminated groundwater. This study investigates variability of NOD for different oxidants and sediments. The effect of the addition of various complexation agents, including EDTA, tween 80, hydroxypropyl-beta-cyclodextrin (HPCD), humic acid, and generation 3 poly(amidoamine) (PAMAM) dendrimer, on the NOD was also examined. NOD was measured for a clay loam (collected from Air Force Plant 44 in Tucson, AZ). Varying amounts of biosolids were mixed with subsamples of the clay loam to create two additional reference soils in order to study the effect of organic matter and other soil characteristics on the NOD. Bench-scale laboratory experiments were conducted to determine the NOD for various oxidants, using the three soils, and replicated with and without various delivery agents. Measured NOD showed variability for each soil and oxidant composition. Additionally, significant differences were observed in NOD with the addition of delivery agents. The results support the elucidation of potential controls over NOD and have implications for in situ, oxidation-based remediation of contaminated groundwater.

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Salinity and Surface-Water/Groundwater Interaction in Two Alluvial Basins, Southern New Mexico

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Poster Abstract 16

Salinity sources along the Rio Grande in Southern New Mexico include anthropogenic (such as agricultural return flows and municipal wastewater discharges) and geologic sources (such as upwelling of deep, saline groundwater). Measurements of surface-water discharge, groundwater levels, specific conductance (SC), and surface-water/groundwater interaction (seepage) over the study period (2009-2013) will allow assessment of how changes in conjunctive-use water may affect water quality in the Palomas and Mesilla groundwater basins. The study area is defined by three continuous streamgages on the Rio Grande: below Caballo Dam, below Leasburg Dam, and at El Paso, which bound the Palomas (Caballo to Leasburg) and Mesilla (Leasburg to El Paso) basins. Probes in 13 shallow alluvial groundwater wells show a consistent decline in water levels. Annual low-flow seepage investigations conducted within the Mesilla basin show cumulative loss for each measurement within the study period. SC data from these wells show different temporal trends; six wells show steady increase, two show steady decrease, and five show variability, but no trend. Threshold-value-defined release/non-release seasons were defined using the daily flow data at each streamgage and evaluated on a daily basis. Dissolved-solids loads were calculated using a locally-derived SC/dissolved-solids conversion factor to quantify the salt mass on a daily basis. Daily loads at each streamgage were aggregated to monthly, seasonal, and annual loads and differenced to estimate the amount of dissolved-solids source or sink and trends within the Palomas and Mesilla basins over the study period.

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The Science and Economics of Water Desalination Using Forward Osmosis

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Poster Abstract 17

Currently, Southeastern New Mexico (SENM) produces in the range of 400 million barrels of produced water/year, with total dissolved solids (TDS) ~ 200,000 ppm. Disposal is most often done by transporting the produced water to injection wells or disposal ponds, costing around $1.2 billion/year with an estimated 0.3 million barrels of transportation fuel used during the transport. SENM ranks 1st among US states in the production of Potash. Potash processing uses highly concentrated brine water. If produced water can be cleaned to an acceptable level for the potash industries providing them with an alternate source of process water.

A Forward Osmosis (FO) based desalination technology is developed under grants from National Energy Technology Laboratory (NETL) of DOE and Office of Naval Research (ONR). Laboratory tests at New Mexico Tech (NMT) demonstrated that an unprecedented water flux can be achieved from a properly designed membrane module. Current efforts are directed towards taking the technology to higher level of system maturity. Economic analysis demonstrates that the FO technology developed has the potential for competing with Reverse Osmosis (RO).

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Estimating Precipitation and Evapotranspiration Rates Using Streamflow Measurements

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Poster Abstract 18

Streamflow through the Middle Rio Grande Valley is largely driven by snowmelt pulses and monsoonal precipitation events originating in the mountain highlands of New Mexico (NM) and Colorado. Water managers rely on results from storage/runoff models to distribute this resource statewide and to allocate compact deliveries to Texas under the Rio Grande Compact agreement. Prevalent drought conditions and the added uncertainty of climate change effects in the American southwest have led to a greater call for accuracy in storage model parameter inputs. While precipitation and evapotranspiration measurements are subject to scaling and representativeness errors, streamflow readings remain relatively dependable and allow watershed-average water budget estimates. Our study seeks to show that by "Doing Hydrology Backwards" we can effectively estimate watershed-average precipitation and evapotranspiration fluxes in semi-arid landscapes of NM using fluctuations in streamflow data alone. We tested this method in the Valles Caldera National Preserve (VCNP) in the Jemez Mountains of central NM. This method will be further verified by using existing weather stations and eddy-covariance towers within the VCNP to obtain measured values to compare against our model results. This study contributes to further validate this technique as being successful in humid and semi-arid catchments as the method has already been verified as effective in the former setting.

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Life Cycle Assessment of Using Dairy Waste for Algae Bio-Energy Production in New Mexico

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Poster Abstract 19

Consolidation in livestock production generates higher farm incomes due to economies of scale. However, it also brings waste disposal problems. New Mexico ranks number one in the nation in dairy farm size with an average of over 2000 cows per farm. Dairy waste is a significant source of nitrates and improper management of animal waste from the state's large dairy farms can produce adverse environmental and health effects, including groundwater nitrate pollution. Optimal management of dairy waste is crucial for the sustainable development of the region. Given the characteristics of the dairy industry and the energy sector of New Mexico, we assess the environmental and economic impacts of utilizing dairy waste for bioenergy production. Instead of conventional land application, dairy waste can be treated through anaerobic digestion for biogas production and nutrient recovery. The post-digestion waste can be used as nutrient source for algae cultivation and bioenergy production. In this study, we employ an integrated life cycle assessment to evaluate the physical and economic feasibility of controlling nitrate pollution from large dairy farms while boosting green energy in New Mexico.

