60th Annual New Mexico Water Conference Poster Abstracts

New Regional Transboundary Integrated Hydrologic Model, New Mexico, Texas & Mexico

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Poster Abstract 1

The Palomas, Mesilla, and Conejos-Medanos Basins in New Mexico, Texas, and Mexico comprise a geologically and hydrologically complex region. Conjunctive use of surface-water and groundwater occurs under a myriad of legal and operational constraints, including the Rio Grande Compact, an international treaty, and the Bureau of Reclamation's Rio Grande Project. New demands are being placed on the interconnected water system, even as the region is experiencing an extended drought. Conjunctive use, adaptation, and sustainability analysis of the use and movement of water in these basins is made possible by an integrated hydrologic model capable of tracking three-dimensional movement of groundwater and the combined effects of surface-water and groundwater use on water availability in the context of changing land use, irrigation practices, and crop distributions, as well as variable climate. To better understand the complex hydrogeologic flow system and to support ongoing resource management decisions, the U.S. Geological Survey (USGS) in cooperation with the Bureau of Reclamation is developing the Rio Grande Transboundary Integrated Hydrologic Model (RGTIHM). The RGTIHM uses the USGS MODFLOW One-Water Hydrologic Flow Model (MF-OWHM) to build on previous hydrologic modeling efforts. The refined model will be an integrated tool capable of simulating the use and movement of water across the landscape and assessing the surface-water/groundwater exchange in the study area. Model development includes expansion of the model domain to encompass a larger geographical area; spatial and temporal refinement of the model grid and stress periods; refinement of the water-use framework; and improved dynamic simulation of water-management alternatives

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Mutually Beneficial and Sustainable Management of Ethiopian and Egyptian Dams in the Nile Basin

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Poster Abstract 2

Ongoing pressures from population growth, recurrent drought, climate, urbanization and industrialization in the Nile Basin raise the importance of finding viable measures to adapt to these stresses. Four tributaries of the Eastern Nile Basin contribute to supplies: the Blue Nile (56%), White Nile-Albert (14%), Atbara (15%) and Sobat (15%). Despite much peer reviewed work addressing conflicts on the Nile, none to date has quantitatively examined opportunities for discovering benefit sharing measures that could reduce impacts on downstream water users resulting from new upstream water storage developments. The contribution of this paper is to examine the potential for mutually beneficial and sustainable benefit sharing measures from the development and operation of the Grand Ethiopian Renaissance Dam and the Egyptian High Aswan Dam. An integrated approach is formulated to bring the hydrology, economics and institutions of the region into a unified framework for policy analysis. A dynamic optimization model is developed and applied to identify the opportunities for Pareto Improving measures to operate these two dams for the four Eastern Nile countries: Ethiopia, South Sudan, Sudan, and Egypt. Results indicate a possibility for one country to be better off and no country to be worse off from a managed operation of these two storage facilities. Still, despite the optimism of our results, considerable diplomatic negotiation among the four riparians will be required to turn potential gains into actual welfare improvements.

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Allelopathic Competition Between Algae: Mechanisms and Potential Mitigation

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Poster Abstract 3

Algae cultivation has garnered much interest for its potential in biofuel production, food and pharmaceutical industries, and wastewater treatment. Algae selected for biofuel typically have a fast growth rate, are easy to maintain, and require less land and water compared to terrestrial crops used for biofuel. As freshwater is a valuable and limited resource, exploring more efficient methods of biofuel production is logical. The United States Southwestern regions have received particular attention as locations for such algae research due to high solar input. However, invading microbial predators, competitors, and infectious agents currently afflict outdoor algae cultures by causing algae population crashes. Here, we focused on allelopathic interactions between algae competitors. Some algae have the ability to exude an allelopathic chemical that inhibits growth of its competitors. We found that biofuel alga Chlorella sorokiniana is inhibited by invader Coelastrella spec. via an allelopathic chemical, although chemical composition and mechanisms of inhibition are poorly understood. We bought a commercially available allelopathic chemical (gramine) and exposed C. sorokiniana to various concentrations at different temperatures. We found that inhibition response by C. sorokiniana is concentration dependent. Furthermore, effectiveness of the allelopathic chemical varies with temperature. Early detection of an invasive competitor might be key for mitigation and salvage of the biofuel algae culture.

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Water Stewardship Partnerships Restoring Watersheds on the Carson National Forest

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Poster Abstract 4

National forest and grasslands produce abundant, clean water to sustain ecosystems and enable communities to prosper. USDA Forest Service employees and partners protect, maintain, and restore a variety of healthy, biologically diverse ecosystems to provide for resilience and adaption to changes in climate, land use, population, and user demands. They ensure that waters on National Forest System lands support designated uses in the quality, quantity, and timing necessary for providing water for multiple uses. Collaborating with partners, we apply a watershed perspective to help ensure that public and private lands function effectively to collect, store, filter, and deliver high-quality waters that sustain people and the resources on which they depend. Examples of collaboration are highlighted in two projects in the Carson National Forest. The Carson is collaborating with other agencies and private entities to grow a premier water stewardship partnership that frames common goals and shared interests in Forest Service priority headwaters in two watersheds. One project, Placer Creek Wetland Restoration Project (2014) addressing extensive erosion and head cutting into an adjoining meadow wetland, which was causing loss of groundwater storage, drying of wetland vegetation, and loss of valuable wildlife habitat. The second project, Comanche Creek Native Trout Habitat Restoration Project (2015) is addressing impacts caused by logging, road building, and heavy grazing. Successful implementation of these projects is improving the ecosystem health of the watershed, improving water capacity of the wetlands, and stabilizing groundwater losses.

