THE IMPACTS OF AGRICULTURAL MANAGEMENT ON THE FATE OF SALTS, NITROGEN, AND HEAVY METALS IN BIOSOLIDS-AMENDED SOIL

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Inclusion of reclaimed effluents and biosolids for agriculture and managed landscapes may allow municipalities such as those along the Texas/Mexico border better use of water and land resources. Land application of organic rich waste has direct economic benefits to Rio Grande border communities. Moreover, organic matter management is often lauded as the key to successful and sustainable landscape and agricultural land management. However, there is concern that salts, nitrates, and heavy metals will threaten food safety, environmental integrity, and/or public health. In arid regions like the middle Rio Grande floodplain, it is often the loss of soil structure from salinity and/or sodicity rather than fertility that reduces the productivity of irrigated soils. Previous field results suggest that soil amended with anaerobically digested biosolids and spent lime improved surface leaching of salts and reduced sodium concentrations in alkaline soil. Anaerobically digested or lime-stabilized biosolids incorporated into acidic soils, or composted biosolids plus gypsum incorporated into alkaline mud in other regions have increased soil porosity and aggregate stability. Biosolids including those products with a high pH need evaluation on alkaline soils. Predicting chemical changes in alkaline soils will provide an understanding of solute movement and potential contaminant mobility. The objectives of this replicated soil column experiment were to: 1) investigate land use of alkaline and pH-neutral biosolids on moderately alkaline soil; 2) quantify the mass balance and movement of nitrogen, salts, and Cu and Zn in soil columns; and 3) evaluate the agronomic practice of adding urea and calcium to field soils in the upper Rio Grande floodplain. The following will be discussed in detail:

Poster Presenter	Poster Presentation
Chrisie Moore-Vogel	The Influence of Heavy Metals on Nitrogen Transformations and Leaching in Biosolids-Amended Soils
Monique Garcia	The Impact of Urea Additions on Salinity in Biosolids-Amended Soil
Christiana Mendoza	Nitrogen Transformations and Movement in Biosolids-Amended Soil
Lulu Sanchez	Copper and Zinc Movement in Biosolids-Amended Soils
Ivey Romero	Effects of Calcium Additions on Nitrogen Mineralization in Biosolids-Amended Soils
Sal Mendoza	Monitoring Dissolved and Extractable Calcium to Predict Soil pH
Vic Kipgen	Salt Movement and Leaching in Biosolids-Amended Soil
Naomi Assadian	The Influence of Added Calcium on Heavy Metal Mobility and Salinity in Biosolids-Amended Soils

Presentation and Poster Abstract - 2

THE USE OF WATER TEMPERATURE AND NUMERICAL SIMULATION FOR QUANTIFICATION OF GROUND-WATER/SURFACE-WATER INTERACTION OF THE RIO GRANDE, ALBUQUERQUE, NEW MEXICO

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An important gap in the understanding of the hydrology of the Middle Rio Grande Basin, central New Mexico, is the rate at which water from the Rio Grande recharges the Santa Fe Group aquifer system. Though several methodologies have been applied to the problem, they yield a wide range of estimates. A study by the U.S. Geological Survey (USGS) is using water-temperature methods to quantify horizontal and vertical ground-water fluxes from the Rio Grande, horizontal and vertical hydraulic conductivities of the post-Santa Fe Group valley and basin-fill deposits, and ground-water fluxes into the riverside drains.

Eight piezometer nests were installed in an east-trending line across the Rio Grande, north of the Paseo del Norte bridge in Albuquerque, to collect temperature- and hydraulic-gradient data between March 1999 and July 2000. The piezometer nests are located between the Corrales Riverside drain (on the west side of the Rio Grande) and the Albuquerque Riverside drain (on the east side of the Rio Grande). Each piezometer nest consists of three piezometers installed approximately 3, 7, and 13 meters below land surface. Automated data loggers collected ground-water temperatures at five depths (approximately 2, 4, 6, 8, and 11 meters) in each piezometer nest at 60-minute sampling intervals. Also, ground-water levels were measured monthly in each piezometer nest. In addition, data loggers collected surface-water temperatures in each drain and in the Rio Grande. Finally, stage measurements of the Rio Grande were collected at the USGS streamflow-gaging station (Rio Grande near Alameda—08329928), located immediately south of the Paseo del Norte bridge.

Data are being analyzed using the two-dimensional heat- and water-transport model VS2DH to estimate directions and rates of ground-water flow beneath this section of the Rio Grande. Model calibration is being aided by the use of the parameter-estimation program PEST. Using the data described above, temperature and head boundary conditions are specified at selected points in the model. For parameter estimation, 100 temperature and head observations were chosen at random from the data set. Currently (July 2002), model calibration and sensitivity analysis is nearing completion. Final results and report approval are planned for late 2002.

Poster Abstract - 3

EVAPORATION ESTIMATION AT ELEPHANT BUTTE RESERVOIR

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Reservoir evaporation is currently estimated from a single evaporation pan placed near the dam at the southern end of the Elephant Butte reservoir. State-surface-area table developed during periodic bathymetric surveys are used to relate the point measurement of evaporation to a volume of water lost to the process. The single pan is located well above the reservoir, more for convenience than for accuracy. Evaporation pans are known to be highly sensitive to exposure, microclimatic variations, and maintenance.

This study started in August of 2001; the goal was to develop a more accurate and precise method for estimating evaporation losses from Elephant Butte Reservoir in particular, and New Mexico reservoirs and lakes in general. The first year was to establish and rigorously validate measurement methods, and to produce a preliminary Penman-based evaporation model calibrated for Elephant Butte Reservoir.

Eddy-correlation measurements above the water surface, water temperature measurements at different depths, skin temperature of water and microclimate are used to investigate evaporation from the lake.

Poster Abstract - 4

PECAN EVAPOTRANSPIRATION USING ONE PROPELLER EDDY COVARIANCE SYSTEM (OPEC)

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Pecan is one of the major crops grown in the Mesilla and Rincon Valleys. It covers about 25% of the irrigated acreage in the county but its water use is not well understood. The objective of this study was to monitor actual evapotranspiration (ET) above a large area of a pecan orchard for one year using One Propeller Eddy Covariance System (OPEC). This will allow a more reliable estimate of the consumptive use of water by pecan. Currently the New Mexico Office of the State Engineer (OSE) estimates agricultural ET using a simple Soil Conservation Service (SCS) Modified Blaney Criddle equation.

A 23 m (75 ft) tower was installed in early June of 2001 in a pecan orchard (Rincon Orchard, R4) located at Stahmann Farms Incorporated (lat: 32-10-36.08 N, long: 106-44-22.39 W; elevation 1144 m) about 26 km (16 miles) south of Las Cruces. The tower is located in a 12 ha (29 acre) orchard surrounded by an average of 14 ha (35 acres) of orchard in each direction. The tree heights are about 16 m (52 ft) tall and range in age from 40 to 60 years old. A One Propeller Eddy Covariance (OPEC) set of sensors were installed on the tower on June 11, 2001 (DOY 162). Additional sensors for monitoring microclimate were also installed.

Evapotranspiration of the pecan orchard was measured by using eddy covariance technique. Intensive data collection for one year is anticipated.

