# THE IMPACTS OF LAND USE CHANGE ON WATER QUALITY IN ALCALDE, NEW MEXICO

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## Poster Abstract 1

Land use change is apparent in the Rocky Mountain West, particularly in rural areas. Urban and residential growths have added to the complexity of existing water issues. Alcalde is a small acequia community located in north-central New Mexico. Residential and economic growth in Alcalde and the surrounding urban centers have placed pressures on scarce water resources. Residential land use conversion has increased considerably in the past 40 years, which poses potential groundwater contamination risks due to significant growth in the number of single household septic systems. The objective of this research was to build a framework with which to determine potential risks to groundwater quality in Alcalde; this was accomplished using GIS. A 2003 land use layer and a point layer for septic tank locations were generated. Then, an overlay analysis was performed using an interpolated depth to water surface, soils infiltration data, and slope. The results showed a considerable amount of the current residential growth, the dominant force behind land use change in the region, is occurring in areas where the groundwater has low to medium vulnerability. The high risk areas largely coincide with agricultural lands, strengthening the case for the need to conserve agricultural lands in the region, which preserves a way of life and curbs environmental impacts associated with urban and residential growth. In concluding this research, we found that the aquifer vulnerability assessment overlayed with the land use data provided a sufficient framework with which to determine the most suitable areas for residential growth to occur.

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# OFFLINE COUPLED WRF-DISTRIBUTED HYDROLOGICAL MODELING: PRELIMINARY TESTING FOR A WARM-SEASON FLOOD EVENT IN THE SOUTHWESTERN US

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**Poster Abstract 2**

By improving skill in short term forecasts of extreme precipitation events, the Weather Research Forecasting (WRF) model has the potential to significantly enhance hydrological forecasting of flood events and distributed land surface variables. Compared to earlier generations of meteorological models, WRF can provide an unprecedented level of detail in meteorological forcings to distributed hydrological models, including long-lead time forecasts of meteorological conditions at high spatiotemporal resolution over a large spatial domain. In this study, we couple the WRF model to the TIN-based Real-time Integrated Basin Simulator (tRIBS) hydrological model in an offline mode. This case study focuses on a warm-season mesoscale convective storm event occurring in the Four Corners region of the southwest U.S. during the late monsoon season (September 2003). We are primarily interested in assessing the potential for WRF to issue improved meteorological forecasts of precipitation during a large, semiarid flood event in Upper Rio Puerco, New Mexico. A three tier interactive nesting (grid spacings of 30, 10, and 3.33 km, respectively) configuration of the WRF model is driven by North American Regional Reanalysis (32-km resolution) data for 4 days with the finest grid centered on the Upper Rio Puerco. Our results demonstrate that WRF captures the essential spatiotemporal features of the mesoscale storm as compared to NEXRAD quantitative precipitation observations. We then compare the tRIBS forecasts from the WRF meteorological fields with a set of run using weather station and NEXRAD data. The comparisons clearly illustrate the value of the WRF simulations for hydrological simulations of streamflow and internal, high-resolution basin hydrological states. Preliminary testing in the offline coupled model will contribute to the development of a fully coupled hydrometeorological prediction system for warm-season flood forecasting in the North American Monsoon region.

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# REMOTE SENSING OF EVAPOTRANSPIRATION AND TAMARISK RECOVERY AFTER FIRE USING THE SEBAL ENERGY BALANCE ALGORITHM

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**Poster Abstract 3**

Millions of dollars have been spent in New Mexico to remove nonnative vegetation such as tamarisk from arid riparian lands along the Rio Grande. One of the tamarisk removal techniques is controlled burning. Tamarisk is early successional after fire, but little is known about succession rates to full maturity. Elevated evapotranspiration (ET) rates of tamarisk are a main factor in motivating the invasive species' control. Satellite derived estimates of spatial ET computed using a Surface Energy Balance Algorithm for Land (SEBAL) provide an accurate means for monitoring vegetation change and water consumption before and after fire. In this project SEBAL was used to compare ET at the burned and unburned areas of three recent fires: 1. Mitchell Fire of April 10-16, 2005, which burned 1,100 acres of private land, 2. Marcial Fire of May 3-6, 2006, which burned 4,819 acres of private land and 755 acres of the southern end of Bosque del Apache NWR, and 3. Bosquecito Fire of June 6-11, 2006, which burned 640 acres of private land. By comparing the SEBAL model results to field point measurements, the method will be evaluated in its effectiveness of estimating spatial and temporal ET and vegetation recovery after fires. This project will ultimately advise hydrological and ecological managers on regeneration rates and changes in ET post-fire. In addition, the project aims to provide data for the implementation of combined burn-herbicide control techniques that have been proven to be up to 90% effective (McDaniel and Taylor 2003).