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Monthly Comparisons of ET for New Mexico

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Poster Abstract 5

At the 2014 Water Conference, we presented comparisons of annual estimates of total ET for the entire state using satellite data with the annual rain fall. We found that two of the estimates, based on the remotely sensed data, were higher than the rainfall totals for the years from 2000 to 2013. To get a better understanding of why the ET estimates were higher, we compared monthly estimates of the remotely sensed ET with ground based measurements at 6 eddy correlation tower sites in the state. These towers were operated by Dr. Marcy Litvak from UNM and these data are available for the years 2007 to 2010. The two models evaluated were the ALEXI (Atmosphere-Land Exchange Inverse) model , which utilizes the thermal infrared data available every 30 minutes from the GOES series of weather satellites, and the SSEBop (Simplified Surface Energy Balance operational) model, which uses surface temperature data from the MODIS instrument on NASA's Earth Observation Satellites (TERRA & AQUA). ALEXI produces ET estimates daily at 4 km spatial while SSEBop produces monthly estimates at 1 km resolution. Both models are producing ET estimates on a quasi-operational basis for the entire US. We found good agreement at the two desert sites within the Sevilleta Wildlife Refuge, but poor agreement for two forested mountain sites in the Valles Caldera. For the latter, the two models overestimated the ET. ALEXI was high for the entire year, while SSEBop was high only in the warmer months.

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Gila National Forest Plan Revision: Assessment of Water Resources

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Poster Abstract 6

Land and Resource Management Plans, or Forest Plans, are required to be revised periodically under the National Forest Management Act (1976). These plans are not site specific, but provide broad, overarching guidance for all management activities conducted on the Forest. All site specific projects, uses and activities must be consistent with plan direction. The Gila National Forest is currently in the initial phase of revising its 1986 Forest Plan. This initial phase is a rapid assessment of existing information to determine current condition, trend and risk to the sustainability of ecosystem services provided by the forest. The ecosystem services approach provides for integration of ecological and socioeconomic values. Topics specific to the analysis of water include watersheds, aquatic and riparian/groundwater-dependent ecosystems, soil and water resources, dominant ecological processes, disturbance regimes and stressors. Assessment methodologies include comparison of current conditions to the historic range of variation or potential natural condition, regulatory criteria or thresholds, representativeness and redundancy analyses, and qualitative assessments. Forest Service data, as well as data from other federal agencies, state, county and local governments and non-governmental organizations, will be considered. Significant changes in resource conditions, uses and demands, social and cultural influences, science and technology have occurred since 1986. The assessment will provide the basis for identifying the need for change to the 1986 plan and aid in the development of the revised plan. A draft assessment report is expected to be released for feedback in the summer 2016.

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Small-Scale Thermal Desalination of Brackish Water Using Biomass Energy

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Poster Abstract 7

Multiple effect distillation (MED), is the oldest thermal desalination process and has a typical plant capacity of 600 to 300,000 m3/day. Because MED units do not use membranes, the capital cost, system complexity, and maintenance costs are usually lower than those for reverse osmosis (RO) systems. The integration of renewable energy with desalination is especially suitable for remote areas and areas lacking connection to electrical energy grid infrastructure. In situations where very small plant capacities are needed and where significant amounts of local biomass residues are available and underutilized, biomass use may be feasible alternative to other renewable energy sources. We have designed and conducted Aspen Plus® process simulations on a biomass pyrolyzer-MED interface targeted for small rural communities and farmers in the southwestern U.S. As a part of that project, we designed and fabricated a lab-scale smooth-tube MED system to study scaling behavior as a function of water chemistry. As a next step, we will be working on improving MED performance and reducing produced water cost. To do so, we will design and fabricate one MED effect with enhanced-geometry tubes to be incorporated into our current MED unit in order to quantify the improvement. Also, heat exchangers will be designed for between the effects to pre-heat the brackish feedwater to prevent excessive temperature drops within the MED. We will use Aspen Economic Evaluation® software to estimate MED unit capital and operating costs.

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WC-Wave Virtual Watershed Platform-Architecture, Functionality, and Capabilities

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Poster Abstract 8

New Mexico has partnered with water researchers in Nevada and Idaho to create the WC-Wave Virtual Watershed, a collaboration tool for secure data storage and processing, modeling, and visualization. The Virtual Watershed platform, developed at the UNM Earth Data Analysis Center, provides a service-oriented architecture of distinct data management, services, and client tiers. Data management offers geospatially enabled object-relational, document-based, and metadata-search databases, as well as file-based storage. Services include RESTful Web services for client (e.g., Web applications, desktop GIS, analytic tools) data discovery and access, ingest and delivery, search and retrieval, and transformation.

The Virtual Watershed's design accommodates numerous scientific data types and model inputs and outputs (I/O), and transforms data formats; for example, the platform ingests iSNOBAL native binary files and outputs binary format and the transformed GeoTiff format. GeoTiff images then can be used in visualization environments. Similarly, vector data sets can be delivered as shapefiles, CSV files, and Excel spreadsheets. Data transformation services allow the straightforward processing of a series of models or operations in a single work flow. Moreover, the Virtual Watershed facilitates the addition of new data and products as researchers' project needs evolve. All of these capabilities constitute the architectural and functional basis for the seamless linking of diverse watershed models that natively employ different I/O data formats. Virtual Watershed data and images need no longer be isolated on an individual researcher's computers. The result: Enhanced data and model development, and data sharing, exchange, and re-use.

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A Dynamic Statewide Water Budget for New Mexico

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Poster Abstract 9

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. During the previous year, work has been started on a dynamic, statewide water budget (DSWB) that integrates information from a variety of sources including United States Geological Survey's (USGS) surface water gages and groundwater models and reports, the New Mexico Office of the State Engineer's (NM-OSE) reports on water use, and the NM-OSE-Interstate Stream Commission's regional water plans. The DSWB has begun to organize this information in a way that can provide planners, law-makers, engineers, and members of the interested public alike easy access to a quantitative r representation of water movement and use throughout the state. The goal of the DSWB is to represent a high level picture of water resources and use in New Mexico via an easily accessible dynamic software platform.