KEYWORDS : Pollution, nitrates, dairy waste, bioenergy

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Oil Production Wastewater Geochemical Variability from Permian Basin of Southwest USA

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Poster Abstract 20

Produced water is water (including fracturing flow-back) coproduced during oil and gas exploration and production. The U.S.generates 21 billion barrels/year of produced water, which is generally considered wastewater. Growing unconventional oil and gas production has increased the need for beneficial use of produced water, especially in arid regions such asthe Permian Basin, the largest U.S. tight oil producer. Produced waters may have variable water chemistries, but generally contain high levels of organics and salts. In order to evaluate the environmental impact, treatment, and reuse potential, there is a need to characterize the compositional variability of produced water. Produced water samples from the Permian Basin were collected from 12 wells across west Texas and east New Mexico. Compositional analyses including gas chromatography-time of flight-mass spectrometry and inductively coupled plasma-optical emission spectroscopy were conducted. The samples show elevated benzene, ethylbenzene, toluene, and xylene, alkyl benzenes, propyl-benzene, naphthalene compared to other heteroaromatics, and complex hydrocarbon compounds containing oxygen, nitrogen and sulfur. Van Krevelen diagrams suggest an increase in concentration of heteroaromatic hydrocarbons with an increase in the depth of the formations, and the sodium-chloride dominant salinity also increased with depth ranging from 37-150g/L. Depth of wells (or producing formation) is a primary control on predicting water quality for management, treatment and beneficial use.

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Northeastern Tularosa Basin Regional Hydrogeology Study, New Mexico

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Poster Abstract 21

The work presented in this report covers the northeastern region of the Tularosa Basin, along the western mountain front of the Sacramento Mountains, from Carrizozo to Alamogordo. This study's goal was to improve understanding of the groundwater resources in this region by identifying recharge areas and quantities, determining groundwater flow rates and direction, and to interpret the groundwater/surface water interactions that exist in the region. Methods used in this effort included geologic mapping, groundwater-level measurements, with geochemical analyses of the groundwater, springs and streams. Using water-level measurements collected between 2009 and 2011, we were able to determine zones where aquifers are recharging, being pumped, declining, or not changing. The geochemical analyses of the groundwater, springs and streams served to emphasize the complex hydrogeologic system of the mountain front. The observations of spatial trends in water chemistry are highly correlated to the geology and the flow path that the groundwater follows through the subsurface. To quantify the total mean annual volume of recharge entering the basin we conducted Darcy Flow calculations along cross sections perpendicular to the mountain front. The Darcy Flow calculations were then compared with other recharge approximations from previous studies to determine the approximate volume entering the system via the different recharge mechanisms: mountain-block recharge and mountain-front recharge. The results of this study have significantly increased our knowledge about the hydrologic system responsible for recharging the northeastern Tularosa Basin region from the east. With increased dependence on local groundwater, community education related to water conservation is highly encouraged.

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An Economic Analysis of Ratepayers' Willingness-to-Pay for Water Utility Infrastructure Investments

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Poster Abstract 22

Australia's regulatory process requires water utilities to consider customers' willingness-to-pay when setting rates and investment priorities. U.S. utilities face challenges to invest in failing pipe infrastructure, environmental regulation compliance, and inadequate water supply. These investments will require significant revenues beyond current rates. Customers are the only viable funding source. Water utilities could follow Australian practices as understanding willingness-to-pay could be informative when structuring rate increases. We present results from a 2009 choice experiment conducted with ABCWUA water utility to examine residential ratepayers' preferences for three investment projects: drinking pipe infrastructure, reuse water infrastructure, and renewable energy. Results indicate that ratepayers significantly value these investments. Reported willingness-to-pay amounts represent the additional amount the median ratepayer is willing to pay on his monthly bill over five years into a dedicated Water Infrastructure Fund. He is willing to pay $0.51 to avoid one additional outage, $0.36 to avoid a one hour increase in average outage length, and $0.06 for a one percent increase in advance notification of planned maintenance outages. Second, he is willing to pay $0.08 for a one percent increase in city greenspace irrigated with reuse water. Third, he is willing to pay $0.09 for a one percent increase in renewable energy used to treat and deliver water. Willingness-to-pay to avoid more frequent outages shows the greatest heterogeneity. We analyze determinants of willingness-to-pay. Individuals with numerous pipe breaks within a half mile of home have a significantly higher willingness-to-pay to avoid longer and more frequent outages. Results are mapped using GIS.

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Bosque Ecosystem Monitoring Program: Providing Water Quantity and Quality Data Along the Rio Grande

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Poster Abstract 23

For over 17 years, the Bosque Ecosystem Monitoring Program (BEMP) has collected data to track long-term changes in the riparian ecosystem along the Rio Grande. Two of BEMP's core datasets include water quantity and quality, both important facets of ecosystem health. Long-term water quantity measures include precipitation, depth to groundwater and well head elevation. Long-term data collected on groundwater, ditch and river water quality include field parameters (dissolved oxygen, pH, temperature, turbidity and conductivity) in addition to chloride, bromide, nitrate, phosphate and sulfate, which are analyzed in the lab. Intermittent, funding-driven water quality testing includes E. coli levels in river and irrigation ditches. BEMP also has data on pharmaceuticals and personal care products from above the San Juan Chama Drinking Water Project Diversion Dam and below the City of Albuquerque wastewater treatment plant. These datasets are analyzed with vegetation, fuel load, and arthropod data to track changes in ecosystem health and provide necessary baseline data to guide natural resource management decisions. BEMP data are requested and used by federal, state and local agencies, scientists and other organizations. Many of BEMP's data users fund BEMP operations or the collection of specific datasets. BEMP data are non-proprietary and are available online at www.bosqueschool.org/bemp.aspx. Here we are presenting some of the questions and land management challenges that BEMP data can help address.

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Assessment of Water Quality in Irrigation Drainage Canals as a Source of Reusable Irrigation Water

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Poster Abstract 24

Main irrigation canals in the Rincon and Mesilla Valleys were designed to convey irrigation return flow back to the Rio Grande River where it is mixed with the river water for downstream use. However, due to several decades of dwindling flows and in some cases no-flow in the river, the mixing of poor quality water from the irrigation drainage canals further degrades the quality of river water downstream. Water quality of irrigation return flows in the southern Mesilla Valley major drains namely the Nemaxas Drain and the West Drain were assessed. Water samples were tested for anions, metals, Chemical Oxygen Demand (COD), Total Nitrogen/ Total Organic Carbon (TN/TOC), Salinity, pH and E.Coli (Escherichia coli) bacterium. This study is in its preliminary phase but the objective is to provide a better understanding of the quality of irrigation return flows for the southern Mesilla Valley in order to develop guidelines for designing riparian zones and their locations that would act as pollutant buffers and/or filtration system. The ultimate goal is to provide a natural method of reclaiming irrigation drainage water for irrigation purposes.

