61st Annual New Mexico Water Conference Poster Abstracts

Hydrogeologic Framework of SW NM Transboundary Aquifers— NM WRRI: 1996-2000

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Poster Abstract 1

As an initial phase of the binational transboundary-aquifer assessment program in the mid-1990s, the NM Water Resources Research Institute (WRRI) developed GIS coverages that integrated large amounts of available surface and subsurface information on basin-fill aquifers in the International Boundary region between El Paso del Norte and southeastern Arizona. Emphasis of this overview is on major GIS elements relating to aquifer composition and general groundwater-flow regimes in four intermontane basin systems of southwestern New Mexico and northwestern Chihuahua: Mimbres, Hachita, Playas, and Animas-Lordsburg. The GIS format allows quasi-3D presentation of hydrogeological information for use in groundwater-flow models. The hydrogeologic framework and hydraulic properties of basin and valley fills are categorized on the basis of 1) hydrostratigraphic unit (HSU) and lithofacies assemblage (LFA) composition, and 2) basin-boundary and intra-basin bedrock and structural controls. Major aquifers are formed by medium-to coarse-grained LFAs deposited by the ancestral Mimbres and Animas rivers. These unconsolidated basin-floor HSU's include upper Gila Group and overlying surficial-alluvial
deposits. Horizontal hydraulic conductivities range up to 10 m/day, and unit thicknesses are as much as 150 m. Piedmont-slope facies and underlying middle and lower Gila Group HSU's have much lower aquifer potential because of finer matrix texture and greater degree of consolidation and cementation. While surface flow ultimately discharges to ephemeral lakes, some groundwater drains to terminal-bolson sinks in Chihuahua or the Gila River. See: Hawley and others (2000) Trans-International Boundary aquifers in southwestern New Mexico. NM WRRI, NMSU; prepared for USEPA-Region 6 and USIBWC; TCR-ICX-996350-01-3, 126 p.

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Hydrogeologic Framework of San Francisco River Basin—NM WRRI: 2008-2010

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Poster Abstract 2

This presentation describes development of a digital hydrogeologic-framework model of basin-fill and bedrock aquifer systems in the San Francisco River (SFrnRv) basin of the west-central New Mexico border region. The SFrnRv is the only perennial tributary to the Upper Gila River, with a confluence located about 10 mi (16 km) south of the Clifton-Morenci (AZ) mining district, the site of the largest open-pit copper mine in North America. The 2,790 mi2 (7,230 km2) SFrnRv drainage basin is in the Datil-Mogollon section of the Transition Zone physiographic province, and includes the Tularosa River (NM) and Blue River (AZ) watersheds. This study and related investigations in the southwestern New Mexico region were funded by the NM Interstate Stream Commission, and are part of continuing efforts to improve geohydrologic models used in management of surface-water and groundwater resources of the Gila River part of the "Lower Colorado River Basin." This is the first integration of stratigraphic and structural geologic information in the SFrnRv basin from a hydrogeologic perspective. The model was developed in collaboration with the NM WRRI GIS Laboratory and includes a 1:500,000-scale map and five schematic cross sections (msl base and 5x vertical exaggeration) were compiled from GIS databases (1:100,000 to 1:500,000-scale) acquired from the NM Bureau of Geology & Mineral Resources, Arizona Geological Survey, and the U.S. Geological Survey. See: Hawley, Kambhammettu, and Creel (2010), Digital hydrogeologic-framework model of the San Francisco River basin, west-central New Mexico and east-central Arizona: NM WRRI, NMSU, TCR-354, 51 p.

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Hydrogeologic Framework of Binational Mesilla Basin Region—NM WRRI: 2004-2016

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Poster Abstract 3

With the exception of recharge from the Rio Grande and a few high-mountain areas, sustainable groundwater resources in the binational Mesilla Basin region of New Mexico, Texas, and Chihuahua (Mexico) are primarily replenished by underflow from local sources that are predominantly brackish. Considering that the region's population now exceeds two million, however, all waters in the fresh to moderately brackish range (<10,000 mg/L) must be considered as assets rather than liabilities. Thick intermontane-basin fill of the Upper Cenozoic Santa Fe Group and thin alluvial deposits of the Late Quaternary Mesilla Valley of the Rio Grande constitute the primary aquifer systems. Bedrock units may also provide significant groundwater reservoirs in the deeper subsurface, and include carbonate and evaporitic rocks of Permian and Mesozoic Age, and Paleogene sedimentary and volcanic rocks. The hydrogeologic maps, and fence- and block diagrams on display illustrate basic hydrostratigraphic, lithofacies-distribution, and structural-boundary conditions at a compilation scale of 1:100,000. They are representative of more than a decade of hydrogeologic-framework refinement in the binational Mesilla Basin and contiguous basin/range areas as part of interdisciplinary, multi-institutional transboundary aquifer-assessment research coordinated by the NM WRRI. In central-basin and river-valley areas of major interest, as much as 300 m of sand-dominated lithofacies that include ancestral Rio Grande deposits form the most productive aquifers. For an aquifer system with an area of 2700 km2 and 300 m average thickness, a conservative estimate of the amount of economically-recoverable fresh to slightly brackish groundwater (<5,000 mg/L tds) is about 80 km3 (65 million ac-ft).

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Transboundary Aquifer Systems Bibliography Compilation, New Mexico and Chihuahua—NM WRRI/UACJ

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Poster Abstract 4

The goal of the 2007 United States-Mexico Transboundary Aquifer Assessment Act program (TAAP) is to characterize, map, and model priority aquifers along the United States-Mexico border at levels of detail determined to be appropriate for a given aquifer system. One initial TAAP task assigned to the New Mexico NM WRRI was to "compile extant information" (including a bibliography) on groundwater and its limited recharge sources in the Chihuahuan Desert region that includes the El Paso del Norte metropolitan district and surrounding parts of Chihuahua, New Mexico and Trans-Pecos Texas. This activity exemplifies the basic TAAP theme of sharing, not only in terms of groundwater resource assessment, but also essential published and unpublished "information." Key NM WRRI collaborators in this activity are the Universidad Autónoma de Ciudad Juárez (UACJ)-Departamento de Ingeniería Civil y Ambiental, U.S. Geological Survey, Texas A&M University-El Paso, and University of Texas at El Paso. A reference list, with alpha-numeric cross-referencing codes for almost 900 items, has been developed to date for this part of the USA-Mexico border. Major topics include: bibliographies and reviews; historical documents; environmental and geologic settings; basic hydrogeologic concepts; GIS/remote sensing and land-use planning; regional geohydrology; basin to local-scale aquifer systems (hydrogeology, hydrochemistry, geophysics, groundwater-flow models, and paleohydrology). Short explanatory annotations (English/Spanish) will be created for specific references where needed; and EndNote® software is being used to facilitate bibliography, reference-list and foot-note word processing. After peer review, the NM WRRI plans to create a bilingual (online) publication for posting on appropriate internet sites.