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The Next Generation of Evaporation Pans

WITHDRAWN

USGS National Water Census: Upper Rio Grande Basin Focus Area Study

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Poster Abstract 11

Increasing demand for the limited water resources of the United States continues to put pressure on water-resource management agencies to balance the competing needs of ecosystem health with municipal, agricultural, and other uses. The Upper Rio Grande Basin (URGB) of Colorado, New Mexico, Texas, and northern Mexico has been chosen as a focus area for the USGS National Water Census, called for in the SECURE Water Act and implemented through the Department of the Interior WaterSMART initiative. Water availability in the URGB will be assessed for 2010–2015 through the investigation of four selected components of a water budget at a hydrologic unit code 8-digit spatial scale: water use (including evapotranspiration), surface water, groundwater, and surface-water/groundwater exchange. Water-use data by category will be compiled from local, regional, and state-scale sources. Actual evapotranspiration will be estimated using the Simplified Surface Energy Balance in conjunction with field verification. Surface-water availability will be evaluated through temporal trends analysis of streamflow and modeling of snowmelt processes. Groundwater availability will be assessed through the development of basin-scale hydrogeologic framework and water-level surface and change maps. Surface-water/groundwater exchange will be estimated through automated streamflow hydrograph and hydrochemical baseflow separation methods, streamflow measurements, and geochemical signatures of water. The URGB focus area study will result in spatially-distributed products by water-budget component, which will be integrated with products from other focus area studies to create a national-scale database of water availability and use.

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3D Model Lagoon using a Solar Powered Low-Cost Autonomous Surface Vehicle

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Poster Abstract 12

Laguna de Bustillos is a shallow lagoon into which all of water in the basin in which Cuauhtemoc, Chihuahua lies drains, and the Laguna has an average depth of 1.2 meters. All precipitation within the basin that does not infiltrate into the soil or evaporate drains to the Laguna. To understand the dynamics of this water body is necessary to calculate the water balance in the basin. This study proposes to establish the actual capacity of the lagoon by measuring its depth using an Autonomous Surface Vehicle (ASV). I will build an ASV. This vehicle consists of a radio control boat, a sonar sensor, onboard GPS unit, an onboard compass, and Arduino components that will allow me to automate the capture of the geo-referenced depth measurements. Then, the points will be geo-processed using a Geographic Information System tool to obtain a digital topographic map. This surface will then be used within a GIS toolbox to build a 3D model and calculate the storage volume at a given height above the bottom. I expect my results to demonstrate that it is possible to carry out a bathymetry study without buying special equipment at exorbitant prices. Two important outcomes are expected: The prototype will be capable of measuring the depth and generating coordinates automatically using a pre-established pathway. At the same time, a high-resolution three-dimensional model will be generated. Also, I expect to build an inexpensive equipment to generate unknown data, and the autonomy of the ASV is expected in 6 hours.

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Exploring the Costs of Waste Water Reuse in Inland Communities

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Poster Abstract 13

Reuse of wastewater is a hotly contested issue in many communities, and the technological issues, performance, and costs of the numerous options can be difficult for the general public to comprehend. Understanding the relationship between costs and customer acceptance begins with a clearer picture of what the costs really are in a specific context. Much research has focused on the costs of planned potable reuse of wastewater in large, coastal communities in the US, but little comparable work has been performed in arid inland areas of the Southwestern US, though the latter group arguably faces similar or worse scarcity issues. It is important to understand the inland context because there are important differences in demographics and the ability to support certain types of reuse technologies as compared to the large, coastal city context. This research which has been funded by the NMWRRI, seeks to better define the costs of seven possible potable water reuse options that are suitable for arid inland areas, including either indirect potable reuse (IPR) or direct potable reuse (DPR). These seven options are explored in detail with the conventional capital, operations and maintenance costs being reported separately and as a total present worth cost for a 20 year life span of the system. Using the inland community of Albuquerque, NM, this research will serve as the ground work for future investigations related to arid inland communities' planned potable reuse options, including how technology choices and costs affect public attitudes and perceptions.

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Use of High Resolution PRISM Data to Visualize Monthly Precipitation in New Mexico

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Poster Abstract 14

At the 2014 Water Conference, we presented comparisons of annual estimates of total precipitation throughout the state using several models that estimate annual rain fall. Of the models (AHPS-NOAA, CHIRPS-CHG-UCSB, PERSIANN-CHRS-UCI, PRISM-PCG-OSU, and TRMM-NASA), we determined that Oregon State University's PRISM dataset produced the most accurate mapping of precipitation for the state by comparing the model outputs with 34 rain gauges monitored by the Jornada Experimental Range and 10 rain gauges monitored by the Sevilleta Long Term Ecological Research. The PRISM dataset used in our comparisons was a monthly, 4km resolution dataset that had been aggregated into annual values. The PRISM Climate Group at OSU also has an 800m resolution version provided in monthly and daily increments, which we purchased for the New Mexico statewide water assessment. The daily dataset is enhanced on a pixel-by-pixel basis using Doppler radar, but is only available east of the Continental Divide and New Mexico west of the Divide has to be interpolated. This process is not performed on the monthly dataset, leading to discrepancies between aggregated daily grid values and monthly grid values. As of July 2015, this has led to the PRISM Climate Group forcing the monthly grid values to equal the daily aggregated values east of the Continental Divide. The 800-meter, monthly and daily aggregated PRISM values were compared to each other and to the sets of rain gauges at the Jornada and Sevilleta for 2000 through 2010. Spatial distribution maps and graphs were created to determine differences between all datasets.

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Applying Geochemistry to Predict Water Quality at Managed Aquifer Recharge Sites

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Poster Abstract 15

Managed aquifer recharge is an important water resource management tool being implemented at sites in New Mexico. This method uses surplus water to recharge aquifers, and to store and recover the water for later use. Predicting water quality of the recovered water is an important part of the initial site characterization. Chemical reactions of the recharged water with both groundwater and the aquifer matrix may be predicted using site-specific data. Several examples from New Mexico will be presented, illustrating the use of geochemical techniques to predict the water quality of the recovered water.

In the Santa Rosa-Chinle aquifer system, potential reactions between treated surface water and the aquifer materials that may mobilize iron (Fe) and manganese (Mn) were evaluated, and the calculated saturation indices (SI) and oxidation reactions indicate that Fe and Mn solubility should be limited during recharge operations.