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Potential of Reclaimed Water Sources for Irrigated Agriculture in New Mexico

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Poster Abstract 25

Water of adequate quality for crop production is considered to be one of the most critical limiting resources for agriculture in the southwestern United States at this time. Recent shortages of traditionally used surface and groundwater are exacerbating the problem. A proposed solution is to utilize reclaimed water sources available in New Mexico; dairy effluent, dairy processing plant wastewater, and oil and gas produced water that are capable of producing acceptable crop yields in six New Mexico economically significant crops; alfalfa, chile, corn, cotton, pecans, and wheat. Practical applications, within a framework of economic feasibility, will be explored. Additionally, alternative crops will be investigated and compared against developed criteria for reclaimed water quality to assess the possibility of cultivating them on a commercial scale. Research opportunities will be identified pertinent to these reclaimed water sources and policy implications discussed.

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Satellite Observations of Ground Water Changes in New Mexico

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Poster Abstract 26

In 2002 NASA launched the Gravity Recovery and Climate Experiment (GRACE) satellite mission. GRACE consists of two satellites with a separation of about 200 km. By accurately measuring the separation between the twin satellites, the differences in the gravity field can be determined. Monthly observations of these differences can be related to changes in the mass below the satellites. On land these mass changes are primarily due to movement of water and GRACE effectively weighs the total amount of water (snow, surface water, groundwater and soil moisture) entering or leaving a region each month. A paper published in Science in 2013 by Famiglietti and Rodell presents results for the rate of change for the observed mass over the US between 2002 and 2013. In particular they found the loss of water from the southern high plains aquifer to be substantial (-2.5 cm/year) and attribute this loss to an overreliance on groundwater to supply irrigation needs. We analyzed GRACE data for 2007 to 2013 covering a location in south central New Mexico (107.8 W and 33 N) and found a decrease in the total water stored of about 2.0 million acre feet a year over an area of 200,000 km^2. We believe this result reflects groundwater depletion in south central New Mexico and the lower than average regional precipitation between 2007 and 2013.

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The Bosque Ecosystem Monitoring Program (BEMP): Effects of River Drying

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Poster Abstract 27

The Rio Grande in central New Mexico is a highly altered desert river with a network of dams and diversions that alter the river's natural flow regime. Extensive water abstraction at several locations including the Isleta Dam south of Albuquerque has created reaches experiencing relatively abrupt changes from perennial to intermittent flow patterns during summer months. This study examines the effect of these drying events on water table fluctuation, terrestrial arthropods and riparian vegetation. Data on arthropods, vegetation, and depth to groundwater were collected by both citizen and professional scientists as a part of the Bosque Ecosystem Monitoring Program (BEMP). BEMP is a joint effort between UNM, Bosque School, and the Sevilleta Long Term Ecological Research (LTER) project. According to Stromberg et al. (2005), changes in groundwater levels resulting from sudden water abstraction can lead to spatial and temporal variation in riparian vegetation community composition. Similarly, desert arthropod community structure and composition are also likely to be altered by the effects of river drying events (McCluney and Sabo, 2012). BEMP data collected along the Rio Grande riparian corridor in both perennial and intermittent river reaches will be used to determine if flow intermittency has affected the fluctuation of the water table, the composition of terrestrial arthropods and the structure of the riparian vegetation.

McCluney K.E. & Sabo J.L (2012) River drying lowers the diversity and alters the composition of an assemblage of desert riparian arthropods. Freshwater Biology, 57, 91-103.

Stromberg J.T., Bagstad, K.J., Leenhouts J.M., Lite S.J., & Makings E. (2005) Effects of stream flow intermittency on riparian vegetation of a semiarid region river (San Pedro River, Arizona). River Research and Applications, 21: 925-938.

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Drought, Salinity, and Invasive Plants: A New Model for Sustainable Water Management

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Poster Abstract 28

The aim of this project is to address the soil water supply, a forgotten but indispensable component of our water budget. The soil water supply is the "hidden half" of our terrestrial water supply that directly influences vegetation and land use. In New Mexico and most of the southwestern U.S., prolonged drought may increase the salinity of our soil water supply. Further, there is an increase in the use of brackish water as land managers seek all possible sources of water due to drought, but need guidelines on how to use these waters. Our recent findings suggest that high soil water sodicity (sodium, or Na) plays an important role in the spread of invasive plant species in the southwestern U.S., and this should be of concern to land managers. Weedy and invasive plants harm the environment, reduce crop yields, and exacerbate drought conditions. We propose that: 1) the quality of the soil water supply can be used as a predictive tool for assessing the risk of our lands to invasive plant encroachment and 2) information on soil water quality improves management decisions for rangelands, riparian areas, grazing, crops, dairy, and the oil and gas industry. Our research will benefit New Mexico and the southwestern U.S. by providing new information to reveal the importance of soil water quality (specifically sodicity) as a predictive tool for assessing risk of our semiarid lands to invasive and weedy plants, and to provide management guidelines for the use of brackish water to diverse land manager-stakeholders.

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NM Statewide Water Assessment: Recharge Data Compilation and Recharge Area Identification

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Poster Abstract 29

The rate and distribution of groundwater recharge to New Mexico's aquifers is the least understood aspect of the state's water budget. Despite a history of precise and distributed measurements quantifying surface water flow, water table elevations, precipitation amounts, as well as current models that describe evapotranspiration, a statewide assessment of recharge has not been completed. While recharge estimates and studies of recharge processes have been conducted, the effort to date has been on the basin scale, or by county and water planning region. With a long-term goal of estimating groundwater recharge on a statewide scale, this study seeks to compile existing recharge estimates throughout the state and to construct a recharge area map. We have compiled several recharge estimates made in New Mexico, many of which are from academic and government studies. Data are displayed in a format that contains the study citation, location (individual basins, counties, and water planning regions), recharge estimate, methodology, and other important information. A geographic information system (GIS) layer was created to display locations of recharge estimate research and water resource planning studies. The map of recharge studies shows a concentration of estimates in the populous central region of New Mexico and makes data gaps very apparent. As a part of the effort to identify recharge areas in the state, raster data from precipitation, evapotranspiration, and elevation models are being analyzed. Future analysis will include layers representing vegetation, surface geology, temperature, and soil water content, detailing where recharge is most likely to occur.