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The Next Generation of Evaporation Pans

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Poster Abstract 5

Accurate tracking of open-water evaporative losses, one of the largest consumptive uses of water in the arid Southwest, will become increasingly important in the future with the anticipated climate shifts toward longer, more-severe droughts. The current methods for estimating evaporation on reservoirs are known to have uncertainties ranging from ± 20 to 40 percent. This uncertainty in evaporation rates needs to be reduced in order to give water-resource managers a better understanding of current and future water supplies.

This study will investigate an improved method for determining open-water evaporation rates by developing a Floating Evaporation Pan (FEP) with built-in wave-guard and adjustable freeboard that will measure continuous evaporation rates at a fixed location within a reservoir. The FEP will be semi-submerged to minimize the difference in water temperature between the FEP and the reservoir. In addition, a goal of the FEP design is to have minimal influence on the atmospheric boundary layer overlying the pan relative to the reservoir. Establishing these two conditions will provide a more accurate quantification of evaporation. The accuracy of the FEP will be verified through the use of a hemispherical evaporation chamber, designed to measure the actual evaporation rate adjacent to the FEP.

Through innovative design and extensive field measurements, this study aims to develop a more accurate, robust, automated, and real-time technique for measuring near-actual reservoir or lake evaporation, leading to effective long-term monitoring and management of our Nation's reservoir and lake water resources.

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Observation of Evapotranspiration in New Mexico

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Poster Abstract 6

Water has been one of the main driving forces of expansion in the American Southwest for over a century. This essential resource has allowed urban centers, populations, and even agricultural areas to expand in places where it was once thought impossible. Knowing and understanding how much water is leaving the surface and vegetation canopy back into the atmosphere allows water managers, hydrologists, and farmers plan a strategy to mitigate risks associated with drought as well as water shortages. This project aims to find an evapotranspiration (ET) model that can be implemented across New Mexico in order to quantify the amount of water returning to the atmosphere from the land surface. Three evapotranspiration models, ALEXI, SSEBop, and MOD16, were analyzed in this study to
test their accuracy against observed field data from flux towers with eddy covariance systems. The models returned individual results and their geographic variations indicated where one worked better than the others. Based on an ordinary least square regression, the newest version of SSEBop performed with the best accuracy statewide. A search for an evapotranspiration/precipitation ratio was also conducted in watersheds where these two components should be close to equal. For precipitation estimates, PRISM M3 800m data were used after being validated with rain gauges scattered across the state.

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The Ute Reservoir Watershed-Based Water Quality Plan

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Poster Abstract 7

In 2014, discussions began between the Eastern New Mexico Water Authority (the Water Authority) and the Canadian River Riparian Restoration Project (CR4) about developing a watershed-based water quality plan for the Ute Reservoir near Logan, NM. The CR4 had completed numerous state- and federally-funded restoration projects and was interested in §319(h) funding from the US Environmental Protection Agency (EPA) and the New Mexico Environmental Department (NMED). The Water Authority was interested in the quality and quantity of reservoir source, which will supply the Ute Pipeline project. The EPA funding addresses non-point-source pollution of impaired waters. NMED has designated the Canadian River and Pajarito Creek above the reservoir as impaired by bacteria, nitrogen and phosphorus. A watershed-based water quality improvement plan for the listed pollutants must be approved by the EPA before funding can flow to local on-the-ground projects. In 2015, a funding grant was approved for the plan. The first step was to explore the watershed values of the stakeholders. Most of the watershed acreage is actively grazed rangeland. A strong local effort in sustainable ranching has led to an understanding of how to protect local streams. The process was successful in envisioning and writing a watershed plan that addressed both the impairments in water quality identified by NMED and the sustainable use of the rangeland. Pending EPA approval, long-term implementation of the plan will test the compatibility of these objectives but we are encouraged by the initial spirit of cooperation between ranchers and regulators.

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Precipitation Estimates for New Mexico

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Poster Abstract 8

When considering the theme of this year's conference "Where Does All the Water Go" we should also consider where it comes from. Most of it comes from precipitation either directly from rivers and reservoirs or indirectly through ground water recharge. The average annual precipitation for the state is about 100 +/- 20 million acre-feet (ac-ft) and since 1980 the trend line has been decreasing at about 1 million ac-ft/year. One of the tasks for the Statewide Water Assessment is to better define the spatial and temporal distribution of precipitation. To do this several models which combine remotely sensed data with ground rain gauge measurements were studied. The Parameter-elevation Relationships on Independent Slopes Model (PRISM) developed by a group at Oregon State University was selected for our use. The model uses elevation, slope and aspect for interpolating between gauge data. The model has recently been augmented by including precipitation radar data to improve the interpolation. The data are available at 4 km resolution without charge and at 800 m resolution for a fee. Daily estimate are available. WRRI has purchased the 800 m data for use in this project. The accuracy of the data was checked by comparing with monthly data from several networks available in the state and which were not included in producing the estimates. The comparison yielded an r2 = 0.8 and a RMS difference of 13 mm/ month. The data have been subsetted to produce estimates on a watershed, county or water planning region basis.