Poster Abstract - 5

ATMOSPHERIC DEPOSITION OF MERCURY IN SOUTH CENTRAL NEW MEXICO

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The Mercury Deposition Network (MDN) implemented and standardized a network-wide survey in the U.S. for routine monitoring and analysis of mercury in wet deposition. An MDN site was established in southcentral New Mexico to characterize mercury in precipitation of an arid landscape. Although the New Mexico site had the highest average concentration of total mercury in 1998 (23.0 ng/L) and 2000 (19.4 ng/L), the site received only 17.64 cm and 28.9 cm of rainfall, respectively. The low precipitation resulted in the lowest wet deposition of mercury in the MDN program for 1998 (4.0 ug/m^2) and 2000 (5.6 ug/m^2). Similar to other sites throughout the MDN program, mercury deposition in New Mexico appears to be seasonal with elevated concentrations during the summer months when rainfall occurs. Although wet deposition is the most important atmospheric input of mercury to a landscape, dry deposition of mercury may be the dominant input to arid ecosystems receiving less than 20 cm of rainfall.

Two dry deposition methods were developed and field tested for a three-week period in January 2000 at the MDN site in New Mexico for (1) dry deposition of particulate and gaseous mercury using passive ion exchange membranes; and (2) atmospheric-particulate and reactive gaseous mercury using ion-exchange filter packs. The average dry deposition of mercury was 4.47 ng/m^2/h with an extrapolated total concentration of 39.18 ug/m^2 for the year. Using the wet precipitation value for 1998, an estimate of net deposition for mercury in southcentral New Mexico was 43.18 ug/m^2/year. The atmospheric composition of mercury was reflected by relatively low concentrations of particulate-bound mercury (1.40 pg/m^3) with an annual extrapolated value of 0.04 ug/m^2/year. In contrast, reactive gaseous mercury was relatively high (0.054 ng/m^3) with an annual extrapolated value of 34.50 ug/m^2/year. Elemental mercury was slightly below (1.12 ng/m^3) the natural background of 1.3 ng/m^3 reported in the literature. Currently, KCl-coated annular denuders have been deployed at the MDN site in New Mexico for collection and comparison of gas phase Hg(II) with the results of the iodated-carbon filter packs and total mercury concentration in wet deposition. Trace metals are being collected in precipitation events to evaluate anthropogenic influences and their contribution to the general sources of pollutants in the atmosphere and how the strength of these sources vary over time.

Poster Abstract - 6

MIDDLE RIO GRANDE EVAPOTRANSPIRATION RESEARCH AT THE UNIVERSITY OF NEW MEXICO: MEASUREMENT, PREDICTION, AND FLUX PROCESSES

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As water supply dwindles, careful accounting of depletions from the water budget becomes a high priority for equitably allocating resources. We are pursuing collaborative research with university, government and non-governmental partners to improve the accuracy and portability of evapotranspiration (ET) estimates for riparian (i.e., bosque) vegetation along the Middle Rio Grande (MRG). To provide the most accurate ET information possible for the water budget and to river operations managers, we have been using three-dimensional eddy covariance technology since 1999 at four sites along the MRG: two above saltcedar forests (Tamarix ramosissima) and two above cottonwood forests (Populus deltoides ssp wislizennii). Over the past three years since 1999, saltcedar ET ranged from 69 cm per year at an unconnected site to 122 cm per year at a frequently flooded site. Since 2000, cottonwood ET ranged from 98 cm per year at a flooded site to 123 cm per year at a disconnected site. Factor and stepwise regression analyses were developed to further elucidate the functional relationships between atmospheric conditions and ET. At all sites, in all years, strong relationships were found to exist between ET and specific humidity, net radiation, wind speed and direction, and temperature. Predictions using the Penman-ET Toolbox, Penman-Monteith, and Jensen-Haise methods were evaluated. Hydrologic models predicted ET well, with close timing of daily variability to measured ET rates and a coefficient of determination up to 0.93. Often, however, such semi-empirical models underestimated short-term ET maxima (spikes) as well as short-term ET minima (dips). This was most likely due to the effects of advected heat and water vapor not represented by the psychrometric coefficient. Specific knowledge of conditions that affect ET rates over various bosque vegetation types promises to significantly improve prediction of depletions due to phreatophyte ET and illustrate the impact of various conservation and restoration activities on the water budget.

Poster Abstract - 7

A 3D GEOSPATIAL MODEL TO ILLUSTRATE THE HYDROSTATIGRAPHIC FRAMEWORK CONTROLLING GROUNDWATER FLOW AT SANDIA NATIONAL LABORATORIES/NEW MEXICO (SNL/NM)

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A 3-D geospatial model was developed to support the Environmental Restoration Division (ERD) long-term monitoring program designed to protect groundwater resources at Sandia National Laboratories/New Mexico (SNL/NM). The primary groundwater resource is a deep (greater than 500 feet below ground surface) regional aquifer that is comprised of unconsolidated sediments of the upper Tertiary Santa Fe Group. This regional aquifer is strongly influenced by current groundwater withdrawal practices that supply potable water to the City of Albuquerque. A localized perched aquifer overlies the regional aquifer in the vicinity of Tijeras Arroyo and consists of a complex assemblage of water producing units separated by low permeability units.

The 3D geospatial model was designed to illustrate the current conceptual model of the hydrostratigraphic framework that controls groundwater flow under SNL/NM. The model displays the complex distribution of alluvial sediments that form the aquifer system. The model incorporates normal and strike-slip faults that offset both the basement rock and the alluvial sediments. The model is based on site data including surface and borehole geophysics, lithologic descriptions, and geochemical distributions. These data were incorporated into the geospatial modeling code earthVisionÒ by interfacing with the existing SNL geographic information system (GIS) ARC/INFOÒ.

The 3D geospatial model is proving valuable as a visualization tool that illustrates site conditions including: (1) the extent of the groundwater capture zones generated by the City of Albuquerque production wells; (2) the effects of faulting on groundwater flow patterns; (3) the extent and thickness of the local perched aquifer unit; (4) the location of groundwater recharge areas; and (5) the simulated groundwater flow patterns as predicted by the site MODFLOW model. The model enhances the technical understanding of these site conditions and is used to initiate a comprehensive long-term monitoring program to assist the ERD in protecting SNL/NM's groundwater resources.

This model provides a unique way to present the complex site conditions in a simplified manner to site engineers, regulators, the public, and other stakeholders and decision-makers involved in the SNL/NM ERD program.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.

Poster Abstract - 8

WESTERN WATER MARKETS

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This study examines the market value of water and the development of markets for water rights in eight arid western states: California, Arizona, Nevada, Utah, Wyoming, Colorado, New Mexico and Texas. These states cover seven hydrological basins: California, Great Basin, Upper Colorado, Lower Colorado, Missouri, Rio Grande, and the Texas Gulf. While each basin varies in the quantity of water in rivers and the pattern of land use, they share the basic economic problem of allocating a scarce resource among competing demands. The economic value of water depends on use, location, regional demographics and legal and regulatory factors. Institutions like water banks and state regulations on rights, leases and diversions largely determine the ease of transferability of a water right in each state. River compacts between states also affect the transferability and value of water. We examine water market transactions over a 10-year period to estimate the price of water rights within each basin.

Notes:
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Poster Abstract - 9

IS THERE ANY WATER TO TRADE IN THE MIDDLE RIO GRANDE?

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Water is undoubtedly scarce in the Middle Rio Grande. Many entities (both commercial and municipal) are trying to "sure-up" their water supply by purchasing additional water rights. This research evaluates the availability of transferable water rights in the Middle Rio Grande. Water rights exist for both surface water and ground water with varying priority dates. Accompanying some of these rights are restrictions on how these rights may be utilized. Using data from the Office of the State Engineer, we attempt to determine the total potential amount of transferable surface and ground water rights that exist in the Middle Rio Grande. We also outline constraints that affect the ability to trade some transferable rights. While an absolute quantification of the supply was not possible, our result is that there is, indeed, very little water left to trade in the Middle Rio Grande.