In the Tesuque Formation, fluoride concentrations were predicted to exceed the U.S. Environmental Protection Agency maximum contaminant level (MCL) in the recovered water, based on fluorite solubility and mixing calculations. This information was used to identify treatment requirements for potable use of the recovered water.

In the Santa Fe Group aquifer system, arsenic concentrations were initially diluted by the injected water but quickly rebounded during recovery pumping, as a result of dissolving iron coatings on aquifer sediments, releasing iron and adsorbed arsenic into solution.

These geochemistry studies provided critical information about operations and treatment of waters recovered from these managed aquifer recharge systems.

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A Method of Estimating Storage Changes in New Mexican Alluvial Aquifers

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Poster Abstract 16

As surface water flows have wavered and societal water needs have increased across New Mexico, groundwater from alluvial aquifers has been commonly used to fill the gap. To understand how groundwater storage has changed in alluvial aquifers in New Mexico over the last several decades, we have developed a quasi-automated workflow that goes from raw depth-to-water (DTW) measurements in wells to basin-wide estimates of groundwater storage change. In New Mexico, alluvial aquifers co-occur with major rivers and basins, and are coincident with large-scale agriculture and communities. Our process begins by extracting unflagged groundwater level data from NMOSE, USGS and NMBGMR databases measured during the winter (non-growing) season. We find the correlation length of the DTW measurements during the time periods of interest using variogram analysis. To have adequate data density, we use the median groundwater level at each well during a user-defined time interval. Then, median groundwater levels for all time intervals are entered into an ArcMap workflow. This outputs gridded estimates of changes in DTW from ordinary kriging or inverse-distance-weighting interpolations that have been clipped to alluvial aquifers and are within the correlation length from at least one well. Using literature-derived specific yields and the gridded maps, we then estimate the total groundwater storage changes. We demonstrate the method in the Mimbres and Estancia basins, NM, where we have estimated roughly 2.5 million acre-feet and 0.8 million acre-feet decreases in groundwater storage since the 1950s.

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Economic Performance of Reservoir Storage Expansion for Irrigated Agriculture: Multi-Basin Analysis

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Poster Abstract 17

Variability of water supply or its scarcity in Afghanistan has serious implications for irrigated agriculture because agriculture is a major contributor to the country's GDP. In many cases, irrigation services in Afghanistan are significantly reduced or even terminated early in the summer crop season due to insufficient water at the source. Afghanistan lacks sufficient dams, reservoirs and flow control structures to adequately manage and control run off during seasons of high precipitation (King and Sturtewagen, 2010; Draft: Trans-boundary Water Issues, 2007). Subsequently, the country is susceptible to severe flooding and drought events, and over population in some areas due to uneven distribution of water.

This study seeks to assess the benefits of infrastructure improvement by river basin, storage capacity level, water sharing arrangement, and crop for a 20 year time horizon. Using constrained optimization through positive mathematical programming, a multi-basin model was developed to analyze the economic performance of reservoir storage expansion with regards to nine river basins in Afghanistan. The result is expected to reveal important patterns on basin water supply, water use, land use, storage and spill/nonuse with expanded storage capacity and water appropriation rule. Furthermore, the model estimation will lead to results on consumer surplus, shadow price, price elasticity, crop prices, discounted net present value and farm income defined by water institutions, basin, storage capacity and crop. More importantly, the expected results as indicated above will help policy makers to make informed decisions regarding the expansion of new and existing storage reservoirs for increased irrigated agriculture.

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

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Poster Abstract 18

The Rio Grande in central New Mexico is a highly altered desert river with a network of dams and diversions that alters 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 effects 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's Sevilleta Long Term Ecological Research (LTER) project and Bosque School. 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. Simiarly, desert arthropod community structure and composition is 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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Uranium Capture on Modified Inorganic-Organic Carbon Hybrid Material for Uranium Specific Filtration

WITHDRAWN

Zeolite Based Nutrient Delivery System

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Poster Abstract 20

One of the primary industries within New Mexico and in the US southwest, in general, is agriculture. From the production of vital crops to the delivery of important water systems around the state, successful agriculture techniques are essential for the progression of the economy in the arid southwest. The purpose of this research project is too develop an efficient method of delivering nutrients and improving soil characteristics using ammonium preloaded zeolites, an abundant mineral located throughout New Mexico. The interest in this research project originates from the zeolites' unique porous-like framework, which accounts for its high cation exchange capacity as well as its ability for "reversible dehydration". In order to develop a good characterization of the projects results, testing of numerous batches with different variables and situations was taken into account. Three different soil samples from around Las Cruces, New Mexico were obtained based on the areas primary crops, one soil sample was taken from the alfalfa orchards, one sample of soil was from the cotton fields, and one soil sample was taken from the pecan fields. These three separate sets of soils were all tested with the zeolites in different contents of water as well as two different ratios of soil to zeolite mixtures, a 60/40 mixture as well as an 80/20 mixture. The objectives of this research project were achieved through manipulation of zeolites in order to derive a method in which they can be used to provide nutrients in an economically friendly way.

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Effects of Turbidity and Water Velocity on Group Cohesion in Cyprinid Fishes in New Mexico

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Poster Abstract 21

Shoaling behavior in fishes is understudied and little is known about the different environmental factors that can change shoaling dynamics in fishes. For this research, we focused on ways that water turbidity can influence group cohesion in NM fishes. We hypothesized that group cohesion is sensitive to turbidity and predicted interfish distance would decrease (i.e. increase group cohesion) in turbid water, based on the selfish-herd hypothesis. Two common cyprinid fishes in NM were used, Notropis stramineus (Sand Shiner) and Cyprinella lutrensis (Red Shiner), in a repeated measures design with 25 groups of five fish each for both species. Groups were exposed to two turbidity treatments (0.34g/L, 0.68g/L) and a control (0g/L), in a randomly chosen order. A video camera connected to a PC utilized a software program, BioSense®, which automatically collected positions of fishes. We tested the influence of species (Red Shiners and Sand Shiners), and turbidity (two levels; 0g/L, 0.34g/L, 0.68g/L), and their interactions, on average inter-fish distances using a three-factor ANOVA with one factor being group identity due to the use of repeated measures. Red Shiners' and Sand Shiners' average interfish distances significantly increases ($p<.001$) in turbid water. However, we did not find significant differences between Sand Shiners and Red Shiners ($p>.05$) using this metric. More analyses are necessary, using other metrics (e.g. group polarity, velocity, etc.) before we can conclude that the species respond similarly to turbidity. Thus far, we can conclude that turbidity can influence group cohesion during shoaling in some cyprinid fishes of NM.