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Web-Mapping Applications as an Information Medium for Displaying Produced Water Quality and Volume Data in Southeast New Mexico

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Poster Abstract 9

Persistent droughts and increasing freshwater demands in Southeast New Mexico exacerbate the need for identifying and characterizing alternative water sources to meet a variety of uses. One potential alternative water source in this region is produced water, or the water that is a coincidental by-product of oil and gas extraction. Stakeholders, decision-makers, and communities members need information on the spatial distribution of both produced water volume and quality in order to make better decisions as to the feasibility of utilizing treated produced water as an alternative water source. A web-map application is an effective platform for quickly conveying information and visualizing spatial patterns inherent in available data. This work helped fill the information gap through the publication of two interactive web-mapping applications employing produced water volume and quality data from the New Mexico Oil Conservation Division (OCD) and the Petroleum Recovery Research Center, respectively. Monthly produced water volume by well, summed by annual volumes, and eight produced water quality parameters were aggregated to the township scale. Functions of the two applications provide the ability to download tabular data, access information on individual wells, examine water quality averages for the available data, and sum volume within a user defined area. Results of this work highlight areas of large volumes of produced water with lower average total dissolved solids. Future work will need to address how reinjected produced water used for water flooding and enhanced oil recovery is reported to OCD in order to obtain more accurate measures of available produced water.

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Economic Performance of Water Conservation and Storage Capacity Development to Adapt to Climate

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Poster Abstract 10

High fluctuations in surface water supply, growing evidence of declining aquifers, and limited capacity to adapt to low and unreliable water supplies are important barriers to discovering sustainable profitability measures to support crop irrigation for economic productive farming systems in the American Southwest. Scarce and aging water storage and delivery infrastructure combined with weak quantitative analysis of a range of water policy measures for adapting to increased evidence of drought and climate heighten the challenge.

Little research to date has investigated in one study the performance of both water conservation as well as storage enhancement measures under alternative water supply futures using methods that integrate the sciences of climate, agronomy, hydrology, and economics. The objective of this work is to contribute to filling this gap. This work strengthens the current weak integration of the various water sciences using state-of-the arts analytical methods to promote, sustain, and secure improved irrigation productivity.

Using the example of the Upper Canadian River Basin in the southwestern USA, three water policy measures considered are: lining canals, removing stored sediment, and expanding irrigation storage capacity. Three water supply scenarios are considered: normal, dry, and drought. An innovative constrained optimization framework is developed to examine economic consequences to farm income resulting from each of these nine combinations of water supply and policy. All policy choices present expensive adaptation measures. Despite its limited scale, findings illustrate a comprehensive framework for addressing future water scarcity to protect rural income security in the developed and developing world's irrigated regions.

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The Impact of Drought on Tourism Employment

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Poster Abstract 11

Weather related events have become more and more frequent and severe. The California drought of 2015 is one of the latest weather catastrophes facing the American Southwest, which has negatively affected a variety of economic sectors. Although large industries in the main urban areas and the agricultural sector receive a lot of attention by the media and scholars during such events, many other sectors are not a prevailing concern by such groups. Communities with different economic strengths and weaknesses are affected in different ways by such climate events. This study contributes to the literature by using state level employment data in the U.S. to investigate the impact of drought on the tourism sector, and examine the related gender and race issues that could arise during such a natural disaster.

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A Dynamic Statewide Water Budget for New Mexico

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Poster Abstract 12

New Mexico Dynamic Statewide Water Budget (NMDSWB) is a multi-year effort to account for the origin and fate of New Mexico's water resources through time. In the first year of the project historic mass balance water budgets were developed for seven major river basins in New Mexico, in addition to the state level. In year two, historic mass balance budgets were extended to include New Mexico water planning regions (WPRs) (NMISC, 1994) and counties. In its current configuration, the NMDSWB uses historic data from 1975-2011 and calculations of stream flows, precipitation, climatological conditions, land use, and water consumption to estimate how much water was available, how it moved through the different spatial units both as surface water and groundwater, and how storage in the different stocks changed through time. The NMDSWB has been developed as a dynamic tool with a structure that will be adapted to allow generation of future scenarios. This will require development of assumptions or projections related to future climatological conditions, population growth, land use, agricultural practices, runoff dynamics, human water use behavior, and other factors driving the occurrence, movement, and consumptive use of water. The goal of the DSWB is to represent a high level picture of water resources and use in New Mexico, such that planners, law-makers, engineers, and the public have an easily accessible dynamic tool to aid in management, planning, and understanding of our states water.

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Geothermal and Brine Sources of Natural Contaminants in Public-Supply Wells, Rio Grande Aquifer

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Poster Abstract 13

In 2014, the National Water-Quality Assessment (NAWQA) Project of the U.S. Geological Survey (USGS) sampled 60 public-supply wells in the Rio Grande aquifer system for a comprehensive suite of analytes to characterize and explain the occurrence of contaminants of concern for human health in groundwater used for public drinking supply. Various isotopes and environmental tracers (including δ18O, δD, 87Sr/86Sr, δ11B, δ13C, 14C, 4He, and 3He/4He) were included to improve understanding of groundwater sources, flow paths, and ages. The Rio Grande aquifer system consists of hydraulically interconnected basin-fill aquifers extending across about 70,000 square miles of Colorado, New Mexico, and Texas. Wells were selected for sampling using equal-area grids to achieve a spatially unbiased dataset across the aquifer system. Concentrations of one or more constituents of natural (geologic) origin exceed current or proposed human-health benchmarks for drinking water in groundwater samples from 22 of the 60 wells (37 percent). These constituents include arsenic, hexavalent chromium, fluoride, strontium, uranium, gross alpha radioactivity, and radon. Preliminary analysis of age tracers indicates that elevated concentrations of most of these constituents occur predominantly in groundwater with calculated mean ages greater than 10,000 years. Groundwater samples from several wells with elevated concentrations of these constituents also have chemical and (or) isotopic markers that indicate contributions from geothermal water or deep sedimentary brines.