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Quantifying Soil Moisture Distribution in Irrigated Croplands of Northern New Mexico

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Poster Abstract 30

Irrigation communities of Northern New Mexico have continued a wonderfully sustainable way of life through irrigation and agricultural practices that have remained practically unchanged for over 300 years. A current problem facing these communities is an increase in urbanization and population pressures. Acequia (irrigation ditch) systems are intended to manage the winter melt discharge used to irrigate crops. There are climate change models which predict less snowpack in the southwestern United States. Understanding the complexities and details of water use in the irrigated valleys may help in improving water management practices which may assist stakeholders with conserving their precious resource and ensure water availability and knowledge for future generations. In order to understand the possible implications of diminished water resources, proper quantitative hydrological data must be collected along with qualitative data seeking to collect and analyze the behavior of water use by stakeholders. The exact nature of the distribution, how and when water is being used on the land is not very well understood. Our objective will be to (1) quantify discharge and soil moisture distribution within irrigated croplands with a focus on grasses and show how each relate to one another, and (2) compare the differences between the three valleys of Rio Hondo, El Rito, and Alcalde, New Mexico. Each valley is presumed to encompass different water availability. Using this information we plan to show the distribution of water over the irrigated cropland. This information will also augment the exactitude of water budget calculations for each valley.

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A Dynamic Statewide Water Budget for New Mexico

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Poster Abstract 31

Tremendous amounts of information have been gathered for decades throughout New Mexico in support of quantification of available water resources and the use of those resources. This information however resides in many places, can be disjointed, and is difficult to synthesize into a meaningful overall picture of where the state stands in terms of water availability and use, and what that might mean for the future. In this poster, we present initial steps in synthesizing historic information from New Mexico Office of the State Engineer's (NM-OSE) water use reports, NM-OSE-Interstate Stream Commission's (ISC) Regional Water Plans, and the United States Geological Survey's (USGS) surface water and groundwater information into a single interactive platform. The Dynamic Water Budget for New Mexico is being developed with support from WRRI. This poster includes a conceptual mass balance structure that is being used to organize water supply and use data associated with the state's 33 counties and/or 16 OSE-ISC planning regions, as well as time series information on water use in counties and regions by given water use sectors.

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Effects of Silvicultural Operations on Water Quality and Quantity in New Mexico Forests

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Poster Abstract 32

In the southwestern U.S, competition with respect to fresh water and requirements for control water resources are growing demands. A clear understanding of the effects of silvicultural operations on the flow of water quality and quantity is an important element for enhanced management. In this study, it was examined that how different cases of forest operations such as burning and thinning influence infiltration, runoff, and sediment yield in the New Mexico forest area. In northern New Mexico forest, two experimental blocks with four treatments were established in Ponderosa Pine, and Mixed Conifer stands on gentle and steep slopes. The treatments consisted of thinning and burning operations with four controls, four lop and scatter, and four pile and inter-space plots. Rainfall simulations were performed to investigate the impacts of thinning and burning practices on the volume of water flowing downstream and sediment yield. Litter was classified into three depths 0-3.5 cm, 3.5-7 cm and > 7 cm. 1m2 runoff plots were placed in each litter stratum treatment in each block and paired with the control runoff plots where there was no cutting or burning. Preliminary results indicated that the amount of runoff from treated plots was less than that from control plots. Control plots had a higher sediment yield than all treatments. Ongoing analysis will attempt to find out if there is a specific forest practices threshold that maximizes infiltration and minimizes sediment yield, and to discover differences between short and long term thinning effect on water yield.

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Sediment and Soil Erosion Control Using Inland Saltgrass Along Drainage Canals

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Poster Abstract 33

Drainage canals in southern New Mexico are often clogged by sediment and debris as a result of flood runoff and therefore degrade the quality of water that returns to the Rio Grande. This study investigated the use of inland saltgrass (distichlis spicata) along Diez Lagos drainage canal at Sunland Park New Mexico to mitigate excessive soil erosion. Saltgrass was planted along the canal to mitigate soil erosion in July of 2014. Trial tests were conducted at an established saltgrass area along the Rio Grande by Caballo, New Mexico. A portable rainfall simulator was used to measure sediment runoff from a dense saltgrass area and bare land at Caballo, and the results were compared. Results from the Caballo site show that sediment transport on bare land was 6 times more than that of dense saltgrass (32.2 g/L versus 5.3 g/L). The soil of bare land and saltgrass was of type sandy loam. Saltgrass at the Diez Lagos drainage canal is not fully established to test sediment transport. However, observations during the 2014 monsoon flood season show encouraging results in reducing soil erosion along the bank of the canal.

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Cost-efficient Detection of Endocrine-Disrupting Compounds in Drinking Water

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Poster Abstract 34

New Mexico has recently increased its utilization of surface water through projects such as the San Juan-Chama Drinking Water Project. This may increase concentrations of certain drinking water contaminants, such as endocrine-disrupting compounds (EDCs), which are known to be enriched in surface water sources. EDCs are a diverse group of xenobiotic chemicals which can disrupt normal hormonal function at concentrations as low as several parts per billion, however, to detect these concentrations it is necessary to employ time-consuming and expensive processes such as gas chromatography-mass spectrometry (GC-MS). In this project we aim to develop a more rapid and economical sensing method for EDCs using aptamers, sequences of DNA which are selected to bind a target. A sensitive and specific aptamer has previously been developed for the well-known EDC bisphenol-a (BPA) and this aptamer will be used to create a microarray sensor. To do this BPA aptamer will be immobilized on a surface, and the fluorescence of an attached fluorophore measured before and after binding of BPA at various known concentrations. Fluorescence should decrease upon BPA binding. In this way a calibration curve describing this decrease relative to concentration can be constructed and used to interpolate unknown concentrations of BPA in a sample. This microarray would be reusable over several to many measurements, would cost less than two or three GC-MS measurements, and would provide results very rapidly.