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Estimating Land Cover in Acequia-Irrigated Valleys Using Historical Aerial Imagery

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Poster Abstract 22

In New Mexico nearly 900 acequias divert and distribute water from rivers and streams for agricultural purposes. At a local scale, these acequia-irrigated valleys link community, economy, and hydrology through land cover. Accordingly, accurate land cover inventory is a primary interest to researchers examining these interactions. Three acequia-irrigated valleys (Alcalde, El Rito, and Arroyo Hondo) representing low, medium, and abundant water conditions within the upper Rio Grande watershed have been the focus of a number of studies. Several of these studies classified land cover for one or more of these valleys at various points in time. However, there has been no attempt at characterizing land cover for multiple associated valleys on a decadal scale. Furthermore, the quality of previous land cover studies was not checked through a rigorous accuracy assessment. This study addressed a data gap by providing a quality-checked and class-consistent land cover dataset for the three valleys on a decadal scale between 1935 and 2014. Historic aerial photos were georeferenced and mosaicked. Land cover features were digitized and classified using visual photo interpretation techniques into five categories: Irrigated Agriculture, Built-up, Orchard, Riparian, and Other. Fuzzy set theory was used to assess the accuracy of the classification. The preliminary results highlight a substantial shift from lands once used for agriculture to non-agricultural uses. Specifically, many former agricultural fields are now long-term fallow. The main contribution of this work will be to provide much needed data to acequia researchers, and which directly ties into parallel projects in the region.

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High Resolution Groundwater Recharge Modeling in New Mexico

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Poster Abstract 23

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 the goal of estimating groundwater recharge statewide, this study seeks to model recharge processes and calibrate the model with independently obtained recharge estimates based on field data. To date, in-place, or diffuse recharge potential has been estimated using the Evapotranspiration and Recharge Model (ETRM), which uses high resolution raster (pixelated) daily precipitation data, the National Land Data Assimilation System reference evapotranspiration, Normalized Density Vegetation Index (NDVI), state soils data, and state geology data to model the daily water balance of the soil over the state. This distributed parameter soil water balance has the advantage of modeling spatially continuous physical processes over a large extent, but is sensitive to inaccuracies in the input data. Work estimating recharge at mountainous sites around the state using chloride mass balance and improving our model with more accurate inputs and a runoff algorithm is ongoing.

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5 Cents is still A lot: New Generation of Anti-bacterial Absorbents Based on Functionalized Cellulos

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Poster Abstract 24

People in rural areas suffer from the lack of access to pure water. Although, granular activated carbon (GAC) is commonly used for removing organic constituents and residual disinfectants in water supplies, high dependence of GAC pore size to the source of carbon makes its usage limited. Here, we propose using nano-cellulose aerogels as antibacterial absorbents for cleaning water. Aerogels are easy to use and promise cleaner water for a cheap price (each gram of absorbent would have a price less than 5 cents). Eco-friendly process and biocompatible product guarantee a green pure water. Functionalizing nano-cellulose with quaternary ammonium groups is an easy approach that will be accomplished using a trivial chemistry. For making aerogels, polyvinyl alcohol (PVA), which is also biocompatible, will be used as binder. For purifying water, the aerogel will be placed in water samples for different periods of time. Aerogel in highly porous and kills the bacteria in water for making it drinkable. Present idea is easily applicable and has a great potential for commercialization. All the materials used in this study are eco-friendly and provide sustainability. Aerogels are light in weight (~99% air) and can be easily used by ordinary individuals in rural areas, where finding a drinkable and healthy water is a challenge.

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In Situ Densimetric Measurements as a Surrogate for Suspended Sediment Concentrations in the Rio Puerco, NM

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Poster Abstract 25

Results of densimetric suspended-sediment monitoring in highly sediment-laden streamflows in New Mexico suggest that this technology may provide more accurate sediment-concentration data – with a higher degree of reliability in data collection – than those obtained by traditional techniques. The capability of monitoring high sediment concentrations differentiates the densimetric technology from other currently used and/or tested surrogate technologies, including turbidity, laser, and hydroacoustic techniques.

Density measurements of stream water via a commercially-available differential-pressure monitoring device can be used to infer fluid density. Fluid density can be converted to a sediment-concentration value when the effect of the sediment concentration overwhelms the effects of other factors, including water temperature and turbulence. The current study on the Rio Puerco near Bernardo, New Mexico, augments results from several studies that analyzed differential pressure to represent suspended-sediment concentration data. These studies include successful results in a laboratory, and results of limited success in the field at the Paria River, Arizona, the Rio Caguitas, Puerto Rico, and northeastern Georgia. Densimetric data collected since 2012 at Rio Puerco indicate that computed uncertainties in the derived data provisionally support the hypothesis that the time-series data, coupled with computed uncertainties, are ultimately more reliable for calculating daily sediment records than a dataset comprised solely of analytical results from collected samples.

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Aquatic Health Assessment of the Gallinas River within Las Vegas, New Mexico, City Limits

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Poster Abstract 26

Urbanized streams often face issues including sedimentation, increased temperatures and peak flows, habitat changes, and the loss of aquatic species. The effects of river urbanization are particularly important in areas in which the system is closely utilized and interacted with by humans. The Gallinas River, which flows through the City of Las Vegas, NM, provides the drinking water supply for the city's residents. Las Vegas also views the river as a potential economic source if restored and developed into a parkway/river walk. Various studies have been conducted determining the health of the Gallinas above and below the city. However, the health of the system within city limits is unknown. The goal of the proposed project is to conduct a baseline stream health study of this river stretch, using chemical, biological and physical measures. To accomplish this goal the following objectives will be completed: conduct a bioassessment using aquatic macroinvertebrates; conduct a water quality assessment using physiochemical and nutrient concentrations; conduct a morphological assessment to determine morphological impacts such as incision and channelization; and conduct a riparian vegetation assessment. Results of the assessment will thus lead to steps taken by the city in order to lessen the urban impact on the river, and help transform the river into a source of pride and economic growth. Ultimately, this study may serve as a model to other cities working to study and improve aquatic health in culturally and scientifically important water systems, thus having a greater impact outside the area of Northern New Mexico.