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Poster Abstract - 10

POT-IN-POT FIELD EXPERIMENT DETERMINES WATER USE AND DROUGHT TOLERANCE OF MEXICAN ELDER

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Recently, consumer awareness for water conservation, water efficient, and drought tolerant plants in urban landscapes has increased. The purpose of this field experiment was to determine water use and identify drought responses in Mexican elder (Sambucus mexicana Presl.) grown in an arid environment. Fifteen Mexican elder trees were potted into 76L pot-in-pot system containers. Five plants were randomly assigned to each of three irrigation treatments: control, moderate, and drought. Plants assigned as controls received daily irrigation of 3L of water. Plants in the moderate treatment group were used to determine daily water use and received irrigation every two days. Droughted plants were irrigated in cycles. When initial pot weight decreased by 30% due to evapotranspiration, the cycle was terminated; droughted plants were watered for a 14 day recovery period, and then subjected to another drought cycle. Plants were subjected to four drought cycles. The length of a drought cycle ranged from 28 to 11 days. From the initiation of the study to the present date (122 days), there has been no natural precipitation. An initial destructive harvest revealed that plants had an average leaf area of 1080 cm^2 and an average root-to-shoot dry weight ratio of 13. Data analysis of transpiration and stomatal conductance indicated a significant difference in transpiration between treatment groups (controls and droughts) for drought cycles two and three. Average transpiration and stomatal conductance for the control group was 189% and 62% higher, respectively, than the droughted group. Maximum fluorescence was 48% higher in the droughted group, which suggests that the plants were subjected to more physiological stress than the control group. Seasonal ETcrop for the moderate treatment group revealed a 2% decrease in water use between the late Winter (2.405 cm (.94")) and early Spring (2.350 cm (.92")) seasons, and an average 50% increase in water use between the early and late Spring seasons. ETcrop for the late Spring season was 3.60 cm (1.4"). Crop coefficient (Kc) values are being determined for plants in the moderate treatment group. In summary, data collected to date indicates that the water use in Mexican elder increases during the Spring and droughted plants may regulate water loss.

Poster Abstract - 11

WATER RIGHTS ADMINISTRATION IN THE SOUTHERN JORNADA DEL MUERTO BASIN, LOWER RIO GRANDE UNDERGROUND WATER BASIN

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The Southern Jornada del Muerto Basin (SJMB) is located within the Lower Rio Grande Underground Water Basin in Doña Ana County, New Mexico. The Office of the State Engineer (OSE) has adapted a model of the SJMB developed by John Shomaker and Associates, Inc., and developed informal administrative criteria to evaluate water rights applications. Many of these were filed over 20 years ago, including applications by the City of Las Cruces for new appropriations totaling 14,000 acre-feet per year.

The SJMB is partially separated from the Rincon and Mesilla Basins by the Caballo, Tonuco and Doña Ana-Tortugas-Franklin uplifts. Santa Fe Group sediments up to 5,000 feet thick comprise the SJMB basin-fill aquifer. Ground water occurs at depths of less than 100 to over 500 feet. Up to 800 feet of freshwater occurs above more saline water at depth. Recharge occurs along the Organ and San Andres Mountains, and at depth from geothermal upflow. Ground-water flows from recharge areas to discharge into the Rincon and Mesilla Basins.

The SJMB model simulates the basin-fill aquifer using three layers. Inflows from recharge and underflow are simulated using injection wells. The Rio Grande is simulated as a constant-head boundary. Evapotranspiration is not simulated. The model has been calibrated to steady-state and transient conditions.

The SJMB is similar to nearby "mined" basins such as the Hueco and Tularosa Basins, where the greatest hydrologic effects of ground-water pumping are drawdowns and freshwater depletion. However the SJMB is also connected to the Rio Grande stream system, which is considered fully appropriated. Informal criteria for the SJMB include limiting well depths to less than 50 percent of the freshwater zone thickness. One-half of the total freshwater thickness is considered recoverable, and one-half of the recoverable freshwater thickness is reserved for uses beyond the 40-year planning period (2000 through 2039). The SJMB model may be used to estimate hydrologic effects. Any model cell with an estimated average water-level decline rate exceeding 3.5 feet per year over the planning period is considered critical. Additional declines in critical cells from proposed new uses or changes in use cannot exceed 0.1 feet per year. Offsets are required for surface water depletions exceeding 0.1 acre-feet per year.

Applications in the SJMB are being evaluated using the model, and the OSE is taking actions based on the criteria, including partially approving the Las Cruces applications for 10,200 acre-feet per year.

Poster Abstract - 12

THE POTENTIAL FOR CLAYS TO REMEDIATE BACTERIAL COLIFORMS IN CONTAMINATED WATER

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The availability of treated water in remote areas and in third world countries is in many cases not monetarily feasible. The overall goal of this research is to find a cost?effective, appropriate and environmentally safe method to treat surface water with the use of natural clays to remove bacterial coliforms. The initial goal is to determine the effect clay has on Escherichia coli K?12 while suspended in sterile water (the sterile water is used for control purposes). E. coli was chosen since it is commonly found in surface water and it is also an indicator of the presence of other coliforms present in water. The detection of such coliforms is important since the consumption of contaminated waters is responsible for the propagation of diarrhea and dehydration in many third world countries and in remote areas. The hypothesis of the research is that clays will sorb bacteria and thus reduce the amount of bacteria suspended in water. The properties of adsorption vary with the different types of clays, and therefore the specific objective of this research will be to test a variety of clays and quantify the difference in cell numbers before and after treatment with clays. The hypothesis is that the number of cells of E. coli K?12 per liter will reduce after treatment with clays. Clays that will be tested are montmorillonite, Arizona montmorillonite, natural zeolite and synthetic clay.

Poster Abstract - 13

TRANSBOUNDARY BASIN-FILL AQUIFERS OF THE SOUTHWESTERN NEW MEXICO REGION- AN OVERVIEW OF THEIR HYDROGEOLOGIC FRAMEWORK AND ASSOCIATED GROUNDWATER-FLOW REGIMES

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During the past six years there has been a major bi-national, multi-institutional effort to characterize geohydrologic systems with significant transboundary components in the western part of the USA-Republic of Mexico border region. This overview illustrates investigations by the NM Water Resources Research Institute and cooperating institutions that emphasize the hydrogeologic framework and associated groundwater-flow regimes of six intermontane-basin aquifer systems in the transboundary region that includes parts of southwestern New Mexico, Trans-Pecos Texas, and northern Chihuahua (MX). From east to west, these systems are 1) Hueco-Tularosa, 2) Mesilla-Jornada, 3) Mimbres-Rio Casas Grandes, 4) Hachita-Moscos, 5) Playas-San Basilio, and 6) Animas-Lordsburg. The latter two aquifer systems are west of the Continental Divide and extend into Arizona and Sonora (MX). The Mesilla-Jornada and Hueco-Tularosa systems include valley segments of the Rio Grande (Gulf of Mexico drainage) and the Las Cruces-El Paso-Ciudad Juárez Metroplex. The only other major perennial streams in the region are the Rio Casas Grandes of northern Chihuahua and the Mimbres River of southwestern New Mexico. They discharge to a large transboundary bolson complex that forms the regional sink for much of the surface and subsurface flow in the area between the Continental Divide and the Mesilla Basin.

