Presentation and Poster Abstract

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.

Presentation Abstract

SALTCEDAR EVAPOTRANSPIRATION STUDY IN THE MIDDLE RIO GRANDE

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Riparian evapotranspiration (ET) is one of the larger loss components in the Middle Rio Grande hydrologic budget and also one of the least understood. Much uncertainty exists as to the consumptive use of riparian vegetation such as saltcedar (Tamarix ramosissima). This study started in 1998 to measure ET of dense saltcedar at Bosque del Apache National Wildlife Refuge. Evapotranspiration measurements in 1999 indicated that saltcedar used about 1325 mm/yr (52 in/yr). Since then more data has been collected and analyzed. Preliminary results indicate not much variance in ET from 1999 to 2001.

Presentation Abstract

OCCURRENCE OF ARSENIC IN GROUND WATER OF THE MIDDLE RIO GRANDE BASIN, CENTRAL NEW MEXICO

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Chemical data from more than 400 ground-water sites in the Middle Rio Grande Basin of central New Mexico indicate that arsenic concentrations exceed the U.S. Environmental Protection Agency drinking-water standard of 10 micrograms per liter across broad areas of the Santa Fe Group aquifer system, which is currently the almost exclusive source of drinking-water supply for residents of the basin. Identification of sources of arsenic to ground water of the basin is complicated by multiple sources of ground-water recharge that differ substantially in chemical composition. Establishment of a clear hydrologic framework for the basin was useful in interpreting the significance of patterns in arsenic concentration. This investigation indicates that there are two main sources of high-arsenic water to the Middle Rio Grande Basin. One primary source is related to silicic volcanism in the Jemez Mountains to the north, where dilute recharge water likely flows through rocks that have been altered by contact with geothermal fluids. The other primary source is mineralized water of deep origin that mixes with shallower ground water in several locations around the basin, particularly along major structural features. Ground water that has not been affected by either of these two high-arsenic sources generally has low arsenic concentrations. In some areas of the basin, values of pH exceeding about 8.5 appear to contribute to elevated arsenic concentrations through desorption of arsenic from metal oxides.

Presentation Abstract

FRESH/GEOTHERMAL WATER MIXING IN THE MESILLA BASIN

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Research in the Mesilla Basin shows that groundwater mixing occurs at various sites between fresh water of the local aquifers and saline geothermal water from a regional source. The purpose of this study is to gain an understanding of mixing between geothermal sources and aquifers within the basin. Rio Grande rift horsts in the basin provide conduits for geothermal waters to rise to shallower depths where mixing occurs with aquifer water. Thirty-four wells in the river alluvium and Santa Fe aquifers were sampled between Radium Springs, NM in the north and Anthony, Texas in the south. The Rio Grande was sampled as a reference; all samples were tested for 75 ions and 6 isotopes. Geothermal water from three production wells has a characteristic geochemical signature high in bromine (0.424-1.2 ppm), chlorine (554-1620 ppm), lithium (0.315-0.733 ppm), potassium (53-149 ppm), sodium (452-1100 ppm), and total dissolved solids (1907-3870). Unmixed aquifer waters and summer river water values are much lower, ranging from 0.07-0.165 ppm bromine, 38-76 ppm chlorine, 0.042-0.15 ppm lithium, 3-19 ppm potassium, 39-70 ppm sodium and 305-558 ppm total dissolved solids. Mixed waters have intermediate concentrations along mixing lines between the geothermal waters and fresh basin water. Recognition of the mixing process and identification of end-members is an important step towards a complete salt balance in the Mesilla Basin.