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# THE PRODUCTIVITY OF WATER IN IRRIGATED NEW MEXICO PECAN PRODUCTION: MEASUREMENTS AND POLICY IMPLICATIONS

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**Poster Abstract 4**

Pecans are a major agricultural crop in New Mexico. Currently there are more than 25,000 acres of pecans in the Mesilla Valley, consuming more than one third of the annual diversion. The research presented here provides previously unavailable broad-scale estimates of pecan ET and the pecan water production function in southern New Mexico. The data which form the foundation of this paper were generated using the Regional ET Estimation Model (REEM) developed at New Mexico State University for agricultural and riparian vegetation (Samani et al. 2005, 2006, 2007). REEM uses remotely sensed satellite data to calculate ET as a residual of the energy balance. This paper extends the results of REEM to an analysis of the productivity of water in irrigated pecan production in the Mesilla Valley. The results of this research provide new insight into pecan water use and the yield results of this water use. This research illustrates the linkages which can be made between remote sensing technology and models and farm-level yields. This research sheds new light on the long-standing practice of deficit irrigation, as well as the yield and conservation impacts of this practice.

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# GEOMORPHIC CHANGES IN THE MIDDLE RIO GRANDE: THE DEVELOPMENT AND FUTURE OF THE SAN ANTONIO OXBOW

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## Poster Abstract 5

Human disturbance has interrupted natural processes, such as the natural flow regime, in rivers of the southwestern United States, including the Rio Grande, for over a century. Oxbows are a natural part of low-gradient river systems, but flow regulation and channelization has caused many of these oxbow habitats to be cut off from the main stem rivers. The San Antonio oxbow in the urban reach of the Middle Rio Grande in Albuquerque, New Mexico is one such habitat. Originally part of the main stem of the river, the San Antonio oxbow began to cut off from the Rio Grande in the late 1960's after the installation of levees and jetty jacks. The San Antonio oxbow is now an isolated wetland habitat with little connection to the river. Restoration of off-channel habitats like the San Antonio oxbow is now a management goal to return connectivity between the channel and the historic floodplain.

The poster will depict the changes to this portion of the river, the creation of the San Antonio Oxbow, and management implications for its protection in the future.

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# EFFECT OF SOLUTE CONCENTRATION ON SATURATED HYDRAULIC CONDUCTIVITY

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**Poster Abstract 6**

Increase in concentration of saline wastewater by evaporation reduces the resistance of clay-based lining material to flow due to the change in the thickness of diffuse double layer. The first objective of this research is to determine the effect of solute concentration on the saturated hydraulic conductivity (Ks) of soil and some liner materials. The second objective is to identify a lining material of low Ks that can be used to immobilize and prevent the leaking of saline wastes from evaporation ponds into the groundwater. Three different chemical compounds (sodium silicate, calcium hydroxide, and magnesium hydroxide) were selected. Columns were packed with a mixture of each lining material (5g) and surrogate soil (60g). Additional columns were packed with a layer of the lining materials (5g) placed between 50 and 10g of surrogate soil. Each column was saturated with solutions of different electrical conductivities (2, 5, 10, 20, and 30 dS/m) and Ks was determined by the constant head method separately for each solution. In general, Ks was lower from the layered than the homogeneous columns. In columns packed with calcium hydroxide and magnesium hydroxide, the Ks decreased with increasing solute concentration. In contrast, Ks increased with increasing concentration in the columns packed with a mixture of surrogate soil and sodium silicate but remained similar in the layered sodium silicate columns. Preliminary results showed that calcium hydroxide and magnesium hydroxide could be better lining materials in the evaporation ponds than sodium silicate.

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# MAPPING OF REDOX CONDITIONS AND pH IN GROUND WATER OF THE MIDDLE RIO GRANDE BASIN, NEW MEXICO

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**Poster Abstract 7**

Data collected in 2005 by the U.S. Geological Survey as part of the National Water-Quality Assessment program's Transport of Anthropogenic and Natural Contaminants study were combined with historical data to create maps of the regional oxidation-reduction (redox) state and pH of ground water in the Santa Fe Group aquifer system of the northern half of the Middle Rio Grande Basin (MRGB). The redox state and pH of ground water can both be important geochemical controls on the solubility and mobility of anthropogenic contaminants and naturally occurring trace elements. For this study, redox conditions were inferred using commonly available redox-indicator species: dissolved oxygen, nitrate, manganese, iron, and (or) sulfate. Conditions were categorized as "oxidized" (consistent with oxygen or nitrate reduction), "reduced" (consistent with manganese or iron reduction), or "mixed." For pH, wells were categorized as producing ground water with pH less than 8 or pH greater than or equal to 8. Although many of the nearly 520 wells included in the dataset had long screened intervals (up to 1,465 feet), vertical discretization of the data was sufficient across large areas—particularly near Albuquerque—to map differences in redox conditions and pH with depth within about the upper 1,000 feet of the aquifer.