Research to date has emphasized development of hydrogeologic framework models and GIS coverages that integrate large amounts of geologic and geochemical information on basin-fill aquifers in the transboundary region. The GIS (ARC/INFO®) format allows 3-D integration of surface and subsurface information that can be used in numerical groundwater-flow modelling and hydrogeochemical interpretations. The hydrogeologic framework of basin-fill aquifers is defined in terms of 1) dominant lithofacies-assemblages (LFAs) that are grouped as informal hydrostratigraphic units (HSUs), and 2) basin-boundary and intra-basin structural controls. Major aquifers are formed by coarser-grained LFAs deposited by the ancestral Rio Grande, Casas Grandes, and Mimbres fluvial systems. The poorly consolidated sediments of the basin HSUs are informal subdivisions of the upper Santa Fe and Gila (lithostratigraphic) Groups and overlying alluvial-basin and -valley fills (late Miocene to Holocene). Contiguous piedmont-slope LFAs and underlying middle and lower Santa Fe and Gila Group HSUs (Miocene) have much lower aquifer potential because of finer matrix texture, and more consolidation and cementation.

Poster Abstract - 14

DEPLOYMENT OF A REAL-TIME MICROCHEMICAL SENSOR FOR GROUNDWATER QUALITY MONITORING AT EDWARDS AIR FORCE BASE

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A real-time microchemical sensor has been deployed in a groundwater well at Edwards Air Force Base, CA, to evaluate its use in providing continuous monitoring of volatile organic compounds (VOCs). The sensor consists of an array of chemiresistors, which consist of a carbon-loaded polymer deposited onto a solid substrate (microchip) between wire-like electrodes. When chemical vapors come into contact with the polymer, the chemicals absorb into the polymers, causing them to swell. The reversible swelling causes a change in the electrical resistance of the electrode that corresponds to the concentration of the chemical vapor in contact with the absorbent. An array of four chemiresistors, each one having a different affinity to different analytes, is packaged into a 3-cm-diameter rugged, waterproof housing that allows the sensors to operate in air, soil, and water.

The chemiresistor-sensor package was lowered approximately 10 m (34 ft) down a monitoring well that contained large concentrations of trichloroethylene (TCE) and other hydrocarbons (aqueous TCE concentrations had been previously measured at ~ 10 ppm). The water table in the well at the beginning of the experiment was about 0.3 m (1 ft) below the location of the sensor package. A temperature/relative-humidity probe and pressure transducer were also lowered down the well to monitor environmental conditions in the vicinity of the sensor. All instruments were connected via cable to a solar-powered data-logging station located at the surface near the well, and data were logged once every hour. During the first week of the test, an unexpected dramatic rise in the water table immersed the chemiresistor-sensor package, which was likely caused by the temporary shut-down of a nearby dual water- and vapor-extraction remediation system.

Results of the chemiresistor sensor during the first week of the test indicated that a significant amount of VOCs were present in the well. Readings from the chemiresistor array yielded maximum calculated concentrations ranging from 30,000 to 40,000 ppm in the gas phase (400 to 600 ppm in the aqueous phase). However, it should be noted that factors that may affect the calculated concentrations include the variation in large water-vapor concentrations (the sensor experienced between ~80% to 100% relative humidity at 21˚C as it was immersed by the rising water table), potential drift (creep) in the sensor readings caused by continual absorption of analytes, and the presence of multiple VOCs (only calibrations to TCE were used in the calculations). Analysis of the impact of these factors and comparisons to VOC concentrations measured by traditional gas- and water-sampling means are currently underway.

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Poster Abstract - 15

MEASUREMENTS OF SEDIMENT EROSION AND BEDLOAD FRACTION WITH THE ASSET FLUME

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Soil and sediments play an important role in water management and water quality. Issues such as water turbidity, associated contaminants, reservoir sedimentation, undesirable erosion and scour, and aquatic habitat are all linked to sediment properties and behaviors. *In situ* analysis is necessary to develop an understanding of the erosion and transport of sediments. Sandia National Laboratories has recently developed the ASSET Flume that quantifies *in situ* erosion of a sediment core with depth while affording simultaneous examination of transport modes of the eroded material. Core erosion rates and ratios of bedload to suspended load transport of quartz sediments were studied with the ASSET Flume. The erosion and transport of fine-grained natural cohesive sediment were also observed. Experiments using quartz sands confirmed that the ratio of suspended load to bedload sediment transport is a function of grain diameter and shear stress at the sediment surface. Data collected from the ASSET Flume were used to formulate a novel empirical relation for predicting the ratio of bedload to suspended load as a function of shear stress and grain diameter.

Poster Abstract - 16

ABILITY OF EXISTING GROUND-WATER SOURCES TO MEET 40-YEAR MUNICIPAL WATER DEMANDS IN SOUTHWESTERN NEW MEXICO

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As part of regional water planning in southwestern New Mexico, the Office of the State Engineer (OSE) evaluated ground-water supplies in Grant, Luna, and Hidalgo counties. Existing municipal uses in the area are currently supplied by ground water. The ability of existing ground-water sources to meet municipal demands to 2040 was evaluated by simulating water-level declines (drawdowns) from historical and projected pumping, using calibrated ground-water flow models.

An OSE model of the basin-fill aquifer in the central Grant County area was used to evaluate demands at Silver City and nearby communities. By 2040 four of Silver City's 12 wells may have less than 100 feet of water column. The remaining wells have about 200 feet of water column or more, indicating Silver City may be able to meet its demands with current sources until the year 2040 by carefully distributing pumping. Average water columns of less than 100 feet at the Santa Clara and Bayard well fields indicate these sources cannot meet projected demands to 2040. Deepening wells in the basin-fill aquifer is not feasible, and successful development of deeper aquifers locally is uncertain. If production at Silver City's wells were increased to meet the demands of Santa Clara and Bayard for a regional system, half of Silver City's wells may have less than 100 feet of water column by 2040. Well deepening is not feasible, but additional wells or new well fields in the Mimbres Basin are options.

An updated U.S. Geological Survey model of the basin-fill aquifer in the Mimbres Basin was used to evaluate the well fields of Deming and Columbus in Luna County. One of Deming's 12 wells may have less than 100 feet of water column by the year 2040. In 40 years the water level will be below the depth of one Columbus well, and one of the two remaining wells may have less than 100 feet of water column. The Deming and Columbus wells could be deepened to regain production, and additional wells in the basin-fill aquifer could extend the life of current sources.

A model of the basin-fill aquifer in the Lower Animas and Lordsburg Basins was created to evaluate the City of Lordsburg's wells in Hidalgo County. By 2040 all of Lordsburg's wells retain more than 200 feet of water column, indicating current sources should be capable of meeting demands for 40 years.

Poster Abstract - 17

UPPER RIO GRANDE BASIN WATER OPERATIONS REVIEW AND ENVIRONMENTAL IMPACT STATEMENT

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Management of the Rio Grande involves many agencies, each with its own mission and set of rules and guidelines. Three of the agencies are working together to develop an integrated plan for water operations at their existing facilities in the upper Rio Grande basin. The joint lead agencies for this effort-the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers, and the New Mexico Interstate Stream Commission, are examining what they can do under existing authorities to improve how water is stored and delivered.

This study, called the Upper Rio Grande Basin Water Operations Review, officially began with the publication of a Notice of Intent in the Federal Register on March 7, 2000. The review will provide the basis for an environmental impact statement (EIS) that will examine selected water operations activities in the Rio Grande basin above Fort Quitman, Texas, that are within the joint lead agencies' existing authorities. Cooperating agencies for this collaborative effort are the U.S. Bureau of Indian Affairs, the New Mexico Department of Agriculture, the U.S. Fish and Wildlife Service, the New Mexico Environment Department, the Pueblo of San Juan, the City of Albuquerque and potentially others.