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Examining the Rights-of-Way Process for Indian Allotment Lands Navajo-Gallup Water Supply Project

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Poster Abstract 14

This research examines the Rights-of-Way process for Navajo allotment lands. Today, there are 566 Indian nations. Each nation has its own history relating to Indian allotment lands. In the 1880s, allotment lands were created through federal Indian policy as tribal trust lands were allotted to individual Indian tribal members of various nations. This research examines a real example of the Rights-of-Way process for Navajo allotment lands as it relates to the Navajo-Gallup Water Supply Project. Land access for allotment lands is questionable. Water access for the Water Supply Project secured and supplied through the recent Navajo Nation San Juan River Water Rights Settlement. The water pipeline alignment will cross six types of land. Each type has its own Rights-of-Way process. This research will examine the current Rights-of-Way process for Navajo allotment lands. This research applied three methods to identify the current Rights-of-Way process for allotment lands. A document review for existing federal and tribal policy for allotment lands finds that the Navajo Nation does not have authority over allotment lands. The U.S. Bureau of Indian Affairs has authority over allotment lands. For Navajo allotment lands, the Rights-of-Way process is initiated by the U.S. Bureau of Reclamation for the Water Supply Project. The Bureau of Indian Affairs will approve or disapprove Rights-of-Way easement. The results show the current Rights-of-Way process for Navajo allotment land is quite general. After examination, the research identifies areas of improvement for the current the Rights-of-Way process. This research provides recommendations to improve and update the current Rights-of-Way process starting with a better framework to understand the Rights-of-Way process for Navajo allotment lands.

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Protecting Food Security in Irrigated Regions: A Multi Basin Framework

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Poster Abstract 15

Emerging needs to protect food security in the face of growing population and growing evidence of changing climate continue to assign high priority for economically informed water policy making in the world's irrigated regions. Afghanistan is a headwater country that serves as the rich upper catchment to several river basins in Central and South Asia. An important challenge for that region is to assess the economic benefit of infrastructure development and institutional innovations which are essential to sustain food security, on the economic value of outputs from irrigated agriculture. This paper examines the impacts of enhanced storage capacity of reservoirs and two distinct water rights innovations on the net economic surplus from irrigated agriculture. A constrained optimization framework is formulated and applied to analyze economic performance levels of farming systems for reservoir capacity expansion and adjusted water right systems. Results reveal that storage capacity expansion has highest impact on irrigated production in economic terms where water supplies have the greatest natural fluctuations. Both reservoir storage capacity expansion and innovative water right systems are economically viable policy measures for protecting food security. Both measures provide important benefits in terms of improve the reliability of water supply, extend the supply of irrigation water in the dry season, and improved food security for a country that continues to face threats of food shortages.
Key words: food security, irrigated agriculture, multi-basin framework, storage infrastructure, water institutions

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Alternative Uses of Treated Produced Water; Guidelines to Water Expectancy for Usage in Agriculture

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Poster Abstract 16

Southeastern New Mexico has experienced over a century of oil and gas drilling along with freshwater shortages and groundwater stress for a number of years as fresh water aquifers and reservoirs are depleted. Fresh water is already a scarce and valuable resource in a semi-arid region where the demand for freshwater has increased due to production practices of the oil and gas industry. Various stakeholders are looking for opportunities to use alternative water sources, such as produced water, to offset freshwater use. Produced water is a byproduct of oil and gas drilling and has shown potential for beneficial reuse instead of being considered a waste. Beneficial uses outside of oil and gas specifically in agriculture are reviewed which can help alleviate the usage of freshwater within these parameters. The importance of agriculture in New Mexico is emphasized, specifically in Eddy and Lea Counties, and describes the type of water quality parameters that would be expected from treated, produced water in order to meet acceptable use in terms of crop tolerance and human health concerns. Fresh water resources continue to decline within the area which has spiked an interest in using produced water within oil and gas industries, but potentially in agriculture. The treatment of produced water to industry and agricultural standards is a distinct possibility that could alleviate some of the water stresses that the state faces.

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Climate Change and the Snowmelt-Runoff Relationship in the Upper Rio Grande Basin

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Poster Abstract 17

Drought and rising temperatures have resulted in reduced snowpack and low flows in recent years for the Rio Grande, a vital source of surface water in three southwestern states and northern Mexico. We assess monthly and seasonal changes in streamflow volume on the upper Rio Grande (URG) near its headwaters in southern Colorado for water years 1958-2015. We use gage data from the U.S. Geological Survey, naturalized streamflows from the U.S. Natural Resources Conservation Service, and observed temperature, precipitation and snowpack data in the URG. Trends in discharge and downstream gains/losses are examined together with covariations in snow water equivalent, and surface climate variables. We test the hypothesis that climate change is already affecting the streamflow volume derived from snow accumulation in ways consistent with CMIP-based model projections of 21st Century streamflow, and we attempt to separate climate-related streamflow signals from variability due to reservoir releases or diversions. Preliminary results indicate that decreasing snowpack and resulting diminution of springtime streamflow in the URG are detectable in both observed and naturalized flow data beginning in the mid to late 1980s, despite the absence of significant decrease in total flow. Correlations between warm and cold season fluctuations in streamflow and temperature or precipitation are being evaluated and will be compared to model projections. Our study will provide information that may be useful for validating hydroclimatic models and improving seasonal water supply outlooks, essential tools for water management.

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Desalination in the Greater Santa Teresa, NM Area

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Poster Abstract 18

Burgeoning industrial growth in the greater Santa Teresa, NM area – coupled with realities of drought and limited freshwater supply – challenge the region's long-term sustainability. Desalination of brackish water serves as a potential solution to these water supply constraints. The effects of establishing a desalination plant here remain unknown. This proposed project will provide a policy evaluation to determine the most sustainable model of desalination implementation and management. Conclusions will be based on three primary areas of sustainability: hydrologic, economic, and social. Review of existing hydrologic studies of the area will be used to identify feasible locations for a desalination plant. In addition, this project will contribute a study of groundwater salinity for a portion of the region. The hydrologic constraints from this research will frame an economic analysis of plant implementation and operation. Investigation conducted regarding the social sustainability of desalination will assess management systems for the new alternative water supply that account for economics, socioeconomics, and public health. This project ultimately works to further the goals of the New Mexico State University-Bureau of Reclamation collaborative partnership, established in 2014 to increase knowledge regarding alternative water supplies. The partnership's directed research project specifically investigates the real world viability of brackish groundwater desalination. A model produced through the directed research project will explore the potential role of desalination alternatives in the Lower Rio Grande water budget; results from the proposed research will serve as a scenario in the model.

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Economic Performance of a Proposed Interbasin Transfer for Northeast New Mexico

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Poster Abstract 19

Interbasin water transfers are one mechanism for moving water from wet to dry regions of the world. Such transfers are one method for a dry community to secure a reliable water supply. With increasing water shortages, this form of water transfer has become one focus in providing communities with sustainable water supplies. Some communities in Eastern New Mexico are running out of reliable affordable water, because their main source of water the Ogallala Aquifer is becoming more expensive over time with future costs not likely to be contained.