Mapping results indicate regional variations in both redox conditions and pH. Oxidized conditions dominate throughout much of the aquifer, except within about the upper 400 feet beneath the Rio Grande inner valley. Reduced conditions along the inner valley could indicate that the aquifer in this area has a greater availability of organic carbon from natural and (or) anthropogenic sources. Patterns in pH values indicate that they commonly equal or exceed 8 in the western part of the MRGB and become more likely to equal or exceed 8 with increasing depth in the aquifer. Higher pH values could generally reflect areas where extensive cation exchange has resulted in greater calcite dissolution.

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# DETERMINATION OF HEAVY METAL CONCENTRATIONS IN URBAN RUNOFF FROM THE CITY OF LAS VEGAS, NEW MEXICO BEFORE DISCHARGE INTO THE GALLINAS RIVER

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**Poster Abstract 8**

The Gallinas River serves a majority of people (approximately 90%) living in Las Vegas, New Mexico for their agricultural, private, recreational, and potable water needs. Recent studies have been carried out on the water quality of the Gallinas River, and much of its quality deterioration has been attributed to the geology of this area. But a significant amount of non-point-source runoff enters the Gallinas River from different zones and areas during wet weather flow. The primary objective of this study will be to determine the concentration of heavy metals in urban surface runoff discharged directly into the Gallinas River. Three sampling sites have been identified that discharge runoff directly into the Gallinas River. Runoff samples will be collected by hand using acid washed bottles at one-hour intervals during storm events, after which samples will be acidified, filtered, and ready for analysis. Expected results will indicate a higher metal concentration in runoffs from high-use and high population areas and the concentration of metals will be highest in runoff following the first precipitation event. The information and methodologies presented may facilitate pollution source characterization and ecological restoration efforts in the Gallinas watershed.

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# BIOASSESSMENT OF ARSENIC CONTAMINATION OF THE GALLINAS RIVER USING BENTHIC MACROINVERTEBRATES

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## Poster Abstract 9

Chemical and organic pollutants in a watershed get into runoff and may impact the water quality of lotic and lentic systems especially during storm events. The distribution pattern of benthic macroinvertebrates (BMIs) has been used in past studies to determine the extent of this potential impact. The current study uses BMIs in this capacity to determine arsenic distribution in the Gallinas River and its impact on the aquatic ecosystem. The aim of this study is to assess the impact of arsenic contamination on the health of the river ecosystem and to investigate possible biomagnification of this heavy metal and risks to local populations. We hypothesize that metal distribution in the sediments would positively correlate with levels found in the BMIs and negatively correlate with physico-chemical water quality parameters for the same sampling sites from the head waters, in the Elk Mountains, to the lower reaches below the city of Las Vegas, New Mexico. Biochemical assessment is also expected to provide evidence of highest accumulation efficiency by predators compared to other guilds. Preliminary results indicate high percentage of pollution tolerant taxa residing downstream from the city of Las Vegas while the upstream sites have higher richness and higher diversity indices. These results correlate with selected physico-chemical parameters of the river measured at the time of sampling. Biotic metrics demonstrate that the river ecosystem is seriously impacted in the lower reaches while the upper reaches near the headwaters remain relatively sensitive or non-impaired.

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# DETERMINATION OF SELECTED HEAVY METAL CONCENTRATIONS AND DISTRIBUTION IN THE GALLINAS RIVER USING MACROPHYTES

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**Poster Abstract 10**

Recent studies have reported elevated concentrations of arsenic and other heavy metals during high flow events in the Gallinas River (GR). Previous research to assess water quality in this river has been limited to conventional analytical methods (soil, sediment, and water sample analyses). The use of macrophytes to assess heavy metal contamination in this river has not been reported. This study is intended to measure the concentration and distribution of heavy metals (Pb, Cd, Cu, Zn, As) within the Gallinas River using macrophytes. We will establish a correlation between heavy metal concentrations in the plants and those in water and sediment samples from previous studies. Macrophyte samples were collected from the same sites that previous GR investigations have used: upper Gallinas (S4), Montezuma (S3), lower Gallinas, above the wastewater treatment plant (S2), and below the wastewater treatment plant (S1). Sampling was done in May 2007 and will be repeated in the fall of 2007. Samples were handpicked randomly from each site, two from S2 and three from the other sites. The plants were rinsed with tap water followed by DDI water. They were separated into roots and shoots (except the mosses), oven dried at 83$^{o}$C for three days and analyzed for heavy metals by High Resolution Inductively Coupled Plasma Mass Spectrometry. Using water quality and flow meters the following in situ measurements were taken at each site: flow, temperature, dissolved oxygen, pH, and conductivity.