A major charge of the Corps of Engineers is flood loss reduction and sediment control. The Bureau of Reclamation primarily manages water delivery to private, municipal, and industrial users, and the Interstate Stream Commission monitors compact deliveries and San Juan-Chama project water storage and releases.

The Review will determine how the lead agencies will use their existing water operations authorities to: 1) Help meet water needs of all users, including the need for conservation of endangered species, 2) Meet downstream delivery requirements mandated by the Rio Grande Compact and international treaty with Mexico, 3) Provide flood protection and sediment control, 4) Assure safe dam operations, 5) Support compliance with local, state, tribal, and federal water quality regulations, 6) Identify flexibility for operation of federal reservoirs and facilities within existing authorities, 7) Assist managing agencies to operate these facilities more efficiently as an integrated system, 8) Improve decision-making processes on water operations through better interagency communications and more public input, and 9) Support compliance by the joint lead agencies with the National Environmental Policy Act, the Endangered Species Act, and all other applicable laws and regulations.

Poster Abstract - 18

DAIRY LAGOON EFFLUENT EFFECTS ON SOIL AND GRASS FORAGE

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Efficient utilization of lagoon effluent to supply nutrients requires crops that assimilate high amounts of nutrients since land for such use is often limited. A study in southeastern New Mexico determined the effect of dairy lagoon effluent on bermudagrass and tall wheatgrass forage yield and uptake of nitrogen as well as soil properties. Treatments included five rates of dairy lagoon effluent at 177 (low), 318 (medium-low), 448 (medium), 520 (medium-high), and 711 (high) kg TKN ha^{-1} and a control with no N applied. Experiments were conducted on a mixture of Reagan and Karro loam soil. Total forage yields significantly increased with lagoon effluent applications compared to the control treatment. The high loading rate produced the greatest yield but it was not significantly different from medium-high treatment. Total-N and chloride concentration in forage tissue and elements removed in the forage were all altered by loading rate. Total N recovery ranged from 12 to 25% for bermudagrass and 12 to 32% for wheatgrass. The highest recovery was observed for the medium-high treatment for bermudagrass and the medium treatment for the tall wheatgrass. The lower recoveries were probably the result of various nitrogen losses and the relative slow release of organic-N.

Soil from both grass areas were uniform at the beginning of the experiment in terms of soil electrical conductivity, inorganic-N, and chloride. No change was observed in soil salinity and NH_4-N values due to effluent application. At the high effluent rate, soil NO_3-N concentrations were elevated, particularly in the subsoil, and 284 kg ha^{-1} was present in the upper 180 cm of the profile. Nitrate-N / chloride ratio was used to calculate leaching fraction and nitrogen loading below the root zone but does not appear to be a valid approach for this study probably due to violation of the assumption for steady state conditions since this was the first year of lagoon effluent application. With appropriate irrigation scheduling, 300% of the crop nitrogen removal could be applied to the bermudagrass and 200% of the crop nitrogen removal could be applied to tall wheatgrass in the first year of application to achieve an optimum yield and minimize leaching losses.

Poster Abstract - 19

PROBABILISTIC MODELING OF THE GROUND AND SURFACE WATER SUPPLY OF THE MIDDLE RIO GRANDE REGION

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Traditionally, water budgets use measured data from past conditions, calculate statistics based on these data, and use these statistics to describe current water usage. While this approach can provide valuable insight into regional hydrology, it is limited to considering observed conditions rather than the range of probable flows, and it produces only static values that can be hard to incorporate into water planning. One of the alternatives to this approach is a quantitative, probabilistic analysis that fits flow distributions to each inflow and outflow term and uses these distributions to calculate the probabilities of possible outcomes. Knowing the likely probability of an event such as a water shortage can often be of more value in planning and economic assessments than fixed flow values.

This type of quantitative, probabilistic description of the conjunctive-use ground and surface water supply available to the Middle Rio Grande region was recently developed as part of the Middle Rio Grande Water Supply Study (S.S. Papadopulos & Associates, Inc., 2000). For the region from Cochiti Reservoir to Elephant Butte Reservoir, a probabilistic model of the water supply was developed. The model incorporates the climate-dependent variability in individual water budget components and simulates present and future impacts of groundwater pumping on surface water conditions. This water supply study provides a framework to support regional water planning efforts for the Middle Rio Grande and describes conditions relevant to maintaining compliance with the Rio Grande Compact.

The study illustrates that variability in several dominant water budget terms, in particular Rio Grande inflow at Otowi and evaporation from Elephant Butte Reservoir, leads to significant variability in the water supply. Modeling of the basin water budget under present development conditions indicates that, absent intervention, credit and debit conditions under the Rio Grande Compact are equally probable outcomes. The future credit/debit balance was also evaluated, taking into account the increase in river depletions through time as a result of lagged groundwater pumping impacts. Increased pumping-induced river depletions result in a higher probability of debit conditions than credit conditions under the Compact.

This study has continued into a second phase. The focus and preliminary results of this second phase are presented in a companion poster.

Poster Abstract - 20

CLIMATE IMPACT ON THE SURFACE WATER SUPPLY OF THE MIDDLE RIO GRANDE REGION

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The surface water supply of the Middle Rio Grande Region in New Mexico is limited, highly variable, and constrained by the requirements of the Rio Grande Compact. Many water studies are being undertaken in New Mexico driven by the desire to improve our understanding of the forces affecting water availability and use in the region and how these will impact Compact deliveries. S.S. Papadopulos & Associates is contributing to this effort through a second phase of the Middle Rio Grande Water Supply Study, which is focusing on:

- Assessing the periods of record used in past studies within the framework of the past 500 years of climate to determine whether previously derived water budgets are likely to represent future conditions in the region;
- Technical revision of both individual water budget terms and the water budget model as a whole, including correlations between current reservoir evaporation and past flows and refined representations of crop and riparian consumptive use;
- A "failure" analysis for the region, looking at how different climatic regimes affect the ability to meet Compact deliveries;
- Planning support for regional water planning groups.

Our assessment of past climate indicates that the 1950-1998 period used in the initial Water Supply Study is a relatively accurate representation of the climate of the past 500 years, capturing both a drought equivalent to a 100-year drought during the 50s and 60s and a wet period during the 80s and 90s. However, we found that the 80s and 90s were unprecedently wet; reconstructed precipitation at El Malpais from 1980-1992 was 125% of the 500-year average. In comparison, 1950-1965 reconstructed precipitation was 90% the 500-year average. We also found the 1950-98 record lacks average flows, instead emphasizing high and low flow years. We also examined climate forcing, such as El Nino and the Pacific Decadal Oscillation, as a predictor of trends in current and past water supply conditions in the region. We found that the inflow to the region at Otowi Bridge is strongly correlated with both El Nino and the Pacific Decadal Oscillation. We discuss implications of this for near-future hydrology in the region.