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Los Alamos National Laboratory Modular Pumped Hydro Feasibility Study for Santa Fe Community College

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Poster Abstract 35

LAUR-14-27902. Recently installed renewable energy produced onsite at Santa Fe Community College (SFCC) through a 1.5 MW solar array will help SFCC reduce its overall electrical usage by 34% to 44% as part of their sustainability plan. The reduction in demand translates into a yearly savings of 174 k$ to 200 k$. Due to the natural variation of daily solar and demand remaining high later in the evenings, a significant peak in demand during on-peak hours is still present. This peak results in a hefty surcharge from the utility above a 500 kW threshold. Los Alamos National Laboratory partnered with SFCC to perform a feasibility study that investigated if Modular Pumped Hydro (MPH) could eliminate or reduce this surcharge and enhance the learning environment. MPH has operational characteristics that make the technology very desirable to use, such as being at least 70% efficient, able to start without grid voltage, reach full power in under a minute, swing from full power production to full energy storage in under 15 minutes, operate at partial load, integrate with existing water systems, and both produce and store energy at the same time. MPH is a sustainable technology that produces no emissions or solid waste, utilizes lined and covered artificial reservoirs' resulting in zero net water consumption, and utilizes a variety of brackish or fresh water conditions. The feasibility study concluded that a 3.1 MWh rated MPH system would be a viable sustainable option, including educational opportunities, resulting in approximately 100 k$/yr savings.

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Fire Ash Influences on Aquatic Primary Producers Through Changes in Water Quality

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Poster Abstract 36

Fire is an important ecological factor in many terrestrial ecosystems, resetting the growth of the ecosystem to an early successional stage. The ash that is produced is often processed within the ecosystem, however with an increase in fire severity and return rates due to decreased precipitation, the ash may be transported into waterways. Few studies have been done on the impacts of fire ash on water quality and even fewer on the impacts of primary producers. Algal communities are an important basis for regulation of water quality and decreases in primary production can cascade in the food web and may cause changes in ecosystem function. The objective of my study is to examine the growth rates of algae that have been grown in fire ash leachate. The study will focus on pH changes caused by fire ash leachate which are expected to occur when the amount of ash entering a waterway exceeds the ability of the natural fauna to stabilize the ecosystem. I will be examining various taxa of diatoms, which are often the most prevalent and diverse type of algae in waterways, for their resilience to ash bound molecules. My expected results are that based on key differences in taxa such as internal nitrogen fixation or carbon skeleton stalks, the diatoms will each react differently to the fire ash leachate than the culture that they were initially grown in.

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Evaluating the Impacts of Particulate Matter Deposition on Snow Melt Processes in the Upper Rio Grande

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Poster Abstract 37

In the Rio Grande Valley, municipalities and farmers rely heavily on water from snowmelt that is captured in dams and released at later times for consumption. Yet, little data is available regarding snowmelt processes for mid-latitude sites, especially south of Colorado. One aspect of snow energy balance that requires further inspection in the Rio Grande Basin, due to its arid nature, is the deposition of particulate matter on snowpack related to albedo decay. The deposition of particulate matter on snowpack is known to decrease the time to melt by increasing absorption of electromagnetic radiation and can lead to significant deviations from theoretical albedo decay, commonly used in snowmelt models. The purpose of this research is to understand how particulate matter deposition on snowpack effects snow energy balance and time to melt. Shortwave radiation will be measured with a net radiometer and biweekly measurements of shortwave and near infrared electromagnetic radiation with a spectrometer during the 2014/2015 winter. The data collected will be used to calculate theoretical and actual albedo decay, with each being used as a parameter to model snowmelt. Dust-on-snow events are likely to occur more frequently with climate change and have the potential to significantly impact time to melt and water budget.

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A Comparison of Precipitation Models for a Statewide Water Assessment of New Mexico

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Poster Abstract 38

Precipitation is the largest component of the water balance in New Mexico as well as being the primary driver of many important hydrologic processes such as groundwater recharge. Although much of the state is arid and receives less than 10 inches of rainfall annually, some areas in higher elevations receive over 20 inches. Currently, estimates of precipitation are based solely on limited and irregularly spaced gauges. Although they can be accurate, it is not practical to monitor a continuous network of thousands of gauges across the state. Therefore, a need to better assess the quantity and distribution of precipitation in the state exists. The NM Water Resources Research Institute is currently funding a statewide water assessment in cooperation with water managers and educational institutions around the state. The goal is to better quantify and understand the variation of our most precious resource both spatially and temporally. As part of this, four precipitation models including: PRISM (Oregon State University), CHIRPS (University of California Santa Barbara), AHPS (National Oceanic and Atmospheric Association/National Weather Service), and TRMM (National Aeronautics and Space Administration) will be compared against independent rain-gauge networks. The objective of this study is to provide a more comprehensive estimate of precipitation, in a spatially continuous statewide format, at a monthly and yearly temporal resolution. This will allow hydrologists and modelers to better assess the resources we have,and to further the hydrologic and allied sciences in the Southwest.

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Chlorine Tolerant Perfluorinated Reverse Osmosis (RO) Membranes by Solution Processing

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Poster Abstract 39

Membrane-based water purification technology such as reverse osmosis (RO) or nanofilitration (NF) has been recognized as energy-efficient, cost-effective, and environmentally friendly approaches for producing clean water. Polyamide (PA)-based RO membranes are currently widely used in the desalination market and water treatments for municipal and industrial water and waste waters due to their high water flux and salt rejection. However, PA membranes suffer from poor chlorine resistance when the membranes need the continual exposure to disinfection process. Such vulnerability of PA membranes would lead to the deformation in the polymer chain or cleavage of the amide linkages, which results in irreversible performance loss. Thus, the additional dechlorination step is required to prevent chemical degradation of the membrane which leads to the increase of processing cost.

In this work, a highly chlorine-tolerant perfluorinated polymer thin film composite (TFC) membranes is developed for RO applications. The composite membranes were composed of an active thin-film layer of perfluorinated polymer and a supporting layer of commercially available ultrafiltration (UF) substrate. For the selective active layer of TFC, we have developed dispersion technique for perfluorinated polymers that enables to fabricate solution processible, mechanically tough, good adhesive and ultra-thin perfluorinated membranes. Moreover, the dispersion technique can make the traditional RO membrane manufacturing process even simpler with total process cost reduction of the membrane-based water purification systems.

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Water Quality Data Submittals - NMED Call for Data

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Poster Abstract 40

The New Mexico Environment Department, Surface Water Quality Bureau (SWQB) defines water quality standards, monitors nearly all surface waters in the state, determines attainment of standards for those waters, and writes permits and restoration plans to preserve water quality. The monitoring staff are responsible for collecting water quality data across the entire state of New Mexico and employ an 8-year rotating basin strategy that focuses on intensive sampling within a given watershed each year.