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# RIO GRANDE BASIN INITIATIVE - INTERACTIVE MAPPING FOR NEW MEXICO

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**Poster Abstract 11**

The Texas A&M Spatial Sciences Laboratory has created interactive web-based mapping services for Texas counties located within the Rio Grande Basin for the Rio Grande Basin Initiative. The goal for NMWRRI is to create an NMSU sister site that preserves the look and feel of the Texas A&M site that will deploy similar map services for New Mexico counties using ArcIMS technology. ArcIMS is a web-based GIS program that is used to create interactive, web-based maps that can be manipulated by the user to show desired data, perform queries, measure distance, create buffers, etc. This ArcIMS project is divided into two phases, the first of which is nearing completion. This Phase One data includes hydrologic data, Toxic Release Inventory sites, Superfund national priority list sites, vegetation data, STATSGO and SSURGO soil data, Digital Orthophoto Quarter-Quad imagery (which are available only on county-level map services), administrative boundaries, geologic data, land use data, climate data, and transportation and infrastructure features. Phase Two data for the project are to include Census of Agriculture data, Census Bureau data, and health related data. In-house data at NMWRRI has been used, as well as data from RGIS, EDAC, EPA, etc. The site is located at http://water.nmsu.edu/website/ rgbi/index.htm and offers a statewide map service as well as individual map services for all 33 counties.

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# WATER QUALITY STUDY ON THE SAPELLO RIVER HEADWATERS, SAN MIGUEL COUNTY, NEW MEXICO

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**Poster Abstract 12**

The upper reach of the Sapello River runs through the Pritzlaff Ranch in San Ignacio, New Mexico. This study will focus on the current water quality in this reach of the Sapello River by assessing and combining various different approaches to watershed health. By incorporating chemical water quality parameters, geomorphology, physical habitat conditions, upland conditions, and water quality conditions based on benthic organisms, a complete view of watershed health will be made. Finally through the use of GIS and GPS technology, a visual analysis will be used to display these measured parameters within a comprehensive map of the study area. Our data will make it possible to assess if water quality standards are being upheld, as well as determine any apparent trends in water quality. The water quality indicators analyzed will also be used to identify current or past land management practices or pressures from drought that may be negatively impacting the stream. Expected results include a negative trend in all water quality characteristics as the sample sites ascend downstream indicating the impact of the accumulative effects of land management practices. It is also expected that the measured biological water quality indicators will increase in tolerance from the upper to the furthest downstream site.

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# NITROGEN AND CHLORIDE DISTRIBUTION IN ONION FIELDS UNDER DRIP AND FURROW IRRIGATION SYSTEMS IN MESILLA VALLEY OF NEW MEXICO

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**Poster Abstract 13**

Water scarcity accompanied by salinity build up is a major challenge faced by the farmers of arid areas. Flushing salts out of the rootzone with large amounts of water is a temporary solution as salts can again accumulate at the bottom of the rootzone with the upward movement of water. To comprehend the leaching with irrigation and subsequent building up of nitrate and chloride at the vadose zone with evapotranspiration, a study was conducted in two onion fields under drip and furrow irrigation systems in the Mesilla Valley of Las Cruces. The total amounts of irrigation, precipitation and fertilizer inputs were obtained for each onion field. Soil samples were collected at six depths, two-hours prior to irrigation, one day after the irrigation, and three days later. Additional soil samples were collected once a month during the entire growing period. Soil samples were used to determine soil profile texture, pH, EC, nitrate, and chloride. The data analysis showed leaching of nitrate immediately after irrigation and subsequent build up of nitrate at the surface due to evapotranspiration gradient. In general, chloride and nitrate distribution patterns within the soil profile were different. The cumulative stressed ET for onion was 687 mm (93% of water applied) for furrow and 736 mm (95% of water applied) for drip irrigated fields. Preliminary results indicate that irrigation efficiencies are reasonable; the ongoing work involves the determination of the usefulness of chloride technique to estimate on-farm irrigation efficiency and calculate nitrate loadings below the rootzone.

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# EVALUATING PECAN WATER USE IN MESILLA VALLEY

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**Poster Abstract 14**

Dona Ana County has been ranked number one in Pecan Production. There are about 1056 pecan growers growing pecans in 23,745 acres of land in Doña Ana County. Pecan is believed to be the highest water user compared to other crops. However, the amount of water used by pecan varies by management practices, irrigation scheduling, soil type, and plant density. Remote sensing technology was used to evaluate the actual water use during 2002, which was a full allotment year. The results of field scale consumptive use for various pecan fields were compared with optimum water requirement of pecan. The results showed that pecans are generally under-irrigated. There is significant potential for increased productivity and increased income from the existing pecan orchards. However, the increased productivity will result in increased consumptive use and the need for diversion of water supply for other crops.