Poster Abstract - 21

EFFECTS OF CATTLE GRAZING ON TWO RIPARIAN AREAS

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Preserving riparian ecosystems and managing their sustainable use depends on our understanding of these complex systems. Scientific literature has failed to adequately address the effects of livestock grazing on riparian areas in the American southwest. Most of the literature is observational research, anecdotal, based on unreplicated experiments, and compares heavily grazed areas to areas from which livestock have been completely excluded. This study in the Black Range of the Gila National Forest, New Mexico compared the effects of a range of seasons (cool, warm and dormant) and a range of intensities (light, moderate, and none) of cattle grazing on young narrowleaf cottonwood (*Populus angustifolia*) populations and streambank morphology in two adjacent southwestern riparian areas. Twig length measurements and stream-cross sections were recorded before and after grazing treatments to estimate the effect each treatment had on the riparian areas. Cottonwoods on lightly grazed plots received 18% (SE 3.0%) use and on moderately grazed plots 33% (SE 2.9%) use. Lightly and moderately grazed plots were significantly different at ($P=0.0027$, $P<0.0001$ respectively) from ungrazed plots which experienced negligible use of 2% (SE 3.0%). Moderately grazed plots in the dormant season had the greatest use of 53% (SE 5.1%).

Stream width/depth ratios and cross section net change were computed from depth-to-channel measurements. Neither season of use ($P=0.2563$) nor intensity of cattle grazing ($P=0.2432$) appear to have a significant effect ($\alpha=0.05$) on the difference in width/depth ratios before and after grazing treatments. Similarly, total change in cross sectional area does not appear to be significantly affected by season of use ($P=0.5874$) or intensity of cattle grazing ($P=0.3196$). Grazing use on cottonwoods is compatible with what might be expected, but impacts on streambanks are contrary to what might be expected. If cattle graze at a greater intensity in one area, it's expected they would have greater impacts on the stream channel, cottonwood population for other factor in that area. Our results do not indicate that cattle grazing at light or moderate levels in cool, warm or dormant seasons have significant impacts on the study riparian areas.

Poster Abstract - 22

SPATIAL AND TEMPORAL VARIATIONS IN NUTRIENTS IN THE RIO GRANDE FROM DEL NORTE, COLORADO, TO EL PASO, TEXAS, 1993-95

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Data collected as part of the Rio Grande Valley National Water Quality Assessment Program were used to evaluate spatial and temporal variations in the concentration of dissolved nitrite plus nitrate (dissolved nitrate) and total phosphorus at selected sites on the Rio Grande from Del Norte, Colorado, to El Paso, Texas, for the period of April 1993 to September 1995. Dissolved nitrate and total phosphorus loads, which were estimated by a multivariate linear regression model (ESTIMATOR2000), are also presented and discussed. Spatial and temporal variations in nutrient concentrations and nutrient loads were used to evaluate how surface-water and ground-water inflows to and outflows from the Rio Grande affect nutrients along the river.

Dissolved nitrate and total phosphorus concentrations generally increase in the downstream direction. Dissolved nitrate and total phosphorus concentrations increase by factors of ten and four, respectively, between Otowi Bridge and Isleta, New Mexico. Dissolved nitrate concentrations do not change between Isleta and San Marcial, New Mexico; however, total phosphorus concentrations increase due to inflow from ephemeral streams. Dissolved nitrate and total phosphorus concentrations increase by factors of three and two, respectively, between Leasburg, New Mexico, and El Paso, Texas.

Dissolved nitrate and total phosphorus concentrations decrease between the mouth of Trinchera Creek, near Lasauses, Colorado, and Otowi Bridge due to dilution by surface-water inflow. Dissolved nitrate and total phosphorus concentrations decrease between San Marcial, New Mexico, and Leasburg, New Mexico, due to nutrient uptake and settling of sediment in Elephant Butte and Caballo Reservoirs.

In several reaches of the Rio Grande, decreasing streamflow and increasing nutrient loads indicate the presence of inflows with large nutrient concentrations (relative to those of the Rio Grande immediately upstream from that inflow); this occurs between Otowi Bridge and San Marcial, New Mexico, and between Leasburg, New Mexico, and El Paso, Texas. The increases in load are due to inflow from wastewater treatment plants and return flows from agricultural areas.

Poster Abstract - 23

WATER QUALITY CASE STUDIES TO SUPPORT TREE, TURFGRASS, AND FLOWER CULTIVATION IN NEW MEXICO – 1999 TO 2002

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Production and utilization of horticultural crops is the fastest growing entity of New Mexico crop agriculture. Horticultural crops pose two water quality concerns that are exacerbated in southern New Mexico's semiarid climate: 1) they are typically sensitive to high salinity, and 2) their intensive fertilization management increases environmental risk to natural water supplies. A recent selection from our work on water quality problems of New Mexico horticulture crops supported by our latest journal article contributions will be presented. The project has been sponsored by ten international, national, regional, and local funding agencies.

A 120-km Mesilla Valley survey (using 15 commercial pecan orchards as an indicator crop) showed that 2/3 of agricultural sites may be on soils too saline for salt-sensitive pecan, onion, chile pepper, lettuce, and field-grown ornamental trees. Of added concern is potential for crop sodium (Na) toxicity along the lower Rio Grande, and some physiological consequences of high Na on plant root systems will be presented. Survey data provide a quantitative basis for continual soil and water quality monitoring in order to assess sustainability of current irrigation and soil management practices in much of this concentrated agricultural region.

Greenhouse experimentation on hybrid bermudagrass has indicated that the source of nitrogen (N) fertilizer, season of N application, daylength, and growth rate of the grass are strong determinants of N use efficiency, and thus attendant risk of N loss. Under autumnal growing conditions, for example, as much as 25 to 30% more applied N fertilizer is lost (e.g., not recovered by the grass) as compared to summer growing conditions, and the lost N is subject to various loss mechanisms to the environment, most notably N leaching loss.

Greenhouse study involving Big Bend bluebonnet (a new cut flower crop in New Mexico) has revealed that accounting for the natural edaphic and climatic habitat characteristics of the plant may improve fertilizer use efficiency. For example, Big Bend bluebonnet is indigenous to calcium (Ca)-rich environments of the Chihuahuan Desert, and supplementation of greenhouse irrigation water with Ca increases crop recovery of applied potassium (K) and phosphorus (P) fertilizer by 5 to 20% over that of non-Ca-supplemented irrigation water.

Our findings support the expanding horticulture industries in New Mexico by taking steps toward 1) abatement of adverse water quality impact by fertilization practices, and 2) amelioration of crop stress imposed by saline agroenvironments often encountered in the semiarid USA.

Poster Abstract - 24

PECOS RIVER WATER MANAGEMENT PROJECT

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Sandia National Laboratories is providing technical assistance to the farmer members of the Carlsbad Irrigation District (CID) in better planning the storage, delivery and application of water in the Carlsbad Project. The surface waters along the Pecos River are allocated by the state of New Mexico to three major entities: 1) State of Texas: each year a percentage of water from the natural river flow must be delivered to Texas as governed by the Interstate Stream Commission: 2) CID farmer members: a fixed portion of water must be delivered to the farming members of the CID: and 3) Wildlife: an amount of water must be allocated to support the wildlife habitat in the Pecos River, most notably the endangered Pecos Bluntnose Shiner Minnow. The Pecos Bluntnose Shiner Minnow habitat preference is under investigation by other state and national agencies. Preliminary work has established that water depth, water velocity, and sediment activity (dunes, ripples, etc.) are key parameters affecting minnow habitat preference. The amount of water necessary to create a preferable habitat to support this species has yet to be determined. Since there is a limited amount of water in the Pecos River and its reservoirs, it is critical to allocate water efficiently such that habitat is maintained, while still supporting the farmers of the CID and commitments to the State of Texas. This study is investigating the relationship between flow rate in the river and water depth, water velocity and sediment activity.