To augment the state's water quality collection efforts, the SWQB collaborates with outside groups whenever possible, offering training, supplies, and support. SWQB has a formal process to collect and submit data, and requires that groups wishing to submit data have a SWQB-approved Quality Assurance Project Plan before monitoring to ensure operating procedures and quality assurance protocols are compatible and the data can be used by the SWQB.

For groups that would like to establish or augment a monitoring program, SWQB is currently exploring ways to provide support through guidance and training, equipment purchase and loaning, and assistance with chemical analysis. SWQB has also created a quality assurance and quality control documentation template to assist with program development and ensure compatibility with SWQB data criteria.

More information about the data submittal process and collaborating with SWQB is found on the SWQB website: http://www.nmenv.state.nm.us/swqb/DataSubmittals/

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Assessment of Water Table and Water Quality Variations with Respect to River Flow Along Rio Grande River

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Poster Abstract 41

This study examines water quality variations and water table depths along the Rio Grande River between Garfield NM and Fabens TX. Approximately 58 observation wells located in Garfield, Hatch, Las Cruces, Anthony in NM and down to Fabens, TX are being sampled on a near monthly basis. Water samples are analyzed for concentrations of selected dissolved solids (magnesium, sodium, calcium and potassium) as well as electrical conductivity and sodicity. Also, river water from Garfield NM and Fabens TX are being sampled for similar analysis. A model will be developed to describe the influence of the river on the water aquifers; and develop a water budget to identify the influence of surface and groundwater interaction on water quality

.Data collected in May through August 2014 indicate a decline in well water levels and an increase in water salinity across portions of the study area. We will provide an extensive dataset that will help to determine if claims by water users on well water levels and water quality are correct and also provide data that can be used for planning and decision making

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Use of a Geoengineering Technique to Re-vegetate Riparian Areas of the Desert Southwest

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Poster Abstract 42

Rehabilitation of saltcedar-managed riparian areas in the Southwestern United States has had limited success due to the lack of soil moisture, timing of precipitation, and inaccessibility to groundwater. A field pilot-scale experiment was conducted at Las Palomas, NM along the Rio Grande River using a geoengineering material to re-vegetate a riparian area previously cleared of invasive riparian saltcedar (Tamarix spp.). A methodology using a geoengineering technique was used to raise water from the shallow groundwater table, by capillary action, to the root system of the plants. Two types of grasses [Sporobolus wrightii (giant sacaton), Distichlis spicata (saltgrass)] and two shrubs [Baccharis emoryi (Emory's baccharis), Attriplex canescens (fourwing saltbush)] were used in the experiment. Treatments of 8 individual plants were transplanted in two 20 m x 20 m plots in either geoengineering media or native riparian soil (4 species x 2 substrates x 8 specimens in each plot). Survival rates, depth to groundwater, and soil moisture were monitored during 2012 and 2013. Depth to groundwater at the site fluctuated between 1.9 m to 3.3 m. Of the four species, saltbush had the highest survival rates ranging from 80 to 100%, for both substrates and plots. Emory's baccharis specimens had significantly higher survival rates in the geoengineering media than those in the native soil for both years in the plot where groundwater was shallower (1.9 m–2.8 m). Results for giant sacaton and saltgrass were inconclusive due to the decline of groundwater which caused a disconnection between geoengineering material and underlying water table

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Addressing Groundwater Level Changes in New Mexico

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Poster Abstract 43

Changes in groundwater levels can reflect very relevant water issues in the arid southwest, such as variations in nearby surface water, fluctuations in recharge, and changes in groundwater storage. As collaborators from NM Bureau of Geology and Mineral Resources/NM Tech, U.S. Geological Survey, NM Office of the State Engineer and NM State University, we seek to address the groundwater storage change component of the Statewide Water Assessment initiated and funded by the NM Water Resources Research Institute.

Our objective is to quantify changes in groundwater levels and groundwater storage in regions of New Mexico. We are currently compiling high quality groundwater-level data into an ArcGIS-database. We will then use these data to develop regional groundwater-level change contour maps over selected time intervals. The intervals of assessment are based on the frequency of the measurements for the particular region, such as 5 to 10 year intervals. Finally, we will use the contour maps and estimates of aquifer properties to quantify regional changes in groundwater storage.

We are in the data compilation phase of this project. The interpretation of groundwater-level measurements is complicated by the irregular spatial and temporal distribution of the data and New Mexico's complex geology. In some regions, our study highlights data gaps where future work is needed. Documenting changes in groundwater levels can identify areas where water-quality changes may be imminent, may help initiate additional water conservation efforts, and provides the State with a useful tool for groundwater quantity and quality management.

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Comparison of Precipitation and Evapotranspiration Products for NM Statewide Water Assessment

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Poster Abstract 44

Precipitation and evapotranspiration (ET) are the major components of the water balance in New Mexico. Therefore, it is critical to acquire accurate precipitation and ET data as input into a statewide water balance. Meteorological stations collect precipitation and ET data, however uneven distribution of existing stations in New Mexico leave many areas without accurate information. We intend to evaluate the performance of remotely sensed and interpolated models that predict and quantify the spatial and temporal distributions of precipitation and ET. We will compare five precipitation products and three ET products, from a variety of agencies and methods, against one another to determine the model that performs better than the others for each component. Early results show a strong relationship between all precipitation products across the state of New Mexico from 2000 to 2013 with an average mean of 314 mm, except for the PERSIANN model which has a rainfall mean approximately 114% higher (673 mm) than the average of the other models. Additionally there is a strong relationship between the ALEXI and SSEB ET models, yet the average mean of these models (485 mm) exceeds the precipitation models average by approximately 54%. The MOD16 ET model has an average mean value (181 mm) approximately 74% less than the average of the precipitation models and 168% less than the average mean of the ALEXI and SSEB ET models. Future work involves the validation and quality control of the chosen precipitation and ET models.