Presentation Abstract

EVALUATION OF GROUNDWATER/SURFACE WATER INTERACTIONS IN THE MIDDLE RIO GRANDE BASIN

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The goal of this research is to quantify interconnections between the river and shallow groundwater along the Rio Grande between San Acacia Diversion Dam and Elephant Butte Reservoir. This reach of the river is crucial for riparian habitat, endangered species, and irrigated agriculture. We are utilizing a network of 30 monitoring wells arranged in transects across the Rio Grande and the parallel Low Flow Conveyance Channel (LFCC), which serves as a drain in this reach of the valley. Monthly monitoring of water elevations in this well network and in the Rio Grande, LFCC, and major drainage canals began in October 2001. Water chemistry including ^{2}H and ^{18}O are being determined quarterly. Data from the winter of 2001-2002 show that surface water and groundwater exhibit distinct chemical and isotopic signatures, and that the river is losing water to the aquifer and the LFCC along most of the reach. There are indications of a deep groundwater contribution to the river/shallow groundwater system at the upper (near San Acacia) and lower (near San Marcial) ends of the reach. We will use our water chemistry and elevation data to calibrate a surface water/groundwater model being developed for the Middle Rio Grande Basin.

Presentation Abstract

ENGINEERING SURFACES TO SORB ARSENIC: THE SANDIA APPROACH

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The acidity of surface sites exposed at metal (hydr)oxide-solution interfaces plays a critical role in determining the effectiveness of filtration, coagulation, and the subsurface transport of anionic contaminants. Surface acidity can be altered from baseline values through surface substitution reactions to achieve the elevated point of zero charge required to sorb many anions from near neutral aqueous solutions. Specific Anion Nanoengineered Sorbents (SANS) have been developed at Sandia National Laboratories by this approach which perform demonstrably better than both activated alumina and granular ferrihydrite at removing arsenate. The SANS materials also effectively remove chromate. Similarly, anion coagulation efficiencies and the sorptive uptake of anions during low-dose lime-softening are readily enhanced. Lastly, laboratory and bench-scale tests indicate that the approach can be applied to treat anion-contaminated aquifers by enhancing anion sorption capacity in situ for a wide range of aquifers.

Presentation Abstract

MODELING OPTIMAL WATER ALLOCATION: A POWERSIM APPLICATION

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This paper uses Powersim to develop a water allocation model for the Middle Rio Grande to simulate water usage over a span of 20 years. The purpose of this model is to simulate water allocations between environmental uses, agricultural uses and municipal uses in the Middle Rio Grande river basin which lies between Cochiti Reservoir and Elephant Butte Reservoir. Using this model we can simulate environmental constraints (such as the recent legal ruling on the Silvery Minnow) and view the affects on the allocation of water for urban usage and agricultural usage. Demand functions for each type of water use are incorporated to show the optimal price path that maximizes current value net benefits.

Presentation Abstract

BENEFITS OF LINING THE FRANKLIN CANAL IN EL PASO, TEXAS

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The Franklin Canal, constructed in 1890, currently flows for 28.25 miles through many of the City's low to moderate-income neighborhoods, and irrigates thousands of acres along its way. Preliminary studies indicate that seepage losses occur along the Franklin Canal, thereby impairing irrigation delivery efficiency. In the meantime, the Franklin Canal also poses threats to public safety such as accidental drowning, and arises health concerns. While still serving its original purpose as an irrigation canal to date, the Franklin Canal needs to be revamped to increase delivery efficiency and enhance public safety.

Recent seepage loss studies indicated that approximately 1,160 ac-ft of water can be saved by lining the first 3.26 miles of the Franklin Canal. Therefore, the first benefit of lining the canal is to improve delivery efficiency and consequently conserve water. The conserved water may then be used for municipal and/or industrial purposes besides agricultural application. The second, three-fold benefit derived from the lining of the Franklin Canal is the lesser amount of maintenance since a lined canal requires less maintenance than an unlined canal does, especially if box culverts are used to line the canal. Box culverts provide a safer living environment for the surrounding community by enclosing the water, and thus reducing the risk of possible exposure to disease and/or accidental drowning. In addition, to further improve the quality of life along the canal path, recreational parks and trails could be developed over the recommended box culverts. The third benefit contemplated with the lining of the Franklin Canal is its preservation as a historic landmark as the Franklin Canal was listed on the National Register of Historic Places on June 19, 1992. The Franklin Canal has a great potential in improving the quality of life of the City and County of El Paso, and lining it could be an initial stepping stone for an improved, safer, and more ludic way of living in our community.

Presentation Abstract

ANALYTICAL SOLUTION FOR CIRCULAR GATES AS FLOW METERING STRUCTURES

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Water measurement in irrigation canals is frequently limited by two factors: head availability and high capital investment costs associated with construction of compatible hydraulic structures.