Poster Abstract - 25

OPTIMIZATION OF IMMUNOMAGNETIC SEPARATION FOR THE DETECTION OF CRYPTOSPORIDIUM IN ENVIRONMENTAL WATER SAMPLES

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The introduction of immunomagnetic separation (IMS) for the recovery of Cryptosporidium parvum oocysts from water was an important and significant improvement to previous methods. However, variation in the performance of the IMS process has been observed in some water matrices, and has previously been tentatively linked to pH and other matrix factors. The objectives for this study were to optimize recovery and characterize variables affecting oocysts recovery during the IMS process. The effect of the buffering capacity (pH), beads, capture time, and matrix were investigated. Recoveries were characterized with two IMS systems (A and B) from six surface water samples from the Rio Grande in New Mexico and four other surface water samples from other problematic water sources. IMS system B produced more efficient and consistent recovery through adjustments of the pH of the 10mL sample concentrate to 7.0 following the addition of the IMS buffers. Results indicated that the buffering capacity of IMS system B was insufficient to accommodate all water concentrates and manual adjustment of pH following addition of IMS buffers improved recoveries by 20-30% in problematic samples. However, it has been shown that IMS system A has buffers with superior pH buffering capabilities, which required no manipulation. Furthermore, this IMS system produced greater recovery efficiencies (89% n=12) compared to IMS system B for the recoveries of endogenous oocysts from surface water. These results indicate that the buffering capacity of the IMS process plays an important role in IMS performance. These results indicate that variation in water samples can also affect IMS recovery ranging from 0.4-60.3%. These results indicate that the IMS process is a central component for efficient recovery of Cryptosporidium parvum oocysts and thus is an important variable to optimize for oocyst recovery.

Poster Abstract - 26

DEVELOPING TOOLS TO OPTIMIZE BENEFICIAL USE OF WATER IN THE RIO GRANDE BASIN

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Water is a limited resource in New Mexico's Rio Grande Valley, with increasing demand for water from various sectors including agriculture, municipalities, industry, and the environment. The predominant method of irrigation in the area is flood irrigation with limited potential for irrigation scheduling. Under this circumstance, there is a serious need to identify methods to improve water use efficiency in the area. This research project involves the first systematic, wide-scale examination of Elephant Butte Irrigation District (EBID) water application data at the field scale. These data have only recently become available as a result of EBID's ongoing development of a comprehensive database. The objective of this project is to identify parameters that affect water needs, water use efficiency, and economic returns from irrigation water in Southern New Mexico's Rio Grande Basin.

The spreadsheet-based datasets include the following variables for alfalfa, pecans, and cotton: account number, time and duration of irrigation, amount of water ordered, irrigated acreage, relevant canal, and soil types.

Summary statistics for acre-feet/acre, hours per acre per irrigation, and total water applied have been developed from the EBID data. Patterns of irrigation practices and efficiency have been identified. Key factors affecting irrigation efficiency include soil permeability, crop, climate, flow rate, and the farmer's approach to irrigation scheduling. A permeability index database and map have been created based on the USDA soil database. The database is used to identify fields with low potential irrigation efficiencies. Preliminary results of farm-level flow measurements and observations of actual irrigation practices support the hypothesis that soil permeability and flow rates at the farm gate greatly affect on-farm water application efficiency. Additional fieldwork and interviews are underway to provide further insight into the technical and socio-economic determinants of on-farm irrigation efficiency.

Our poster will present results of the water application database analysis for alfalfa, pecans, and cotton. Information about the development and use of the soil permeability index also will be presented. In addition, results of the on-farm research will be presented.

This research is part of the "Efficient Irrigation for Water Conservation in the Rio Grande Basin" project (a joint project of the Texas A&M University System Agriculture Program and the College of Agriculture and Home Economics at New Mexico State University).

Poster Abstract - 27

MANAGEMENT OF A LAND APPLICATION INDUSTRIAL PARK WASTEWATER TREATMENT FACILITY

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The City of Las Cruces, New Mexico, is authorized to discharge treated effluent from the West Mesa Wastewater Treatment Facility using a land application system for further treatment and disposal of the wastewater. The wastewater receives secondary treatment prior to land application to native vegetation (creosote, mesquite and four-wing saltbush and several varieties of annual and perennial mustards). The City developed 80 acres to receive the wastewater through a fixed head sprinkler irrigation system based on a preliminary study (J.G. Mexal and W.H. Zachritz II 1999). At the time the plan was developed, the assumptions were that the Industrial Park would generate 400,000 gpd wastewater with 2,000 mg TDS/L, 48 mg total N/L, and BOD5 of 38 mg/L. These assumptions led to the recommendation that only native vegetation could tolerate this level of salt loading with minimum risk of groundwater contamination.

Prior to the start of the study, baseline soil samples and a vegetation survey were taken. Currently, the wastewater treatment plant discharges an average of 166,000 gallons a month over a 1.25-acre test plot. Biomass samples are taken in six-week intervals throughout the growing season. The vegetation is analyzed for nutrient content, bud break in mesquite, leaf area index, specific leaf area and overall condition of the foliage. The emergence and percent coverage of various annual and perennial ground covers is also measured. Wastewater quality, soil moisture, and general weather conditions are continuously monitored at the site.

The objective of the research is to develop a practical management plan for the application of wastewater to the native vegetation. This plan will permit the greatest loading to maximize biomass production and prevent contamination of groundwater resources through leaching. Through biomass and chemical analysis data, we will determine the amounts of contaminants removed by the native vegetation. The major practical outcome will be development of a low-input wastewater management system useful for desert communities searching for cost-effective wastewater disposal system.

Poster Abstract - 28

THE ROLE OF FLOODING IN REDUCING FIRE HAZARD IN THE MIDDLE RIO GRANDE RIPARIAN FOREST

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Damming, diversions and drought in the past 50 years have resulted in a mostly dry forest along the Rio Grande, with much accumulation of woody debris and leaf litter on the forest floor and a thick understory of exotic trees such as saltcedar and Russian Olive. All of these factors serve as fuel for fire, which has grown to be a great concern in recent years. It can be seen that flooded forests have less litter and wood on the forest floor compared to nonflood forests due to scouring of the floor during the flood and higher rates of decomposition. However, few studies have quantified the differences in amount of litter and wood in flood and nonflood sites. We are investigating how four flood and four nonflood sites within a 160 km stretch of the Middle Rio Grande in New Mexico differ in terms of total litterfall and amount of wood falling from the canopy and amount of existing wood and litter on the forest floor. In addition, leaf decomposition rates in flood and nonflood sites will be estimated. Results will be used to advise policy-makers on how to manage the riparian forest for reduced fire danger.

Poster Abstract - 29

HYDROLOGIC RELATIONS IN THE MIDDLE RIO GRANDE RIPARIAN FOREST

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The native ripairan ecosystem of the Middle Rio Grande in New Mexico is in decline and is aging. This ripiarian forest, or bosque, is dependent on the annual flood pulse that in the past 50 years has been nearly eliminated by dams, diversions and drought. We are studying the difference in hydrologic connectivity between four flood and four nonflood sites within a 160 km stretch of the Middle Rio Grande from Cochiti Dam to Elephant Butte Reservoir. These hydrologic factors include river levels, rainfall rates, groundwater depth and soil moisture. The relationship among these factors will help us understand hydrologic differences in flood and nonflood sites and what is critical in maintaining the native riparian ecosystem. Results from this study will be used to help inform policy-makers on potential tools such as managed floods that could be used to restore the native bosque of the Middle Rio Grande.