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The Effect of Soil Moisture, Runoff and Infiltration on Understory Density in a Pinyon-Juniper Woodland

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Poster Abstract 45

It is hypothesized that an increase in grass cover in pinyon-juniper woodland areas may increase infiltration of water into the soil; reduce soil erosion and surface runoff. The study will be conducted near Santa Fe, New Mexico and will consist of six small watersheds in which data will be collected to obtain a hydrological evaluation of the area. Remote hydrological sensor instrumentation will be implemented in the six watersheds. The sensors will be used to gather runoff information, moisture in the soil and rainfall in order to understand understory responses to these variables. Half of the watersheds are thinned the other half are not, making them a treatment and control, respectively. Time domain reflectometry probes will be used to measure the amount of moisture found within each watershed. Precipitation data will also be collected using a rain gauge located within four of the six watersheds. The objectives of the project will be (1) to determine the rate of infiltration that is postulated to increase grass cover and reduce soil erosion as well as amount of runoff, and (2) to compare the control and treatment watersheds. The importance of the project will be to find the effect of density of pinyon-juniper trees on soil moisture, infiltration, and runoff.

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Watershed Condition Framework and Interactive Map

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Poster Abstract 46

The Watershed Condition Framework (WFC) was developed in 2011 by the USDA Forest Service as a consistent, comparable, and credible process for proactively implementing restoration efforts on priority watersheds on national forests and grasslands. The WFC uses a six-step approach to improve the health of Sixth-level HUC watersheds: Classify, Prioritize, Develop, Implement, Track, and Verify. Priority watersheds are classified and ranked as Class 1 Functioning Properly, Class 2 Functioning at Risk, or Class 3 Impaired Function. The Watershed Restoration Action Plan (WRAP) is developed to identify comprehensive projects that would improve watershed conditions. After implementation and completion of all projects in the WRAP, the priority watershed can then be reclassified to an improved state. The accomplishments are tracked for performance accountability and verification through field monitoring of the watershed and stream conditions. Recently in 2014, the Upper Spring Valley Wash on the Kaibab National Forest in Arizona completed all seven essential projects planned in the WRAP, and transitioned from a Class 3 to a Class 2 Priority Watershed. The Interactive Map online allows users to view the priority watersheds, read why the watershed was selected, download the WRAP and understand other important planning items. This interactive mapping capability provides current and future partners with important information on potential needs for watershed restoration and will also increase the public's awareness of their local watershed conditions and the role they can play in improving them.

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Test of the New LAS MkII Scintillometer for Validation of Statewide New Mexico ET Maps

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Poster Abstract 47

New Mexico WRRI is in the process of improving the quality and temporal resolution of the water quantity and availability data that are needed by water resource managers. Evapotranspiration (ET) is an important component of this water budget, but estimating ET at the km-scale using traditional methods is difficult as well as costly. We propose the use of scintillometry to measure sensible heat flux (H), which can be combined with radiation meters or remote sensing measurements of net radiation (Rn) to calculate latent heat flux as LE=Rn-H, assuming the daily ground heat flux is zero. Kleissl et al. (2008) found significant inter-instrument bias, 5% to 20%, in measurements of H with the first generation Kipp & Zonen Large Aperture Scintillometers (LAS). Kipp & Zonen have since developed a retrofit for the first generation LAS that greatly reduces inter-instrument bias (1-3%). But we must first confirm that the bias is indeed reduced in conditions typical of New Mexico before wide scale implementation. H measured with a retrofitted first generation scintillometer over a 500m homogeneous desert transect in the Sevilleta National Wildlife Refuge will be compared with H measured with an Eddy Covariance station in the center of the transect. Based on promising results from testing in the Netherlands and UK, we expect to observe reduced instrument bias. Once validated for use in New Mexico our research group will be able to redeploy the New Mexico scintillometer network to assist ongoing efforts to validate operational ET products for the Statewide Water Assessment.

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The Detection of Antibiotic Resistant Bacteria (ARB) in the Gallinas River

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Poster Abstract 48

Five sites will be sampled along the Gallinas River: Site 1 above the Santa Fe National Forest boundary (no human influence); Site 2 downstream before the City of Las Vegas (agricultural influence above); Site 3 water from water treatment plant (WTP); Site 4 above the waste water treatment plant (WWTP); and Site 5 downstream from the WWTP (reentrance into the Gallinas River). Samples will be taken seasonally (fall 2014-fall 2015). Standard methods will be utilized for culture of water for Escherichia coli (E. coli). Pure cultures will be verified on Eosin-Methylene Blue (EMB) plates. Growth characteristics of E. coli via EMB plate method provides a highly probable identification of E. coli. A combination of the following tests will be utilized to confirm E. coli isolates (>98-99% accuracy): Triple Sugar Iron agar test (TSI), Citrate Utilization, and/or via the Indole test. Upon preservation of E. coli isolates, antibiotic resistance of twelve (12) commonly prescribed human and animal antibiotics will be tested using the Kirby-Bauer method. I anticipate the presence of antibiotic resistant E. coli isolates will be greater in number the further downstream the Gallinas River (human influence) in addition to the number of multi-drug resistant E. coli.

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Enhanced Photocatalytic Water Treatment Using Immobilized Nanocomposite Thin Films

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Poster Abstract 49

An innovative photoreactor was designed, characterized and investigated for degradation of organic contaminants in water. Polymer assisted hydrothermal deposition method was employed to coat TiO2 and dope metals to TiO2 thin films on optical fibers as a means of light transmission medium and photocatalysts support. The photocatalyst films were characterized using scanning electron microscope, energy-dispersive X-ray spectroscopy, and X-ray diffraction. The photocatalytic activities of the photocatalysts were studied by the degradation of Rhodamine B, a dye of which the concentration can be quickly quantified by a spectrophotometer.

Experimental results showed that doping metals in TiO2 thin films expanded the light utilization efficiency from UV to broad visible light spectrum, significantly increasing the photocatalytic efficiency. The coupled adsorption and photocatalytic degradation of Rhodamine B follows the Langmuir-Hinshelwood kinetic model. To investigate the long-term sustainability of the synthesized photocatalysts for water treatment, the method for reactivation of the used catalysts was studied.

The work supports the future study of investigating the removal of environmental contaminants from impaired waters such as contaminated surface water, groundwater and reclaimed water using solar energy. This type of photoreactor will be suitable for arid and semi-arid regions because of abundant solar resources, ease of operation, and minimized water loss in a closed treatment system.