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# IMPACT OF BRACKISH GROUNDWATER AND GRAY WATER ON TOMATO GROWTH

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**Poster Abstract 15**

This paper presents findings of the potential for safe and beneficial use of brackish groundwater and graywater for vegetable crops irrigation from the field experiment in El Paso. Fast growing cities in arid and semi-arid regions such as El Paso, Texas, and Ciudad Juarez, Mexico, demand alternative water resources for sustainable development of the region. Therefore extending water supplies is essential for the Rio Grande Basin. Discovering safe, beneficial, and economically feasible strategies to utilize reclaimed wastewater and salty ground water will benefit the basin. The objective of the study is to assess the impact of brackish groundwater (well water) and laundry water irrigation on tomato growth. Two types of tomatoes were studied, beef and cherry tomato. Results showed that laundry water increases fruit yields and the number of fruit harvest from selected tomato plants relative to those receiving well water irrigation for initial harvest. The irrigation water also has impacts on the size of fruit. For beef tomatoes, laundry water irrigation produces larger size fruits than well water irrigation. For cherry tomatoes, well water irrigation produces larger size fruits than laundry water. The results show that both brackish water and gray water can be used for crop production.

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# USING AN INFRARED IMAGING CAMERA TO DETERMINE EVAPOTRANSPIRATION RATES FROM A SEPTIC DRAIN FIELD

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**Poster Abstract 16**

Currently, there is uncertainty regarding how water moves in a septic drain field. There are two possibilities: either the water is taken up by plants that are planted over the drain field and is emitted into the atmosphere through evapotranspiration (ET) or the water percolates through the soil down through the infiltrative surface biomat to the groundwater. The ET rates will help in understanding how much of the septic water is being evapotranspired upwards or how much is leaching down towards the water table. Using an infrared camera, remote heat-sensing, one can visually identify temperature variation in the drain field. Temperature readings from a weather station, the surface temperature of the IR based septic drain field temperature, are incorporated into the standardized evapotranspiration equation. When compared to an estimated ET using the weather station data and the standardized evapotranspiration equation, the surface temperatures were very close and indicate that the surface temperatures given from the infrared images can be utilized to calculate ET rates of the drain field using a modified ET equation. These estimated ET values can be used to verify how much water is being lost through ET or how much wastewater is leaching towards the groundwater.

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# EFFECTS OF SOIL CONDITIONING ON SOIL AND LEACHATE QUALITY WITH LAUNDRY WATER AND BRACKISH WATER IRRIGATION

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**Poster Abstract 17**

With prolonged droughts in semi-arid and arid regions and growing demands for fresh water as urban areas expand, agricultural production will need to rely increasingly on alternative water sources for irrigation. Laundry water and brackish water are among those alternative sources. In this paper, the authors assess effects of soil conditioning on soil and leached water quality using a column test in a greenhouse environment. A total of 18 soil columns were used, of which six are empty, six with mulch, and six with mulch and lime. Two kinds of water were applied, namely laundry water and brackish well water. The organic amendment with or without lime initially increased leachate EC, particularly from soil irrigated with well water. The mulch contained high quantities of nitrogen that translated to high concentrations of nitrates in leachate. Nitrates contributed to elevated leachate EC after the first irrigation cycle. Conversely, the addition of organic amendments slowed the gradual increase of leachate sodicity. This was most apparent for leachate from laundry water irrigation. Soil conditioning had less impact on leachate quality when well water was used for irrigation. Leachate SAR and Na were slightly reduced. The results indicated the soil salinity and sodicity may not be immediate issues when sandy soils receive alternative water supplies. Sandy soils have very low water holding capacities and low cation exchange capacities. Organic (mulch) amendment and lime were added to soil to ensure or increase water infiltration and drainage by enhancing soil particle aggregation and porosity.

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# HISTORICAL INVESTIGATION OF SOLUTE TRENDS IN THE UPPER RIO GRANDE BASIN

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**Poster Abstract 18**

Water salinity is a major concern in the southwestern United States. Poor quality waters can lead to decreased crop yields, damaged residential water pipes, and endanger aquatic life. Water quality concerns in the Rio Grande Basin pre-date the turn of the century. Chemical data collected in the early twentieth century are compared with decadal averaged data from the 1930s to 2005. The historical comparison reveals a decrease in solute load over time, both in conservative and reactive solute species. The cause of this decrease is difficult to ascertain, but is likely related to the accumulation of solutes in soils. In the early 1900s a drainage network was constructed which seems to have flushed out the solutes previously trapped. The data illustrate this theory with a pulse of high saline water in the 1930s-40s, which tapers off in the 1950s.

Spatial trends were also investigated. In general, the solute load for each chemical constituent increases downstream from the headwaters in Colorado into Texas. Concentrations of magnesium, calcium, and bicarbonate decrease below Elephant Butte Reservoir, which may be caused by precipitation of carbonate minerals within the reservoir and possibly in irrigated fields below Elephant Butte.