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Potential Postfire Debris Flow Estimates - La Jara Creek Watershed

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Poster Abstract 27

The community of La Jara New Mexico relies on perennial surface water for drinking and irrigation water. The La Jara Creek watershed has not experienced fire in the last 75 years resulting in notable fuel load buildup. Given recent wildfire severity trends in the Jemez Mountain over the last 15 years, the likelihood of moderate and high severity fire has increased. Wildfire can increase the probability of debris flows, a potentially hazardous and destructive form of mass wasting in landscapes that have otherwise been stable throughout recent history. Such an event has the potential to destroy critical drinking and irrigation infrastructure. Although there is no way to know the exact location, extent, and severity of wildfire, or the subsequent rainfall intensity and duration before it happens, probabilities of fire and debris-flow occurrence for different locations can be estimated with geospatial analysis and modeling efforts. This approach addresses two of the fundamental questions in debris-flow hazard assessment: where might debris flows occur and how big might they be? The Range Improvement Task Force and the Water Resources Research Institute have teamed up to estimate the probability and volume of a potential debris flow given a range of wildfire intensities and precipitation events in the La Jara Creek watershed. Mitigating efforts are being explored and discussed with local community members.

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Informing Solute Tracer Investigations Across Stream Orders

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Poster Abstract 28

Solute transport studies in streams and rivers often begin with the introduction of conservative and reactive tracers into the water column. Information on the transport of these substances is then captured within tracer breakthrough curves (BTCs) and used to estimate, for instance, travel times and dissolved nutrient and carbon dynamics. Traditionally, these investigations have been limited to systems with small discharges (< 200 L/s) and with small reach lengths (< 500 m), partly due to the need for a priori information of the reach's hydraulic characteristics (e.g., channel geometry, resistance and dispersion coefficients) to predict arrival times, times to peak concentrations of the solute and mean travel times. Current techniques to acquire these channel characteristics through preliminary tracer injections become cost prohibitive at higher stream orders and the use of semi-continuous water quality sensors for collecting real-time information may be affected from erroneous readings that are masked by high turbidity (e.g., nitrate signals with SUNA instruments or fluorescence measures) and/or high total dissolved solids (e.g., making prohibitively expensive the use of salt tracers such as NaCl) in larger systems. Additionally, a successful time-of-travel study is valuable for only a single discharge and river stage. We will develop a method to predict tracer BTCs to inform sampling frequencies across stream orders using empirical relationships developed from multiple tracer injections spanning several orders of magnitude in discharge and reach length. This method will be tested in 1st to 8th order systems along the Middle Rio Grande River Basin in New Mexico, USA.

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Implementation of Drip Irrigation System Facilitates Collaboration between Future Agricultural Leaders

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Poster Abstract 29

Drought conditions intensified by climate change are making water management, especially for agriculture systems, a priority worldwide. Like New Mexico, Casanare Colombia will have to develop resilient water management strategies prompted by drought conditions. Theobroma cacao, also known as the chocolate tree, is an agroforestry crop known to be negatively affected by water scarcity. Effective water delivery methods, such as drip irrigation, can optimize water use and promote resilience of drought intolerant crops. In order to design an effective irrigation system and schedule, meteorological data consolidation, evapotranspiration calculations, engineering principles, and creativity must be utilized. Augmentation of data through installation of solar radiation sensors and field measurements will be completed in Colombia early next year. This system is expected to supply water to over 440 trees, and provide infrastructure to scale up to over 2,440 trees in the future. Using a New Mexico inspired irrigation design to address a problem in the Colombian savannas provides an opportunity for international collaboration between New Mexico State University and Universidad de la Salle Utopia campus agroforestry group. This project aims to design and implement a drip irrigation system at the Utopia campus. Utopia is a campus for rural education that empowers young leaders for positive social change through a rigorous agricultural engineering curriculum. This collaboration will create bridges for cultural and educational exchange, enable development of resilient water management techniques via drip irrigation design, facilitate international collaboration, and entice young agricultural leaders through proactive knowledge transfer.

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Improving Evapotranspiration Estimation Using Remote Sensing Technology

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Poster Abstract 30

Understanding and modeling of water budget is the basis for long-term management and sustainability of watersheds. The water budget of a typical basin consists of four components: surface water, groundwater, precipitation and evapotranspiration (ET).

The critical step in understanding the water budget in a basin is the accurate estimate of ET. In a watershed or basin, ET is considered the net loss from the hydrologic system and precipitation as a gain to the system, while the other components of the water budget such as groundwater and surface water can interchange but still remain in the system. There are various methods of estimating ET using satellite technology, but the methods are complex and require precise local calibration. This project aims at developing a simplified remote sensing model which can be used for estimation of ground level ET throughout New Mexico based on satellite technology without the need for local calibration. The objective of the project is to simplify the process and reduce the cost and time requirement without the loss of accuracy.

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Development of a Design and Calibration Manual for Simple Flow Measurement Devices in Open Channels

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Poster Abstract 31

Flow measurement is a necessary component of proper water management and conservation creating a need for simple flow measuring devices in open channels by farmers, extension agents, and water managers. Current literature on flow measurement devices detail the design of expensive structures, are often too complex for practical application, and do not fit the conditions of the low gradient open channels in New Mexico.