This project will identify planning requirements facing a community that wishes to construct a major pipeline in order to transfer water to the importing community. Using the Eastern New Mexico Water Utility Authority as an example, this work plans to report on what measures have been attempted as well as testing my own theories against the facts using systematic approaches. I plan to address the questions such as, what are alternative sources of water and what are conservation options facing proposed water importing communities? Is there enough water available until the pipelines completion? Is the Ute Reservoir the best source of water to use? Should we pipeline water from another source? A final goal is to conduct an economic cost benefit analysis of the proposed Interbasin transfer project compared to the status quo.

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Relationship between Tree Canopy Cover and Discharge of Gallinas River Through Time in Las Vegas, NM

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Poster Abstract 20

With the advent of climate change, it is expected that the US Southwest will experience warmer average temperatures in all seasons, longer summers, shorter winters, and reduced snowpack in the higher elevations. In the northeastern part of New Mexico, the City of Las Vegas has been dealing with the threat of water shortage since the beginning of the 21st century. Gallinas River is the primary source of potable water for the 15,000-18,000 residents of Las Vegas. The purpose of this study is to find out if there is any correlations between the tree canopy cover of the Gallinas watershed and the stream flow of the river from 1939 to 2015. This study will use aerial photography and GIS techniques to determine the percentage of tree canopy cover in Gallinas watershed from 1939 to 2015. It is expected that by observing the percentage of tree canopy cover incrementally, every 10 years, will provide a view of how the canopy cover has changed through this period. The statistical analysis will then allow us to determine whether relationships between tree canopy cover and discharge are stronger than the relationships between precipitation and discharge. This will help us distinguish the extent of the impact each of these factors has on the discharge of the Gallinas River. Therefore, available data on tree canopy cover changes and their impact on the stream flow can provide critical input to decision-making of environmental management and planning the future.

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Modeling Debris-Flow Potential in the Santa Fe Municipal Watershed

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Poster Abstract 21

In the southwestern Rocky Mountains, moderate to severe forest fires can increase the likelihood of debris-flow events by consuming rainfall intercepting canopy, generating ash, and forming water-repellant soils resulting in decreased infiltration and increased runoff and erosion. This destructive form of mass wasting in landscapes that have otherwise been stable throughout recent history creates significant hazards for people and challenges for natural resource managers. Although there is no way to know the exact location and severity of wildfire, or intensity and duration of a subsequent precipitation event before it happens, probabilities of debris-flow occurrence and volume can be estimated using USGS developed geospatial modeling analyses. This approach addresses two fundamental questions in debris-flow hazard assessment: where might debris flows occur and how big might they be? In this study we will create a series of GIS produced maps and accompanying data that show the estimated probability and volume of post-fire debris flows for the Santa Fe, NM watershed given a 5- and 10-year, 30 minute rainfall event following a moderate to high severity wildfire. We hypothesize watershed basins with slopes greater than 30% will be identified as potential debris-flow zones. Results will provide city and forest managers an opportunity to prepare and mitigate potential issues associated debris flows.

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Principles Guiding the Design of Water Banking for Shortage Adaptation in New Mexico's Lower Rio Grande

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Poster Abstract 22

Drought, combined with future climate threats, is an important indicator of future agricultural water shortage which might be expected in the Lower Rio Grande region of southern New Mexico. While adjudication of water rights has been undertaken in this region, the process remains incomplete even though such adjudication would simplify the administration of future supply shortages when they occur. Previous work in the region has explored water banking activities which local farmers have indicated they would accept for adapting to shortages. However, progress in implementing such a system has been limited. The objective of this work is to identify a structure for a water banking program best suited to protect and sustain both water supplies and irrigated agricultural in the region. This solution should allow water to move from low value senior rights holders to high value junior rights holders while also incentivizing conservation. During the summer, the first wave of individual interviews were conducted with area farmers to explore the guiding principles which they feel are most likely to sustain water use in the region. Preliminary survey results have shown great interest in water banking as a method of both marketing and conserving the region's water supplies. The remaining challenge will be to create a workable mechanism by which such a banking program may be implemented within the current framework of water supply and administration while avoiding the need for priority administration by the New Mexico State Engineer.

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Groundwater Storage Changes from 1950s to Present in New Mexico Basin-Fill Aquifers

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Poster Abstract 23

In response to increasing water needs of New Mexico, we have estimated the historical groundwater storage change in most of the unconfined basin-fill aquifers of the state. Unconfined basin-fill aquifers in New Mexico form the major groundwater reservoirs in many of the state's urbanized and agricultural areas. This collocation has led to these aquifers being a major water source over the last 70 years, possibly leading to declines in storage through time. These aquifers are mostly in Rio Grande and Basin-and-Range physiographic provinces. Our estimates are based on depth-to-water measurements available from the USGS online database, and datasets that conform to USGS measurement standards. Measurements affected by pumping or those that were taken during irrigation season were removed, except for locations in rangeland areas with poor data coverage. Each decade, the median measured depths-to-water are interpolated. The resulting gridded estimates are restricted to regions that are statistically correlated and in Quaternary sediments as mapped at 1:500,000 scale. In almost all cases, groundwater storage has decreased, or, at best, remained constant over the last 70 years. In closed basins, storage declines are controlled by the balance of pumping vs. recharge. In open basins with a large through-flowing river, groundwater storage changes are related to the pumping rates, local connection to the river, and distributed recharge. Local connection to the river can buffer the withdrawals due to pumping. Our results provide a coarse resolution view of groundwater storage in New Mexican alluvial aquifers, without burrowing into societal controls on water use.