On the other hand, many irrigation systems have circular sliding gates in place, which are used as diversion and flow control structures. The Fresno Irrigation District investigated the feasibility of using such circular gates (Armco Model 101) as flow metering stations in the 1920s. This early work demonstrated that circular gates, which exhibit relatively low head losses, could be used simultaneously for both flow control and as flow measurement structures. The original work is compiled by USBR, 1953 as 10,500 data points and is presented in tabular fashion for gate diameters varying from 18 to 48 inches. The authors present an analytical solution that accurately predicts the tabulated values. Use of the proposed algorithms improves interpretation of field information and facilitates the use of this concept in automatic flow metering stations. Use of these algorithms also allows flow estimation for gates that are not presented in the original tabulations.

Presentation Abstract

ANY GOOD NEWS? MEDIA COVERAGE OF SCIENCE RELATED TO ALBUQUERQUE'S WATER SUPPLY

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Water availability is potentially the most volatile policy issue in the Western United States and it is currently a focal point for researchers in disciplines ranging from ecology to hydrology to policy. In western newspapers, the large number of water-related stories provide testament to this topic's significance. But, to what extent do these stories include the geologic and hydrologic information necessary to make sound water policy decisions? This project focuses on the connections among media coverage of relevant science, public perception, and water policy decisions. The research is based on well established evidence that: 1) policy development relies heavily on public opinion and 2) the minimal scientific knowledge the general public possesses is learned via the mass media. The fundamental question is how does "mediated" language about geology and hydrology impact policy decisions about water?

This project used media coverage and policy decisions concerning the Middle Rio Grande aquifer as a case study. In 1993 a USGS report challenged the long-standing belief among the public and many policy-makers that the aquifer serving Albuquerque, NM was sufficient for an infinite future. The newly recognized information generated a flood of media coverage and debate surrounding water quantity and quality. The research reported here analyzed the media coverage as well as subsequent policy decisions to assess connections between how the media covered the geology and hydrology and the level of science being employed in the decision-making processes. Results indicate that, typical of these kinds of issues, the story moved almost immediately from being a science-based issue to a political issue and scientists had a very narrow window in which to interject information. The media language used reflects a poor understanding of the hydrology involved and the coverage has focused little on the actual data or research processes presented in the 1993 study or subsequent studies. The impacts have been that public perceptions about water in Albuquerque and New Mexico track very well with the media coverage and not so well with the actual physical evidence that researchers have been presenting for the past decade. This has influenced policy-makers and contributed to decisions that may not adequately address long-term water quantity issues.

Presentation Abstract

COOPERATIVE MODELING FOR COMMUNITY-BASED WATER RESOURCE MANAGEMENT

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Dynamic simulation modeling is a powerful tool for many aspects of natural resource management, including data interpretation, testing effects of alternative management strategies or environmental conditions, public outreach and education, sensitivity and uncertainty analysis, and more. Although modeling tools have long been used by scientists and management agencies, they have often been relatively inaccessible to policy makers and the public, and therefore limited in their exposure and use. Cooperative modeling is an approach in which resource stakeholders are drawn from all sectors and special interests of a community to work with modelers and scientists in the development of a model aimed at assisting in difficult and contentious resource management decisions. The collaborative community effort is intended to build transparency into the modeling process, and to assure that all important issues and viewpoints are represented in the model. A portable PC environment, a user-friendly model interface, and the ability to make easy modifications to model parameters and to receive immediate simulation results make the modeling tool highly accessible. This approach is being applied to water resource management in the Middle Rio Grande Basin in a collaboration between the Middle Rio Grande Water Assembly, the Utton Transboundary Resources Center, and Sandia National Laboratories. This presentation describes the processes employed in that collaboration, and a demonstration of the model being built.