The objective of this research project is to develop a design and calibration manual that can be used by farmers and extension agents to design, build, and calibrate simple, low-cost flow measuring devices in open channels. The manual will specify design characteristics for a variety of channel shapes and hydraulic conditions including rectangular channels, circular channels (pipes), and trapezoidal channels with various side slopes. Flow measurement data will be collected by constructing and testing various flumes in the hydraulics lab at New Mexico State University. These flumes will be tested at different slopes and under varying conditions to develop a formula which will allow for construction of these flumes in the field requiring a few existing channel inputs. This manual can then be used by farmers, extension agents, and water managers in New Mexico and across the United States to build low-cost, accurate flumes which measure flow in open channels.

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How Does Nutrient Processing Change Along a River Continuum?

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Poster Abstract 32

Eutrophication is one of the main causes of water impairment in the U.S. The fate of nutrients in streams is typically described by the dynamic coupling of physical processes and biochemical processes. However, isolating each of these processes and determining its contribution to the whole system is challenging due to the complexity of the physical, chemical and biological domains. I will conduct column experiments seeking to understand nutrient processing in shallow sediment-water interactions along representative sites of the Jemez River-Rio Grande continuum (eight stream orders), in New Mexico (USA). For each stream order, I will use a set of 6 columns packed with 3 different sediments, i.e., silica cone density sand ASTM D 1556 (0.075-2.00 mm), gravel (> 2mm) and native sediments from each site. I will incubate the sediments for three months and perform two sets of tracer experiments in the laboratory under similar flow conditions, seeking to normalize the physical processes along the river continuum. In the first set, I will add a short-term pulse of NO3, resazurin and NaCl. In the second set, potassium acetate, NO3 and PO4 following the Redfield's ratio (106C:16N:1P). I will determine metabolism and nutrient processing using the Tracer Additions for Spiraling Curve Characterization method (TASCC). With these experiments I will be able to determine how natural changes in bacterial communities and sediment composition along the river continuum define nutrient uptake. This work will support the development of a new generation of field and lab experiments to quantify nutrient processing in large rivers.

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Will Engineered Natural System Using Inland Saltgrass Along the Urban Drains Reduce *E. coli* Levels?

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Poster Abstract 33

This study assesses whether inland saltgrass grown in a sandy soil and sandy soil mixed with zeolite could reduce fecal coliform bacteria concentration from flood runoff or water from drainage canals. The long-term goal is to use the information from the study to engineer systems such as ponds that would reduce pathogens in urban drains before the water from these drains are conveyed to the river or infiltrate groundwater. Six plots of 40 ft x 40 ft were built at a test-bed site at Sunland Park, New Mexico near a drainage canal. The soils in the plots were classified as sandy soils. Three inch layer of in-situ soil amended with zeolite was added to 3 of the 6 plots. Saltgrass was planted in the six plots during spring-summer of 2014. A drainage pipe was installed in summer of 2015 to collect leachate from the plots. Water with coliform bacteria was used to irrigate the plots and the water quality of the leachate sampled. Progress of the project is presented here.

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Hydro-Weirs: A Technology for Low-Head Hydropower Generation

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Poster Abstract 34

Human engineered weirs across rivers and streams, while creating partial impoundment of water resources, serve three primary purposes. 1) Provide fresh water for fish and agriculture; 2) allow gravity-fed flow to continue through diversion canals for power generation, and 3) control soil erosion downstream. As water overflows the weir, the abundance of unused hydropower energy dissipated at the drop offers the potential for harvesting energy. The Poster highlights a Senior Capstone Design Project to conceive, design, build and test a scalable revolutionary technology for low-head hydropower generation. The outcome is aimed towards enabling the transformation of two historic weirs of New Mexico, namely, the Percha Dam, and the Leasburg Diversion Dam, into hydropower generating sources. For this purpose, the NMSU Hydraulics Laboratory will be utilized to simulate the behavior of a conventional weir and provide a 1-meter drop for developing a harvester prototype. A centrifugal sump pump provides continuous flow while testing to simulate the hydro potential arising from various flowrates over the weir. The harvester with its vertical-axis Kaplan-type turbine and electromechanical components is custom-designed to fit the weir. With an estimated 200 Watt potential in the hydraulics laboratory setup, the objective is to harness the energy dissipated at the weir and show as a proof-of-concept the ability to precisely target the estimated hydropower capacity. Test results will show technical feasibility. With 3D printed turbine components and off-the-shelf electromechanical and power conversion components, the Hydro-Weir Project aims to show low-cost manufacturability. Modularity and scalability make this a viable technology.

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Hydrogeology of the Taos Plateau and Rio Grande Gorge Springs, Northern New Mexico

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Poster Abstract 35

The Taos Plateau is a high-elevation, basalt-capped plain that lies between the Rio Grande and the Tusas Mountains. Pliocene Servilleta basalts and volcanic domes and flows form the major aquifer. A water-table surface illustrates: 1) regional west-to-east groundwater flow from the Tusas Mountains to the Rio Grande; 2) a groundwater divide near the Rio San Antonio in southern Colorado; and 3) local plateau recharge. Chemical, thermal and isotopic data define three sources of inflow or recharge to the plateau aquifer — underflow from the Tusas Mountains, central plateau recharge, and deep mineralized upflow near the Red River and Cerro de la Olla fault zones. Seepage data quantify a river gain of ~94 cfs from more than 60 springs and seeps in two zones. The Ute Mountain Spring zone discharges ~37 cfs of east-side groundwater in a 1.5-mile reach south of Ute Mountain. This spring zone includes Lava Tube Spring, a large subaqueous artesian spring that discharges from the bottom of the river channel at the Gorge fault. Discharge from Lava Tube Spring has been measured between 6,000 gpm (13 cfs) in fall 2009 and 12,500 gpm (28 cfs) in summer 2012. The Bear Crossing-Felsenmeere Spring zone discharges ~57 cfs of west-side Taos Plateau groundwater in a 1-mile reach at the Red River fault zone.