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# DITCH AND FIELD SEEPAGE EFFECTS ON FLOODPLAIN WATER BUDGETS AND RIVER FLOW

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**Poster Abstract 19**

Changing land and water use patterns in northern New Mexico may reduce irrigation diversions from the Rio Grande into acequia irrigation systems. Groundwater and river flow may be affected by reductions in irrigation. To identify the effects of acequia system seepage on groundwater and river flow, this study measures components of the Rio Grande floodplain water budget and integrates hydrologic fluxes with computer modeling. Over the 9-km length of the Alcalde Acequia, 12-16% of canal flow seeps from the earthen canal. In flood irrigated fields, 15-62% of applied irrigation water percolates below the rooting zone to the shallow water table. After the onset of the irrigation season, the water table rises 1 to 2 m and groundwater flow paths orient towards the river, indicating seepage becomes shallow groundwater return flow to the river. The project uses 2- and 3-dimensional modeling of the Alcalde Acequia system and the larger 20 km-long valley to identify amount of return flow and its effects on the river hydrograph. Preliminary analyses suggest on the order of 25% augmentation of late-summer and early-fall river flow from groundwater return flow that originated as irrigation seepage. Water quality analyses show the seepage dilutes nutrients and salts in resident groundwater, improving the quality of return flow. Remote sensing-based estimates of evapotranspiration will be used to refine initial estimates of riparian vegetation evapotranspiration. Ongoing work will provide an integrated characterization of floodplain hydrology at the large watershed scale and enable system dynamics simulation of future reduced acequia water deliveries.

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# A MULTI-DISCIPLINARY STUDY OF A COLD-WATER TUFA SPRING MOUND IN SANTA ROSA, NEW MEXICO

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**Poster Abstract 20**

A comparative study was conducted of a tufa mound precipitating from a cold-water spring near Santa Rosa, New Mexico, relative to two non-precipitating control springs within 8 km. Using measurements of dissolved $CO_2$ and chemistry (TDS, anions, cations, pH, temperature, alkalinity, conductivity, etc), the waters from the three springs were compared and contrasted. The primary control of the precipitation may be either physico-chemical or biogenetic. A core taken from the spring mound was analyzed for biologic indicators including ATP and percent biologic carbon. To determine the current precipitation rate, artificial substrates consisting of calcite slides, glass slides, stainless steel wool, and copper wool were placed on the spring mound in the area of active precipitation. Copper serves as a nucleation site for physico-chemical precipitation of calcite crystals. Biogenetic precipitation rates on copper will be lower since copper inhibits microbial action.

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# ESTIMATION AND SPATIAL DISTRIBUTION OF RECHARGE TO THE SOUTHERN HIGH PLAINS AQUIFER, IN AND NEAR CANNON AIR FORCE BASE, CURRY COUNTY, NEW MEXICO

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**Poster Abstract 21**

During 2004, the U.S. Geological Survey, in cooperation with Cannon Air Force Base (Cannon AFB), conducted a project to estimate the rate and spatial distribution of recharge to the Southern High Plains aquifer in and near Cannon AFB, southern Curry County, New Mexico. The rate of recharge was estimated using the chloride mass balance method as an indicator of moisture flux in the vadose zone. The spatial distribution of recharge was determined from age tracers including tritium and CFCs.

Soil moisture and chloride concentrations in the vadose zone at two sites located in undisturbed areas indicated that soil water was being removed by evapotranspiration in the upper vadose zone and that diffuse areal recharge in undisturbed areas does not contribute substantially to the Southern High Plains aquifer. Soil moisture and chloride concentrations in the vadose zone at a site located in a retention basin indicated that chloride has not accumulated in the vadose zone and that recharge is likely occurring in areas of focused infiltration.

Age tracers support the conclusion that ground-water recharge is not evenly distributed across Cannon AFB and indicate that wells with modern water have substantially greater concentrations of most major ions than wells without modern water. Ground water from wells in the northern part of Cannon AFB is a mixture of older (CFC-free and tritium-free) water with a component of modern water. Ground water from the southern part of Cannon AFB is predominantly older water. These results indicate that surface-infiltration conditions are more favorable in the northern part of Cannon AFB for recharge than in the southern part.

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# CHARACTERIZATION OF NONEQUILIBRIUM SORPTION OF PRODUCED-WATER COMPONENTS BY SURFACTANT-MODIFIED ZEOLITE

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**Poster Abstract 22**

Surfactant-modified zeolite (SMZ) has been shown to effectively remove benzene, toluene, ethylbenzene, and xylenes (BTEX) from water generated during oil and gas production (produced water). The BTEX sorption isotherms are linear and noncompetitive, suggesting that the removal mechanism is partitioning into the surfactant's hydrophobic bilayer. Even though BTEX sorption in batch systems is rapid, chemical equilibrium models do not accurately describe BTEX transport through packed beds of SMZ. Comparison with transport of a nonreactive tracer (tritium) suggests that diffusive nonequilibrium sorption controls BTEX transport.