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Climate Change Adaptation Plan for the Santa Fe Water Supply

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Poster Abstract 50

The City and County of Santa Fe have partnered with the Bureau of Reclamation on a Basin Study for the Santa Fe Watershed, and other components of the water supply for the city and county. The study partners evaluated the impact of climate change on water supply and demand, and worked to develop adaptation strategies. The Preliminary Assessment, completed in 2012, summarized impacts in the watershed on forest health, fish and wildlife, food security, land use, transportation, and other factors, and presented strategies to minimize impacts compiled at a public forum. The impacts on the city and county's municipal water supply portfolio was evaluated in more detail, using climate projections developed by Reclamation, the water operations model URGSiM, and the city's Water Management and Planning Simulation (WaterMAPS) model, which simulates surface and groundwater supplies, water demand, water rights, system capacities, and water storage contracts. The Santa Fe water supply portfolio includes both surface water and groundwater sources. The surface water supply in the area is highly variable and the groundwater is mined from aquifers that are slow to recharge. The population continues to grow and the needs of the community continue to expand. A suite of potential development and water management scenarios were simulated, and used to generate probabilistic outputs to support planning for a more resilient, sustainable, and innovative water supply system. This Basin Study is the latest in a series of efforts to understand and strengthen water supply management in the Santa Fe area.

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Treatment and Beneficial Use of Produced Water

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Poster Abstract 51

Produced water management is a major challenge to oil and natural gas exploration and production, in particular for unconventional development. Rapid development of oil and gas production, regulations, water scarcity, concerns of environmental impacts, and limited disposal options are driving producers to consider, plan and change their current hydraulic fracturing and produced water management methods. Development of beneficial use of produced water has become a new trend for sustainable oil and gas production. Treatment and beneficial use of flowback and produced water can minimize environmental impacts, reduce demands on local water supplies, increase economics, and meet regulatory requirements.

New Mexico is experiencing rapid development of unconventional oil and gas, especially in Permian Basin, where oil is the major product and horizontal drilling is adopted widely. Water use in oil and gas industry in New Mexico is about 0.059% of total water use in the state. New Mexico State regulated produced water as hazardous waste, which allows only onsite water reuse and deep well is the primary disposal method. However, produced water beneficial use potential is expected high due to water shortage and environmental concerns. The presentation discusses the factors affecting the feasibility of beneficial reuse including water quality and quantity, appropriate treatment technologies, economics, disposal options and capacities, environmental impact, and regulations.

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Effects of Turbidity on Group Cohesion in Sand Shiners and Red Shiners from the Pecos River in New Mexico

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Poster Abstract 52

Turbidity varies considerably in the waters of New Mexico. Generally, turbidity levels will be high in eutrophic (nutrient overloaded) waters. In lotic environments, turbidity levels also tend to increase during strong rains by stirring up suspended materials. Although turbidity is known to influence feeding and growth in fishes, little is known about behavioral changes and group cohesion in fishes in turbid waters. I hypothesize that turbidity will increase both intraspecific and interspecific group cohesion in fishes from the Pecos River, NM. A "test arena" will be constructed using a two m circular tank. Replicable turbidity will be created by placing bentonite clay per L water; and the water depth in the tank will be kept to 1 – 1.5 cm so that fishes may be seen from above. Fishes will also be injected with a sub-dermal spot of brightly-colored, non-toxic latex paint on the dorsal surface of the caudal peduncle to facilitate observation. After acclimation, photographic samples will be collected in five-minute observation periods, and the distance between fishes will be collected and recorded. I expect to see a significant decrease in the inter-fish (for intraspecific and interspecific groups) distance as turbidity increases. I expect that adding predator pheromones will decrease inter-fish distances even more. The significance of this study is that it will allow us to understand the influence turbidity has on group dynamics in two species of fishes commonly found in the Pecos River, NM. Basic knowledge of fish behavior will be gained through the testing of my study.

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Energy-Positive Produced Water Treatment Using a Microbial Capacitive Desalination Cell

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Poster Abstract 53

The rapid development of unconventional oil and gas production has generated large amounts of wastewater for disposal, raising significant environmental and public health concerns. The United States Department of Energy estimates that 3.3 billion m3 of produced water are generated per year, a number that is expected to rise with the global energy demand. Treatment and beneficial use of produced water have been hindered by the intensive energy consumption and capital costs. To address the energy and water issues, a microbial capacitive desalination cell (MCDC) - an innovative bioelectrochemical system integrated with capacitive deionization - was developed and the feasibility of the system in treating real produced water was investigated.

Produced water is mainly sodium chloride with a total dissolved solids concentration of 15,870 ± 290 mg/L and the chemical oxygen demand concentration ranging from 800 to 1100 mg/L. Sorption and biodegradation resulted in a combined organic removal rate of 6.4 mg DOC per hour in the reactor, and the MCDC removed 65% salt (36 mg salt per gram of carbon electrode) from produced water. Over each desalination cycle, the energy harvested from the regeneration of the carbon electrode yielded 36 mJ/m2 of electricity. These results demonstrate the MCDC's ability to consistently remove salt and organics from produced water over consecutive runs while maintaining a stable electrical production. Compared to conventional wastewater treatment technologies that consume significant amount of energy, the MCDC is an attractive option for organic degradation and desalination of highly contaminated produced water without external energy input.

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Real Time Monitoring of Flood Control Dams for Emergency Action Management

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Poster Abstract 54

Many dams across the United States and in New Mexico are consider to be deficiently designed and built for their current hazard classification, and are not in satisfactory conditions. Engineers are faced with the task of addressing and resolving these deficiencies while also facing major infrastructure funding gaps. Since the dams are known to be inadequate, monitoring their status during potential flood events is critical for alerting downstream residents, thereby limiting the potential consequences of major outflow or failure. For this project, we will be exploring safety instrumentation with two case studies in southern New Mexico's Mesilla Valley. They are Broad Canyon Dam north of Las Cruces and Apache-Brazito-Mesquite Dam 1 (ABM 1) to the south of Las Cruces.

The objective of this research project is to identify, classify, and analyze the case study dams based on capacity, storage, and inflow. Data will be collected via remote sensors (piezometers) that will be positioned at various elevations of the dams. Data will be transmitted in real time to Elephant Butte Irrigation District (EBID) headquarters using their existing radio telemetry system. This data would be used to determine the volume in storage, rate of rise of the water in the dam as well as normal and auxiliary spillway flow rates. Using this data, an effective early warning alarm system will trigger emergency plan execution for emergency flood management downstream of the dams. The data type, alarm criteria, and instrumentation used on these two dams could then be generalized and used as a guide for the monitoring of other dams in the state of New Mexico and the United States.

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