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Supporting Agro-Ecological Resiliency through Increasing Recharge in the Southwestern United States

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Poster Abstract 24

In the Southwestern United States, what underlies drought as a social crisis is a water storage problem. Less winter rain has diminished snowpacks and resulting runoff. Water users pump ground water to supplement, further reducing surface flows. Agriculture often withdraws the largest water quantities, yet these "working landscapes"- farming and ranching lands - also have the largest potential to influence recharge and contribute to longer term system resiliency. This study outlines a proposal to develop a tool that characterizes surface and ground water connectivity through an index identifying areas that can yield higher quantities of water. The tool will adapt existing system dynamics models to understand the mass water balance in specific regions and then feed back into a regional model to characterize the implications on larger scales. The intent is to reveal sustainable water management strategies that optimize infiltration to recharge our ground and surface water stocks. In dryland areas, surface roughness is the largest controlling factor for infiltration, pointing to the potential value of restoring vegetation density and flood flow along channel floodplains, as well as other land management practices that inhibit evaporation. Sending water below the surface and slowing its delivery to reservoirs inhibits evaporation, which would offset the increased vegetation transpiration. This approach has the potential to align social investment with sustainable management goals. Finding feasible mechanisms to allow working landscapes greater access to precipitation runoff can assist in critical production needs, mitigate catastrophic flood energy, and increase the ecological health upon which our communities rely.

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Adaptability and Productivity of Hybrid Poplars in a Semi-arid Climate

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Poster Abstract 25

The consideration of whether to grow plantation trees in the semi-arid Southwest is complicated due to limited water resources and harsh growing conditions. One genus of interest is Populus, which is fast-growing, adaptable to different soil types, and able to produce a variety of short rotation woody crops (SRWCs) under limited drip irrigation. To explore this potential, NMSU Agricultural Center at Farmington began research on water use of Populus canadensis (a P. deltoides x P. nigra cross) in 2007 with a trial aimed at monitoring growth of this species under varying irrigation levels. Four clones (entries 433, 544, 910 and 911) were planted as cuttings in April 2007 on 2.75 ha at 3.7-m spacing (770 stems ha-1) and irrigated at 70, 80, 120 and 130% of crop evapotranspiration (ETc) (later adjusted to 80, 100, 120 and 140% of ETc in 2013). Overall, clones 433 and 544 performed best in terms of growth and health. As of late 2015, entry 544 led for height (20.3 m), surpassing entry 433 (clone OP-367) at 19.1 m. However, both clones were statistically similar and highest for DBH (mean of 24.1 cm), wood volume (mean of 254 m3 ha-1), and total aboveground biomass (mean of 169 Mg ha-1). While biomass production tended to increase with higher irrigation levels, results varied by clone, year and other factors. Hybrid poplar seems to be adaptable to a semi-arid climate, with appropriate germplasm selection, site management and irrigation.

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Aquatic and Morphological Assessment of the Gallinas River within Las Vegas, NM, City Limits

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Poster Abstract 26

Urbanized streams 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 perennially flows through Las Vegas, NM, provides the municipal drinking water supply. City leaders also view the river as a potential economic resource 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. The urban effects within city limits have not been determined, however. The goal of this project is to conduct a thorough baseline stream health study of this river stretch, using chemical, biological and physical measures. To accomplish this goal, the following objectives will or have been completed: conduct a bioassessment using aquatic macroinvertebrates and fish; 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 lead to steps taken by local stakeholders in order to lessen the urban impact on the river, and help transform the river into an aquatically healthy source of pride and economic growth. This study ultimately may have a greater impact outside the area of northern New Mexico by serving as a model to other cities working to study and improve aquatic health in culturally and scientifically important water systems.

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Calculating High-Resolution Distributed Reference Evapotranspiration in Complex Terrain with GADGET

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Poster Abstract 27

Research at NMT as part of the NM WRRI Statewide Water Assessment (SWA) project has focused on determining water fluxes in mountainous regions, specifically improving the accuracy of evapotranspiration to enable improved estimates of groundwater recharge. In order to improve evapotranspiration (ET) estimates in complex terrain a procedure was developed to downscale gridded meteorological and solar radiation data at a spatial resolution adequate for assessment of ET and groundwater recharge in the mountainous regions of New Mexico. Gridded Atmospheric Data downscalinG and Evapotranspiration Tools (GADGET) uses three operational gridded products: NLDAS, METDATA and a 250 meter resolution Digital Elevation Model (DEM) for the calculation of reference ET. The topography (slope, azimuth, shading) is taken into account to adjust global incoming radiation for a horizontal surface from NLDAS (12.5 km x 12.5 km) to the DEM scale based on topographic parameters derived from a DEM. The gridded meteorological data downscaling scheme adjusts meteorological data similarly using elevation differences between the METDATA resolution (4 km x 4 km) and the DEM resolution (250 m x 250 m) by applying standard lapse rates to temperature and pressure. The net radiation determined from the topography-adjusted global solar radiation and the elevation-adjusted meteorological parameters determined for each DEM pixel are used to calculate a distributed daily Penman-Monteith reference ETr at 250 meter resolution for the state of NM and is being used to determine actual ET in the statewide soil-water-balance model, ETRM, also developed at NMT as part of the NM WRRI SWA.

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Mapping Water and Water Discourse across the CAERT Curriculum

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Poster Abstract 28

The CAERT Curriculum was created to deliver agricultural and environmental educators resources for providing secondary students the intellectual and practical training necessary for sustainable agriculture. Given the critical water issues in New Mexico, the objective of this study was to determine how water, water use, and water management were addressed across a purposeful sample of the New Mexico CAERT Curriculum. Using qualitative content analysis, initial findings indicate that the curriculum content is thematically consistent with the empty world socio-ecological regime. These findings are significant because the empty world regime is grounded in the assumption of resource abundance, an assumption that is inconsistent with resilience and adaptive responses to critical water issues.

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Modeling Focused Recharge through Ephemeral Streams in New Mexico

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Poster Abstract 29

Understanding the rate and distribution of groundwater recharge to New Mexico's aquifers is important because it defines a limit for the availability of water for humans and ecosystems. However, groundwater recharge is the least understood aspect of the state's water budget. With the goal of estimating groundwater recharge statewide, we are developing the Evapotranspiration and Recharge Model (ETRM), which uses existing spatial datasets including, PRISM precipitation data, Normalized Difference Vegetation Index (NDVI), state soils data, and state geology data to model the daily soil water balance over the state. Currently, while the model does calculate the amount of runoff for each 250 m x 250 m cell, the estimated recharge values represent in-place or diffuse recharge only. It is important to include focused recharge (recharge resulting from water infiltrating through ephemeral streambeds) in our estimates because this process likely accounts for a significant proportion of recharge in New Mexico. Initial efforts to estimate focused recharge focuses on analyses for three ephemeral streams in NM: Mogollon Creek, the Zuni River, and the Rio Puerco. Total runoff estimated by the ETRM within sub-basins above existing USGS stream gauges will be compared to measured stream discharge at the gauges. Statistical analyses will relate the ratio of measured discharge/ modeled total runoff to basin characteristics, such as geology, topography, vegetation type, etc. These analyses will likely allow us to establish an algorithm to estimate this important component of the water balance for the entire state of NM.