Presentation Abstract

A PROBABILISTIC ASSESSMENT OF WATER-RESOURCE SUSTAINABILITY: USING THE MIDDLE RIO GRANDE AS A TEST BED

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Water-resource sustainability is a problem of international proportion, and modeling tools for water resources management can make a valuable contribution to addressing it. Our systems-level dynamic simulation model of the Middle Rio Grande Basin simulates the movement of surface and groundwater through the watershed at an annual time step for a period of 30 years into the future, including feedbacks and time delays associated with the various inflow and outflow terms. Our model uses historic inflow and meteorological data to build distributions from which future projections on inflows and environmental conditions are drawn. We use Monte Carlo analysis to simulate those future conditions, and also to propagate parameter uncertainty and variability as a way to probabilistically project the range of potential future consequences given current and alternative water management policies. In this study, we simulate a set of base case projections and then test four alternative scenarios. The base case projects current consumption and population growth trends into the future, and reveals unsustainable resource use. The first alternative scenario simulates large but viable reductions in indoor and outdoor water uses. In the second alternative, we simulate a 50% reduction in the amount of land under agricultural cultivation. In the third we simulate a change in species composition in the riparian forest that removes salt cedar, a non-native phreatophyte, and replaces it with cottonwood. Finally, we simulate a combination of changes drawn from the first three scenarios. Generally, the results show that new water conservation policies will probably need to extend across all the major use sectors to achieve sustainability; and, although the Monte Carlo analysis showed that uncertainties compounded dynamically over time, our results showed clear differentiation between the various policy options we investigated. The model is currently undergoing modifications and is being used by regional stakeholders in the development of a 50-year Middle Rio Grande water plan.

Presentation Abstract

A DIALOGUE: PEOPLE, PLACE AND WATER

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Isleta Boulevard runs north and south through the South Valley, a semi-rural community adjacent to, and southwest of, Albuquerque. As a part of a road improvement program planned for the roadway, the Bernalillo County Public Works Department and the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) have given particular attention to storm-water management. The drainage plan focuses on water detention strategies, with sites for surge ponds along Isleta, and a 14-acre detention area on a county-owned site south of Isleta, the former Sanchez farm.

The South Valley has an active citizenry that took great interest in how both the road and the drainage system were to be designed and built, and voiced the concern that all improvements should enhance economic activities, historical character, neighborhood values and quality of life along the corridor and in the neighborhoods. Residents were adamant that they did not want detention or surge pond sites to become “big holes” in their community landscape.

While engineers from the county public works and AMAFCA agreed, the question remained as to how to articulate alternative ideas for these sites and represent those ideas through design. In order to address these issues the County engaged the Resource Center for Raza Planning and the Landscape Architecture Program, both of the School of Architecture and Planning at the University of New Mexico.

Our role was to develop a process in which residents could discuss their visions for the South Valley Landscape in the context of the Isleta road improvement, to facilitate a conversation between residents and engineers, to propose design strategies for a surge pond site at Deadman's curve along Isleta Boulevard, and for a detention site on the former Sanchez farm.

The research and design team worked with the community and the public agencies to develop a solution that fulfills the needs and aspirations of the community residents while meeting the engineering performance specifications for land drainage and flood control. The result is a design that makes land drainage infrastructure a neighborhood amenity. This project represents our contribution to an important dialogue between community members and public engineers about how to circulate traffic and water in a way that enhances rather than detracts from an historic community.

Presentation Abstract

WATER QUALITY HYDROLOGY INVESTIGATIONS IN NEW MEXICO

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Two areas of investigation central to improved natural resource management in New Mexico are being conducted by Sam Fernald, Watershed Management Assistant Professor at New Mexico State University. These two areas are: 1) Surface water/groundwater interaction effects on hydrology and water quality, and 2) vegetation treatment effects on runoff and sediment yield.

Acequia associations along river corridors in New Mexico are coming under increasing pressure to line acequias with concrete to increase conveyance efficiency. Lining acequias and other irrigation ditches may have undesirable side effects including: 1) loss of riparian vegetation that depends on ditch seepage, 2) lowered shallow water tables, 3) contamination of deep groundwater from loss of flushing shallow subsurface flows, and 4) reduced return flow to rivers. Effects of ditch lining on surface water/groundwater interactions are poorly understood. This presentation describes a study that is part of a USDA special project on Irrigation Efficiency for Water Conservation in the Rio Grande Basin. This study has sites in northern, central, and southern New Mexico and will quantify effects of lining irrigation ditches on hydrology and water quality.