We conducted individual batch experiments with SMZ to determine the nonequilibrium sorption kinetics of each BTEX constituent. We also ran a combined batch experiment containing all BTEX compounds in order to quantify kinetic sorption variations due to competition among the multiple constituents.

A bicontinuum sorption model was fit to the batch experimental data. The model estimated three sorption parameters: the distribution coefficient, fraction of instantaneous sorption, and the sorption rate constant. The fraction of instantaneous sorption and the sorption rate coefficient were both inversely related to the octanol/water partition coefficient(Kow) of the BTEX compounds, while the distribution coefficient was directly related to the Kow. The distribution coefficient and fraction of instantaneous sorption were not affected by constituent competition; however, the sorption rate constant decreased by 40% for the combined test. These kinetic sorption results will be used to parameterize a nonequilibrium transport model to predict BTEX removal under varying flow conditions. The accuracy of predictions will be tested in laboratory column experiments using produced water from the San Juan Basin, New Mexico.

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# SPATIAL VARIABILITY OF SOIL HYDRAULIC PROPERTIES ALONG A DESERT MARGIN TRANSECT AT LTER SITE, SE NEW MEXICO

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**Poster Abstract 23**

Saturated hydraulic conductivity (Ks) is an important soil hydraulic property that affects water flow and the transport of dissolved solutes. Determining sufficient and reliable Ks is difficult because of high spatial variability of soil properties. The objectives of this study were to analyze the variability of soil hydraulic conductivity, water retention, and plant available water (PAW) along transections that transverse three geomorphic surfaces (GS) and eight soil mapping units (SMU) at the LTER, SE New Mexico. The geomorphic surfaces were: Playa, Jornada II, and Isaack's complex. The SMU were: (i) Dalby, (ii) Headquarters 1, (iii) Headquarters 2, (iv) Bucklabar, (v) Berrino, (vi) Onite, (vii) Doña Ana, and (viii) Aladdin. Ninety soil samples were collected at 0-15 and 15-30 cm depths at 30m intervals along a transection that was replicated three times. The overall coefficient of variation (CV) for Ks along the transection was high (>35%), and same high CV were obtained within the GS and the SMU. Water retained at field capacity (FC) and PAW showed moderate CV, while water retained at permanent wilting point (PWP) showed high variability within GS and SMU. For the 15-30 cm depth the overall CV for Ks along the transection was high; however, for the individual GS, the Playa and Jornada II showed a high CV (151% and 53% respectively), while the Isaack's complex showed moderate variability (33.5%). Hydraulic conductivity also showed high variability within SMU, except for Berino and Onite which had a moderate CV (31 and 34% respectively). Water retained at FC and PAW showed a largely moderate CV, while for PWP 50% of the SMU showed moderate CV and the other 50% high variability. It was concluded that hydraulic properties showed moderate to high variability within GS, and this high variability was also shown at SMU level.

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# METEOROLOGICAL DATA QUALITY AND STANDARDIZED ET ESTIMATION IN THE MESILLA AND RINCON VALLEYS OF NEW MEXICO

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**Poster Abstract 24**

Accuracy of water use estimates depends on the quality of meteorological data collected. In the Mesilla and Rincon valleys of New Mexico, the meteorological data are collected from automatic weather stations throughout the valleys. In an effort to evaluate the quality of data, the weather stations were located and plotted to determine their spatial distribution and suitability of the surrounding environment. Data were collected from 2004 to 2006 and analyzed. Due to the varied topography of the valleys, several weather stations such as the Golf and National Weather Stations did not reflect agricultural conditions. The Leasburg, Plant Science Center, and Chamberino Weather Stations were the best locations for computing standardized evapotranspiration (ETsz) in the valleys. Results from the data analysis indicated that solar radiation sensors at the Plant Science Center and National Weather Stations were not working properly during the period of study. High wind velocity was observed at the NMSU Golf and Leasburg Weather Stations. Air temperature did not vary significantly, but maximum relative humidity did vary among the weather stations. The ETsz for years 2004 and 2005 ranged from approximately 1400 mm to 1900 mm per year.