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Improving Water Quality in Urban Streams Using Native Riparian Vegetation

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Poster Abstract 30

Riparian areas along urban drainage canals and streams are vital to the overall health of the environment but the investment in their management is a major barrier due to difficulty of quantifying the associated benefits. It is difficult for decision makers to assess the amount of funding that should be invested in riparian habitat restoration. To improve our understanding of the riparian areas along urban drains and streams, this study investigates the use of native plants specifically the Rio Grande cottonwood and black willow to improve water quality. The study is on-going and preliminary results are presented.

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Attached Growth and Suspended Cultures for the Algal Remediation of Arsenic

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Poster Abstract 31

Arsenic contamination of water is a highly important global health concern. Arsenic readily leaches into ground and surface water from soils of high arsenic content as well as through anthropogenic activities, such as mining and agricultural practices. Once introduced into a water system, arsenic can affect a range of mild to detrimental health effects to the human body. Easily applied, low-cost solutions to this issue would be of great benefit, especially in developing, rural, and tribal communities, where resources are limited. To this end, our research group is investigating arsenic remediation by algae in suspended growth and attached growth (biofilm) cultures. In order to determine the best use of this technology, kinetics of uptake and arsenic retention within the algae will be studied. These experiments will be explored at bench scale (1L) at UNM, and expanded to pilot scale (200L) employing raceway bioreactors located at Santa Fe Community College. Arsenic removal will be quantified by monitoring concentration within the synthetic feed using inductively coupled plasma-mass spectrometry (ICP-MS). A local, abundant algal polyculture dominated by Scenedesmus will be investigated. Our results will carve a path for additional research towards the application of algal populations in remediation of metals from water.

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Water Quality within the Middle Rio Grande

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Poster Abstract 32

Water within Rio Grande supports hundreds of miles of riparian forest, abundant and diverse fauna, and thousands of individuals throughout the watershed. Anthropogenic influences can lead to highly impacted river systems, particularly through dense urban areas. The Bosque Ecosystem Monitoring Program (BEMP) has sampled the Rio Grande three times per year (spring, summer, and fall), since 2011 at 13 locations along 137 km of the river from Bernalillo to San Acacia, NM. These sample locations were selected to investigate changes in quality as the water flows downstream.

Samples were taken from the river, a nearby ditch, and several groundwater wells at each location. Each sample was tested for pH, dissolved oxygen, turbidity, conductivity, and analyzed for anions. Additional testing for E.coli, fecal coliform and polychlorinated biphenyls (PCBs) was performed on ditch and river samples (and a few groundwater wells). Four of the river sampling sites were tested for pharmaceuticals and personal care products (PPCPs).

Large variation within the field parameters occur between seasons and throughout the years. Data shows that levels of E. coli in the river and ditches increase as the water travels downstream. Large increases in PPCPs occur south of Albuquerque, with detected compounds including artificial sweeteners, pesticides, flame retardants, antibiotics and more. To date, no PCBs have been detected in any water samples. Continual monitoring of our river system will allow us to better understand human influences on water quality and how it may impact downstream users and the adjacent riparian ecosystem.

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Effects of Wildfire on Hydrologic Dynamics in New Mexico

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Poster Abstract 33

In the mid-1980's large wildfires in western North American forests increased markedly in spatial extent, duration, frequency, and severity in association with higher spring and summer temperatures, as well as reduced winter precipitation. This regional increase in large wildfires occurred in association with an unprecedented multi-year drought that may have been a consequence of climate warming and a harbinger of a prolonged intensification of aridity in this region. In addition to prolonged drought, another factor contributing to this increase in large wildfires is a history of fire suppression in the western United States that has resulted in a 'fire deficit' relative to long-term patterns. Examination of historical periods of climate warming implies that conditions conducive to large wildfires will continue as Earth's climate warms further. Many of these wildfires have burned and are expected to burn in New Mexico forests. These New Mexico wildfires have caused geomorphic changes, influenced water quality, and influenced the water balance across a wide range of spatial scales. Accurately modeling the water balance in burned areas requires knowledge of fire effects on soil hydraulic processes, and how these effects vary with burn intensity and with passing time. Most past research investigating wildfire effects on soil hydraulic properties has not considered long-term effects of wildfires on soil properties. The goal of the proposed research is to improve our understanding of the impacts of ecological disturbances on exacerbating or mitigating existing water shortages in water-limited regions of the conterminous United States.

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Oxidation of Arsenite by a Carbon Nitride Photocatalyst with Graphitized Polyacrylonitrile

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Poster Abstract 34

The presence of toxic arsenic in various water bodies is a matter of concern in New Mexico (NM). The highlight of this project is to develop an efficient process for toxic and carcinogenic arsenic removal from water, while this contaminant is sourced from mining, industrial waste, etc. Utilization of an environmentally benign photocatalyst such as g-C3N4 and its incorporation with a charge carrier (g-PAN) may offer a promising solution towards the reduction of arsenic contamination in NM. g-C3N4 or g-PAN can be obtained by simply heating melamine or PAN in an inert atmosphere at an elevated temperature. Surface and optical properties will be evaluated using SEM, TEM, FTIR, UV-vis. spectroscopy, and BET adsorption. Above all, the objectives of this research project are to (i) determine the BET surface area of g-C3N4 and its composites with g-PAN, (ii) evaluate photocatalytic oxidation of As(III) as a function of the percentage g-PAN in g-C3N4, and (iii) correlate the results with the BET surface area.