Increased tree densities compared to historic densities in ponderosa forests and piñon-juniper woodlands have prompted calls for tree thinning to increase water yield and grass cover while reducing rapid runoff, erosion and sediment yield. Relatively few studies exist in New Mexico that show effects of tree clearing on runoff and sediment yield. This presentation describes studies beginning in three locations to investigate runoff and sediment yield effects of tree clearing. Study locations include: 1) piñon-juniper woodland at the Santa Fe Ranch near Santa Fe, 2) ponderosa forests in the Mora River Watershed, and 3) ponderosa forests in the Gila National Forest. These studies will quantify changes due to vegetation clearing on grass cover, hydrologic budgets and water quality.

Presentation Abstract

FEASIBILITY STUDY OF A NATIONAL DESALINATION RESEARCH CENTER IN THE TULAROSA BASIN

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Congressional legislation in FY01 authorized the Bureau of Reclamation in cooperation with Sandia National Laboratories to investigate the feasibility of establishing a national desalination research center in the Tularosa Basin of New Mexico. The Tularosa Basin has a wide range of water qualities and water chemistries in very close proximity, as well as access to abundant renewable energy resources. These attributes provide a unique opportunity to test new desalination technologies over a wide range of conditions at one location.

Sandia and the Bureau of Reclamation worked cooperatively throughout FY02 to conduct and complete the feasibility study. Sandia contracted with Livingston Associates of Alamogordo in association with RosTech to provide consulting engineering services for the study. Also as part of the study, Sandia organized an executive committee to oversee and provide input on developing a regional and national mission and research role for the facility, facility siting and conceptual design, and development of potential operational and management plans. The executive committee consisted of regional and national desalination experts, representatives from state and national water resource agencies, and representatives of large regional municipalities.

The feasibility study has been completed and the results are available through the New Mexico Water Resources Research web site at wrri.nmsu.edu. This presentation will summarize the results of this feasibility study including the identified mission of a Tularosa Basin desalination research center, how such a facility would complement other national water research centers and capabilities, the overall facility conceptual design and layout, and the suggested primary research directions, opportunities, and capabilities.

Presentation and Poster Abstract

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.

The authors thank Mary Spencer, Irene Nester, and Tara MacHarg for their project-management support and Chad Davis for his calibration of the chemiresistor sensor. This work was funded by Edwards AFB through a Work for Others contract #061010824-0 (MIPR #W62N6M12477926). 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.

Presentation Abstract

SENSITIVITY OF A TRANSIENT GROUND-WATER-FLOW SIMULATION TO RETURN FLOWS IN THE TULAROSA BASIN, SOUTH-CENTRAL NEW MEXICO

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The U.S. Geological Survey in cooperation with Holloman Air Force Base and the City of Alamogordo, New Mexico is currently developing a transient ground-water-flow simulation of the Tularosa Basin for the period 1948-95. The sensitivity of the simulation to changes in return flow was evaluated by comparing simulated 1995 water levels calculated using scenarios of 1) potential annual return flow and 2) zero return flow. Potential return flow is that part of a ground-water withdrawal or surface-water diversion that is available to recharge a surficial aquifer. Potential return flow is calculated as ground-water withdrawal less ground-water depletion plus surface-water diversion less surface-water depletion. Depleted water is that part of a withdrawal or diversion that has been evaporated, transpired, incorporated into crops or products, or otherwise consumed and is not available for surficial aquifer recharge. Potential annual return flows from agricultural irrigation applications in the Tularosa Basin between 1975 and 1995 were estimated using withdrawal, diversion, and depletion data reported at five-year intervals by the New Mexico Office of the State Engineer. Potential annual return flows from agricultural irrigation applications between 1948 and 1974 were estimated using available historical data on agricultural land and water use. Potential annual return flows from urban areas, including the City of Alamogordo, Holloman Air Force Base, and White Sands Missile Range Post Headquarters, between 1948 and 1995 were assumed to be 55 percent of the water annually entering the respective distribution systems (Livingston Associates and John Shomaker and Associates, written communication, 2002).