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# DISPOSAL OF ARSENIC RESIDUALS IN A DESERT ENVIRONMENT VIA LAND APPLICATION WITH MUNICIPAL WASTEWATER

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**Poster Abstract 25**

Chronic low-level exposure to arsenic has been found to increase health risks for cancer, skin lesions, and numerous other illnesses. In January 2006, the EPA lowered the MCL for arsenic in drinking water to 10 ppb. This new standard has affected many New Mexico communities and brought the topic of arsenic contamination of groundwater to the forefront. Arsenic in the soils of New Mexico has received far less attention. In a study performed by WRRI, soils irrigated with water containing arsenic were investigated. That study concluded that arsenic accumulated within the soil profile and estimated that greater than 80% of the arsenic in irrigation water is retained by field soils. The new EPA drinking water standard has forced many New Mexico communities to develop procedures for lowering arsenic concentrations in their drinking water. Disposal of arsenic residuals is a problem that must be considered when developing such a procedure. A simple and low cost solution to this problem is to land apply the arsenic concentrates with the municipal wastewater. In this study, sorption/desorption experiments are performed on two soils collected from a land application facility near Columbus, NM. The effects of presence or absence of microbes in the soil and wastewater are tested, as well as differences due to soil properties. Since the waste is applied using a flood irrigation system, sorption/desorption amounts will be compared under batch and column experiments that mimic a flood irrigation procedure.

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# OPTIMIZING ELECTRODIALYSIS BY CONTROLLING VOLTAGE, TEMPERATURE, AND FLOW RATE

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**Poster Abstract 26**

Electrodialysis is a method of separating salt from water that could potentially be more effective than other more common desalination processes, such as reverse osmosis. Electrodialysis works by applying a voltage across a stack of membranes through which water flows. Ions in the solution (i.e. Na+ and Cl- ) are pulled to their respective positive or negative ends. A series of membranes with built-in charges determine which ions can permeate the membrane. The result is a system with alternating diluted and concentrated salt water tanks. The purpose of this study was to determine the effect on desalination by electrodialysis when the flow rate, temperature, and voltage are varied. Factors such as flow rate, voltage, and temperature were optimized to provide the most energy-efficient desalinization process. The baseline data and trends provided by this study will give an accurate way to gauge the effectiveness of novel lab developed membranes. Given enough time, the study would like to look at the effects of multiple cell pairs as well as the ability and effectiveness of membranes prepared from novel polymers to desalinate water.

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# LONG-TERM PERFORMANCE OF COOL AND WARM SEASON GRASSES UNDER SALINE IRRIGATION

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**Poster Abstract 27**

The paper addresses the problem of the impact of water salinity extent on turf grass performance. Three salinity levels of irrigation water (650, 1200, 2500ppm) and two types of irrigation (sprinkler and sub-surface irrigation) were examined on seven cultivars of cool season (CS) grasses and eleven cultivars of warm season (WS) grasses. Significant variability in grass quality responses to salinity was observed among cultivars. Seashore Pospalum (*Paspalum vaginatum*) had the highest visual quality and was considered to be the most tolerant to the salinity among WS grasses. Visual quality of Seashore Pospalum was not correlated with salinity level of irrigation water and type of irrigation. One of the most sensitive to salinity WS grasses was Zoysiagrass (*Zoysia spp.*). Visual quality of Zoysiagrass was correlated with salinity level of irrigation water, but not with the type of irrigation system. Among CS grasses, Tall Fescue (*Festuca arundenacea*) watered with potable water using the sprinkler system had the highest visual rating and Alkaligrass (*Puccinella spp.*) had the poorest. Generally, the grass performance correlates with changes in the soil properties. The drip system leads to increase in electrical conductivity (EC) of high soil horizons. The sprinkler irrigated soils had the highest level of EC in the 50-60 cm of depth. We also observed that the increase rate of Sodium Absorption Ratio strongly depends on the horizon depth: it increases substantially for 1-10 cm and 10-20 cm and stays almost constant at a depth of 50-60 cm.

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# WATER USE ANALYSIS OF WEEDS COMMON TO THE GREATER LAS CRUCES CANAL SYSTEM

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**Poster Abstract 28**

In the arid southwestern states where water is a precious and limited resource, weeds are a major concern because they use water needed for other purposes. In New Mexico, we rely upon canal systems to deliver water from the Elephant Butte reservoir outside of Truth or Consequences throughout the lower Rio Grande Basin. Often, the canal banks will be overrun by invasive weeds. Some of these weeds use a lot of water, and when you combine the water usage per plant and multiply that by the number of plants along the canals, it quickly becomes apparent that targeted weed control could potentially increase the water transfer efficiency of the canal system. We hope to determine which plants are more problematic than others. Our long-term goal is to recommend a low water use plant to use as a ground cover for the canal banks to prevent the problematic weeds from maintaining a foothold on the canals.

Our experiment was divided into eight trials. Seed or plant material of 14 species common to the canals or undesirable on the canals was harvested and the plants established in our greenhouse. After the plants were well established and moderately large in size, we subjected the plants to a 24-hour testing period to determine how much water is used by each plant per unit of leaf area or biomass relative to bermudagrass. Currently we conduct our trials in the greenhouse, but extra trials to compare greenhouse water usage to outdoor water usage are planned.

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