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

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Poster Abstract 35

The USGS National Water Census provides a nationally consistent set of indicators that reflect status and trends of water resource availability in the US, provides information and tools that allow users to better understand the flow requirements for ecological purposes, and reports on areas of significant competition over water resources and the factors that have led to the competition. As a part of the National Water Census, a Focus Area Study has been initiated in the Upper Rio Grande Basin with the objective of spatially integrating of a variety of data sources to better understand the components of the water budget on a basin scale (at HUC-8 resolution), and how these have changed over time (where possible). This poster will provide an update on progress to date (currently in year 1 of a 3-year study) in each facet of the study, including a basin-wide water-use compilation, advances in snow process modeling, NEXRAD-based estimates of actual evapotranspiration using the SSEBop model, groundwater status and trends, basin-wide chemical baseflow separation, and hydrologic watershed modeling using the PRMS model.

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Pore-Scale Transport of Strontium and Chromate during Dynamic Phase Changes in the Unsaturated Zone

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Poster Abstract 36

Dynamic water content changes in the unsaturated zone caused by natural and manmade processes, such as evaporation rainfall, and irrigation, have an effect on contaminant mobility. In general, in the unsaturated zone, evaporation causes an increase in contaminant concentrations, potentially leading to sorption of contaminants on aquifer materials or precipitation of crystalline or amorphous phases. On the other hand, an increase of water content may result in dissolution of precipitated phases and increased mobility of contaminants. A goal of this study is to determine the oxidation state when strontium and chromate sorb and/or precipitate on sand using X-ray absorption near-edge structure spectroscopy. The objective of this study is to develop a quantitative model for the transport of strontium and chromate (chromium-VI) through sand under dynamic water content conditions, as a function of strontium concentration, chromate concentration, pH, and ionic strength. Strontium was selected as a surrogate for strontium-90, a by-product of nuclear reactions. Chromate was selected because of its known mobility in the environment, being a carcinogen, and a good surrogate for an anionic contaminant.

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Pathogenic Bacterial Impairment and Regrowth Along the Rio Grande Near Albuquerque

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Poster Abstract 37

The USEPA considers the Rio Grande near Albuquerque (between Angostura and Isleta diversions, ~60 km reach) to be impaired for E. coli bacteria. Concentrations exceed water quality standards year-long, with dramatic exceedances typically July through August. Although most E. coli are not pathogenic, these bacteria are considered an indicator of pathogenic fecal coliforms which can cause serious illness in exposed humans and animals. Downstream water users (Isleta Pueblo), the Albuquerque public, and others affected by irrigated crops grown in the area all risk exposure. The Total Maximum Daily Load (TMDL) establishes allowable waste loadings for entities discharging to this reach, to which end ~$20 million were spent on monitoring and mitigation in the Albuquerque urbanized contributing area from 2000-2010 . Reductions in bacterial contamination have not been observed. It is still not known which sources contribute most significantly to bacterial loads and how these sources may vary seasonally. Current EPA specifications acknowledge but do not take into account the potential for bacterial regrowth in surface water and streambed sediments to contribute bacterial loads, contributing to summer exceedances.
The objective of this project is to quantify processes controlling bacterial exceedances in the Rio Grande near Albuquerque by monitoring and modeling the growth potential and decay rates for E. coli bacteria in the Rio Grande main channel and streambed sediments. This will benefit discharging entities' contamination reduction strategies and water users' health by giving a better understanding of the sources and sinks of E. coli along the reach throughout the year.

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Improved Meteorological Infrastructure for Water Management in the Middle and Lower Rio Grande, New Mexico

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Poster Abstract 38

Management of water in a basin requires an accurate estimate of water budget. Consumptive use or evapotranspiration (ET) losses in the water budgets are often estimated by meteorological methods using data measured by the climate stations which are spread in agriculture and riparian regions of New Mexico. The climate stations in the Middle and Lower Rio Grande, which the consumptive use (or ET) for water management depends upon, have deteriorated due to lack of proper maintenance and funding. Improper maintenance of instrumentation at the climate stations can result in meteorological data measurements that are prone to large errors which then affects the consumptive use estimates in the water budget. In an effort to begin the process of improving meteorological infrastructure within the Middle and Lower Rio Grande, the status of the climate stations and their spatial distribution are presented.

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Gila National Forest Stream Temperature and Intermittency Monitoring Network to Assess Effects of a Changing Climate for Native Fishes of Special Interest

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Poster Abstract 39

Stream temperature, flow, and the presence of non-native fishes can affect the distribution of native cold- and cool-water fishes. This is especially true for native fishes that have already experienced significant contractions in their historic range. The Gila and Mimbres drainages, located in southwestern New Mexico, support a unique cold- and cool-water native fish fauna adapted to the arid stream systems in which they evolved. These fishes, however, are losing ground to non-native fishes and the loss of habitat due to intermittency from stream drying. The objective of this work is to establish a stream temperature and intermittency-monitoring network throughout the two drainages in coordination with federal, state, and NGO partners. Temperature data from this network will be used to model current and future distribution of native fishes and co-occurrence of non-native fishes. Implementing this network will require three types of temperature data loggers over 100 sites across two drainages. Either the ProV2 or the Tidbit loggers (Onset, Inc.) will be used to record hourly water temperature across varying habitat conditions. In addition, a modified HOBO™ Pendant Temperature/Light data logger will be deployed in streams to document intermittency from drying (presumably loss of fish habitat). The use of these loggers coupled with current and historical fish population data will allow us to model current and future critical habitat. The monitoring network is planned to extend past the lifetime of the WRRI grant and continue to aid in the management of fishes of greatest conservation need.

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Transboundary Aquifer Assessment Program

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Poster Abstract 40

Groundwater represents the major available source of freshwater in the world. More than half the world's population depends on groundwater as a primary water source. Irrigation and domestic uses are the main sectors of the society demanding water from aquifers. Increases in population and excessive amounts withdrawn have caused a rapid depletion of groundwater level. Contamination of aquifers is another problem, which makes it very difficult to clean up groundwater; prevention, assessment and monitoring are essential to protect groundwater resources. Binational efforts between the U.S. and Mexico through the Transboundary Aquifer Assessment Program have contributed to achievements such as binational research plans, and compilation of U.S. hydrologic and geologic data (Jac van der Gun, 2012). Current cooperation efforts with Mexico were shown in the binational meeting regarding the transboundary aquifers between the United States and Mexico hosted by IBWC last September 29th in El Paso, addressing current efforts, next steps and future objectives.

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