Simulated 1995 water levels calculated using each scenario were compared at six simulation calibration points. Four calibration points are in an agricultural area near Tularosa, New Mexico, and two calibration points are within the Holloman Air Force Base Boles Well Field. Simulated 1995 water levels differed by 13 to 32 meters at calibration points in the agricultural area and by 1 to 2 meters at calibration points in the Boles Well Field. The apparent insensitivity of the simulation in the Boles Well Field to changes in return-flow may be explained by the lack of proximity of the well field to areas of agricultural or urban return flows. The sensitivity of the simulation in the agricultural area to changes in return-flow suggests a need to better understand the spatial variability and importance of return flows in the Tularosa Basin.

Presentation Abstract

DEVELOPING A WATERSHED MANAGEMENT MODEL OF THE PECOS RIVER BASIN: FRAMEWORK AND ISSUES

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Water users in the Pecos River basin are acutely challenged by the Basin's many competing demands and hydrologic complexities. Persistent inability to deliver on compact obligations and the threat of priority administration has raised tensions among water users, threatens the stability of the regional economy, and undermines credibility in New Mexico's ability to manage effectively its water resources. To address these issues, the Pecos River Basin Ad Hoc Committee recently identified a range of short- and long-run alternatives, including: purchasing and leasing water, using water banks, pumping groundwater, improving drainage, reducing salt cedar and reducing riparian vegetation. Evaluating the effectiveness and relative impacts of these and other alternatives is paramount to the successful long-run management of the Pecos River Basin.

To enhance water management capability in the Basin, this research presents a modeling framework that: 1) integrates the biophysical features of the Basin (e.g., climate, surface- and ground-water hydrology, vegetation, infrastructure, inflows and diversions), with economic uses (e.g., agricultural and municipal), and institutional characteristics (e.g., Compact obligations, endangered species); 2) differentiates features and uses both regionally and temporally; and 3) permits a systematic evaluation of the effectiveness and impacts of alternative management approaches. By simulating efficient market response and water transfers, while accounting for return flows, upstream and downstream users, subsurface interactions, and other features such as riparian vegetation, the model features a watershed-wide perspective within a framework of voluntary market response. By applying a consistent framework to the evaluation of various water supply and demand management alternatives, resource managers can examine both short- and long-run implications and impacts, project the trajectory of water use and system response over time (factoring in the lagged response associated with some alternatives), and suggest approaches that minimize economic adversity while meeting Basin obligations.

Presentation Abstract

EFFECTS OF ARROYO SEDIMENT INFLUXES ON THE RIO GRANDE RIVER CHANNEL

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Arroyos that flow into the Rio Grande River Channel along the US-Mexico Border provide periodic influxes of sediment that can obstruct the channel and may cause overflow as well as sedimentation problems farther downstream. This phenomenon was studied using an in-situ method for measuring erosion properties of sediments with depth and at high shear stresses. Results of the investigation confirm that the arroyo sediments can affect the channel of the Rio Grande River by introducing sediments that are more difficult to erode compared to the sediments present in the Rio Grande Channel. Two sites were mapped and characterized in terms of vegetation and soil distribution. Sediment samples were collected and erosion rates, mineralogy, and sediment grain size distributions were determined.

Presentation Abstract

INTEGRATED GROUNDWATER AND SURFACE-WATER MODELING OF THE LOWER PECOS REGION: TOOLS AND TECHNIQUES

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Streamflows on the lower Pecos River in New Mexico need to be quantified in order to meet various requirements including New Mexico irrigation water users, the Endangered Species Act (ESA), and to ensure compliance with interstate stream compacts. A set of quantitative tools has been developed in order to estimate streamflows in the Pecos River under various management scenarios. These tools will be used to evaluate the relative efficacy of different management alternatives for the river system in meeting the requirements of the ESA and specified state-line streamflows. The toolkit includes a MODFLOW 2000 model of groundwater flow in the Carlsbad area, which is linked to a RiverWare surface-water model via a custom interface developed using Visual Basic for Excel. The Carlsbad Area Groundwater Model (CAGW) simulates groundwater flow in the Capitan Reef and overlying alluvial aquifer in the Pecos River Basin from Lake Avalon to the Malaga Bend. It simulates surface-water irrigation, groundwater diversions, losses, and irrigation return flows, and predicts base inflows to the Pecos River. The CAGW takes advantage of the automated parameter estimation features contained in MODFLOW 2000. The RiverWare model simulates Pecos River hydrology and reservoir operations from Santa Rosa to Lake Avalon. In addition to the suite of numerical tools presented above, a variety of geographic information system (GIS) techniques have been used to evaluate regional parameterization of input data for the models. Analyses using the GIS have included evaluation and comparison of irrigated acreage determination using data from a variety of sources and estimation of riparian evapotranspiration based on vegetation type and land cover in riparian areas.