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Thin Scale Eco-Hydrological Data and Relations at Semi-Arid Regions: Methodological Approach

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Poster Abstract 36

In semi-arid regions worldwide the vegetation is organized in patches surrounded by bare soil with marked differences in their soil properties that play important roles in runoff and infiltration. Chihuahuan-Sonoran deserts and Patagonian Monte (South American) deserts show floristic similarity greater than that expected from the geographical barriers between them. These similarities ease comparisons of hydrological estimates between regions. We propose a methodology that focuses on generating thin scale eco-hydrological data and relations at the Chihuahuan desert to compare them with estimates obtained at the Patagonian Monte. We will perform 20 micro-plot-field experiments to estimate the effect of vegetation and associated microtopography on combined infiltration and runoff dynamics. A DEM with milimetric resolution of each micro-plot will be constructed through a stereo-photogrammetry procedure. Irrigation will be supplied with a single nozzle on a small area of the micro-plot. The runon-runoff flow areas will be video-recorded and soil samples will be taken at each micro-plot. Antecedent and post-irrigation soil moisture will be measured by means of a pin-probe Time-Domain Reflect meter. Infiltration tests to obtain soil moisture-dependent infiltration curves will be performed using a tension disk infiltrometer. These results will be incorporated into hydrological models to generate information about hydrological interactions and compare them with the Patagonian Monte estimates. The relations between ecological (vegetation coverage), soil properties estimates (topography, microtopography, soil bulk density and vegetation roots and gravels concentration) and hydrologic responses (infiltration and runoff) are expected to provide a scientific foundation for ecologically sustainable water management.

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Hybrid Poplar: A Potential Drip-Irrigated Plantation Tree for the American Southwest

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Poster Abstract 37

Establishment of tree plantations in the Southwest has progressed slowly due to water scarcity and poor-quality soils. To address the need for biomass, biofuels and other products from short rotation woody crops (SRWCs) derived from 'beneficial water use,' NMSU Agricultural Science Center at Farmington began research with drip-irrigated hybrid poplar in 2002 with a provenance trial of clones obtained from the Pacific Northwest. Based on the success of Populus canadensis (a P. deltoides x P. nigra cross) in that and later studies, a new test was established in 2007 to study its growth under varying irrigation amounts (70, 80, 120 and 130% of ETc). Four top-performing clones (433, 544, 910 and 911) were planted as 23-cm cuttings in April 2007, on 2.75 ha at 3.7-m spacing (770 stems ha-1). Overall, clones 433 and 544 grew best, and the 120% target irrigation level was deemed most practical for buffering occasional irrigation shortfalls and promoting satisfactory growth. Across water treatments, wood volume (WV) for the 120 and 130% ETc levels was 145 m3 ha-1 and aboveground biomass was 115 Mg ha-1. Across clones, entry 433 led for height at 15.5 m and WV at 132 m3 ha-1. Both clones 433 and 544 had similar diameters at breast height (DBH) of 19.5 cm and biomass (~103 Mg ha-1). Water use efficiency was best for clones 433 and 544 at 1.89 and 1.78 kg m-3, respectively. Hybrid poplar can flourish in a semi-arid area, provided that BMPs are used for germplasm selection and irrigation.

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Development of Calibration Procedures for LAS for Validation of Evapotranspiration Maps

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Poster Abstract 38

Evapotranspiration is a large component of New Mexico's water balance, but quite difficult to measure in the field. Through the use of large aperture scintillometers, one can reliably measure the daily sensible heat flux, which in turn can be used to derive evapotranspiration. Currently, New Mexico Tech has nine first generation Kipp & Zonen scintillometers, as well as one second generation Kipp & Zonen scintillometer. The second generation scintillometer is more advanced and accurate in its measurements. In order to ensure high quality measurements are taken from the first generation scintillometers, a procedure will be developed to calibrate the first generation scintillometers against the second generation scintillometer, so that the ten scintillometers can be optimally deployed for water resources research in New Mexico.

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Tools for Adaptation and Mitigation of Climate Change on Southwestern Working-Lands

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Poster Abstract 39

In February 2014, the USDA established 7 Hubs and 3 Sub Hubs across the nation to assist farmers, ranchers and foresters in adapting to the effects of climate change. Specific vulnerabilities related to projected climatic changes in the Southwest (SW) include water scarcity, the effects of elevated temperatures on livestock production and regional cropping systems and elevated wildfire risk. In the first 18 months, the SW Climate Hub initiated projects and programs to help New Mexico farmers and ranchers adapt to climate change. The Climate Hub Tool Shed provides information on tools that can assist agricultural and forest land managers in adapting to climate variability and change. The SW Hub launched several projects to translate scientific information and reach the public such as 1) authoring of a vulnerability assessment of southwestern working lands to climate change, 2) partnering with Cooperative Extension Service to host landowner workshops on climate change and 3) supporting education of future generations via a climate change - water cycle educational module, tailored to the SW, comprised of 10 one-hour lessons. To reach a broad audience, the SW Hub hosts a website, provides a monthly bulletin, partners with sister federal climate change programs and convenes sessions at scientific meetings.

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The Impact of Climate Change on Water Quality on an Impaired New Mexico River

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Poster Abstract 40

Climate change is predicted to advance runoff timing in snowmelt basins and decrease available water, particularly in arid and semi-arid regions. Researchers have suggested that the impacts of climate change will degrade water quality by reducing dilution. We use coupled snowmelt and water quality models to quantify the impacts of climate change on the Chama River, a New Mexico waterbody presently impaired to temperature, nutrients and pathogens. We use the Snowmelt Runoff Model and downscaled temperature and precipitation to simulate the impacts of a statistically selected range of future climate conditions (warmer/wetter; warmer/drier; hotter/wetter; hotter/drier) on streamflow. SRM streamflow for base and future scenarios is coupled with a water quality model (LOADEST) to evaluate the impacts of climate change on water quality. There is a shift in timing of the delivery of water quality loads with more early small peaks during autumn and winter and an earlier and lower peak in snow melt runoff loads. The impacts of climate change vary by hydrograph phase, with higher loads during baseflow, particularly for the hotter/wetter simulation, but lower loads during snowmelt runoff for all parameters. Water quality responses vary by parameter and year, indicating a range of impacts of climate change on water quality which should be evaluated separately for each parameter.

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The Economics of Groundwater Extractions, Crop Choice, and Hydrology of Mesilla Valley

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