Presentation Abstract - 30

HYDROLOGIC MODELING OF THE RIO GRANDE SURFACE WATER / GROUNDWATER SYSTEM FROM SAN ACACIA TO ELEPHANT BUTTE RESERVOIR

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This paper describes the development and calibration of a surface water/groundwater model of the Rio Grande reach from San Acacia to Elephant Butte reservoir. The purpose of the model is to evaluate potential system-wide depletions that may result from changes in operation of the Low Flow Conveyance Channel (LFCC), riparian vegetation restoration projects, and riverbed aggradation. MODBRANCH, a USGS program, is used to simulate the Rio Grande channel, the LFCC, main irrigation canals and drains, and the alluvial and the Santa Fe group aquifers. Physical processes represented in the model are surface water routing, surface water/ground-water interaction, discharge from springs, riparian and crop depletions, groundwater withdrawals and groundwater levels.

The model is being calibrated against surface water flow measurements and groundwater levels and is used to investigate different scenarios to optimize surface water depletion. Initial results indicated that the river is highly connected to the shallow groundwater system. Model runs using different alternatives of surface water routing revealed that using the LFCC to route surface water flow is more efficient than using the river channel. Aggradation of the riverbed was also shown to increase conveyance loss in the river channel.

Poster Abstract - 31

APPROPRIATE PRESERVATION OF DAIRY WASTEWATER SAMPLES FOR ENVIRONMENTAL ANALYSIS

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Thousands of gallons of water are used in dairies to wash cows before milking and for cleaning equipment. The wastewater generated contains elevated levels of organic matter and pollutants, including nitrogen that once converted, may contaminate groundwater with nitrates. Strict guidelines have been established by state regulatory agencies and water quality control boards to prevent groundwater contamination by dairies and other agricultural operations. Sampling and analyses are required to monitor effluent water quality which requires that all samples must be appropriately preserved to ensure valid results.

This study was conducted to determine the amount of sulfuric acid needed to preserve wastewater samples from a New Mexico dairy in the southwestern U.S. Titrations of wastewater from a local dairy using full strength (18 *M*) sulfuric acid were performed to determine the amount of acid needed to bring the pH of the sample to below two, the recommended pH for sample preservation. An average of 0.33 mL of acid was required for every 100 mL of wastewater. However, due to sample variability it is recommended that 0.4 mL of sulfuric acid be added for every 100 mL of dairy wastewater sample to ensure adequate acidification. This quantity is twice the current amount recommended in U.S. Environmental Protection Agency guidelines. In addition, the longer a dairy wastewater sample was kept without being preserved, the more acid was needed to lower the pH.

Poster Abstract - 32

THE HYDROLOGICAL EVALUATION OF LANDFILL PERFORMANCE (HELP) MODEL ASSESSMENT OF THE GEOLOGY AT LOS ALAMOS NATIONAL LABORATORY, TECHNICAL AREA 54, MATERIAL DISPOSAL AREA J

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This project utilizes the Hydrological Evaluation of Landfill Performance (HELP) model to determine the rate of transport for leachate at Material Disposal Area J (MDA J), a landfill located on Los Alamos National Laboratory (LANL) property. Modeling of the downward percolation of contaminants has become a very important tool within the regulatory field. By modeling contaminant migration, an estimate can be made as to the rate of transport for possible landfill contaminants. This is a factor in the total assessment of how a landfill may pose risk to human health. The HELP model is just one of the tools that is used for this process and is the focus of this thesis project. The HELP model integrates climate, geologic, and landfill data to model contaminant transport.

Climatological and landfill data have been acquired from LANL's Weather Machine web page (http://weather.lanl.gov) and LANL archives. The subsurface geology of the study region comprises numerous volcanic and sedimentary strata that have been fractured, faulted, and offset in some places. The aim of this research was to use the HELP model to estimate the amount of leachate that will reach the regional aquifer within the regulatory post-closure timeframe of thirty years.

Data from this study suggests that there will not be significant downward percolation of leachate from the surface of the landfill cap to the aquifer. Average leachate transport rates have been calculated to be approximately 1.51E-6 m/d, and the volume of leachate reaching the aquifer has been estimated to be 5.8 m^3 after thirty years. This poster will summarize the development of the HELP model, including site characteristics, limitations and assumptions, and hydrologic implications and describe the application of the model results to demonstrate the MDA J landfill does not pose a significant risk to human health during the regulatory post-closure care period.

Poster Abstract - 33

DETERMINING THE FATE OF BRINE DISPOSAL IN AN OILFIELD USING BRINE INJECTION FOR PRESSURE MAINTENANCE

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Petroleum production began in the early 1960s at an oilfield in western Abu Dhabi Emirate. Beginning in 1970, water-injection programs for maintaining pressure in the petroleum reservoir were initiated. From 1970 through 1994, about 4,862 million barrels (Mbbls) of brine were withdrawn for injection at this oilfield. Most of this brine was injected; however, about 400 Mbbls were discharged to unlined pits in the desert where the brine either evaporated or slowly seeped into the ground. Because the underlying Liwa aquifer is a regional source of slightly saline to moderately saline water, contamination caused by brine seepage from the unlined pits may be an environmental hazard.

To conclusively determine whether brine has contaminated the shallow Liwa aquifer at the oilfield, the discharge pit associated with a particular brine-supply well was further investigated. Since 1986, about 12.6 Mbbls of brine with a total dissolved solids (TDS) concentration of about 220,000 milligrams per liter (mg/L) have been discharged into an unlined pit near this well. A 342-meter (m)-deep borehole drilled in the pit showed that the base of the Liwa aquifer (composed of eolian sand and silt) is at a depth of 150 m. The water table in the borehole was about 1 m above the regional water levels measured in seven nearby wells, which suggests a ground-water mound beneath the pit, and hence, recharge beneath the pit. The phasor induction, micro-SFL borehole geophysical log run in the borehole indicated the presence of a saline plume from the water table to a depth of 88 m, which is near the shallowest occurrence of clay detected in the drill cuttings. The borehole geophysical log-calculated concentration of maximum TDS in the plume was 169,100 mg/L, which is similar to the TDS of the water sample collected from a well screened in the lower part of the plume (160,350 mg/L). The TDS concentration of the water sample from the pit well is much higher than those of water samples collected from seven shallow wells located within 1.5 kilometers of the pit; TDS concentrations of water from these wells ranged from about 1,300 to 19,000 mg/L.

In summary, brine discharged and pooled in an unlined discharge pit has seeped into the Liwa aquifer to a depth of 88 m near a particular brine-supply well. The presence of the brine plume indicates ground-water degradation due to oilfield activities.

Poster Abstract - 34

WATER PLANNING GIS FOR THE PASO DEL NORTE REGION

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The purpose of the project is to develop and create a regional geographic information system (GIS) to support regional water planning in the Paso del Norte region. The basic geographic spatial databases, also known as framework or basemap data, consist of seven components. These are: geodetic control, orthoimagery, elevation, transportation, hydrography, governmental units, and cadastral information. The project involves the cooperation of GIS professionals at the three universities in the region. Cooperation among the three universities will allow for the gathering of required data and natural resource information for the purpose of creating a regional GIS system. A major task of this project is to acquire and evaluate existing digital data useful to water planning activities with a goal of combining them into seamless products. Where digital data are not available, tasks will be designed to assess requirements for their development. In addition, the GIS system should contain other databases that would be useful for regional water planning. Examples include groundwater aquifer boundaries, water well locations, watershed boundaries, and land use classifications. Project team members will work closely with regional planners to identify and incorporate other useful information. As the combined products are developed, they will be shared broadly, with each participating unit making them available via their websites. Procedures developed in this project could be used as a template for other border areas.