Presentation Abstract

ARE CITY WATER PIPES A FUTURE SOURCE OF ARSENIC CONTAMINATION?

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Analyses of corrosion/scale deposits from Albuquerque, New Mexico water distribution pipes indicate substantial amounts of pipe-associated arsenic. Although the concentration of arsenic in the distribution water is low (5 ug/L), the concentration of arsenic in the corrosion and scale deposits exceed 100 ug/Kg (20 times the concentration found in the distribution water). Initial analysis using scanning electron microscopy and x-ray diffraction shows that the principal phases present are magnetite, chlorite and quartz. Limonite-colored stains on sample surfaces suggest the presence of this material, though it is not abundant enough to be detected by X-ray diffraction. It is likely that much of the arsenic present in the samples is sorbed onto this minor component.

This paper will report on arsenic distribution in the pipes at different locations throughout the Albuquerque water distribution network. The mechanism of sorption of the arsenic to the corrosion and scale-forming passive layer(s) will be addressed. This study will also report on laboratory scale experiments designed to anticipate potential arsenic mobilization due to front-end removal of arsenic from the source water.

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Presentation Abstract

SELECTING TURFGRASSES FOR NEW MEXICO - A CLIMATIC DILEMMA

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Water is the biggest concern in turf management in New Mexico, as in most regions where its availability is limited. During times of water shortage, priority is given to water uses that are deemed more essential to human society. As a result, growing attention is being focused on the amount of water used to irrigate landscape and recreational areas such as home lawns, parks, golf courses and athletic fields.

Turfgrasses can be divided into two major groups, the cool season and the warm season grasses. Cool season grasses need considerably more water, are less drought and salt tolerant, and have a darker green color compared to warm season grasses. Warm season grasses go dormant and lose color during the winter, and use water more efficiently. In most parts of New Mexico, the climate is semiarid, and daily seasonal temperatures can fluctuate widely, due to the high altitude. This creates a dilemma as to which turfgrass species are the most suitable. On the one hand low precipitation suggests that warm season grasses are more appropriate. On the other hand, low temperatures, particularly in the winter, due to high elevations make cool season grasses the better choice. Selecting adapted turfgrass species in the respective areas of New Mexico, especially improved cold tolerant warm season grasses, would not only lead to an overall quality improvement of the turf areas, but would also help reduce quantities irrigation water used.

To determine which turfgrasses are best suited for the many different climatic areas in New Mexico, turfgrass screening trials were established in Las Cruces, Tucumcari, Artesia, Los Lunas, and at the Santa Ana Pueblo near Albuquerque. The turfgrass trials at the respective locations include up to 36 grasses. Some of the grasses were introduced to the turf market only a few years ago and have never been tested under New Mexico climatic conditions. First years' results revealed that all grasses established well in Tucumcari and Las Cruces under proper irrigation and fertilization conditions. At the end of August, three months after seeding, almost all plots showed ground coverage of 75% or higher. At the end of the growing period (beginning of November), all turfgrass plots showed complete coverage, with the exception of crested hairgrass. Even after 5 months of establishment, plots seeded with crested hairgrass cv. 'Barleria' averaged only 80% of coverage.

Presentation Abstract

WASTEWATER REUSE TECHNOLOGY EMPLOYED BY ALAMOGORDO, NM

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The City of Alamogordo, NM, like many communities in the arid southwest, is constantly looking for ways to stretch their limited water resources. The City recently embarked on a project of beneficial reuse of wastewater effluent. This presentation will report on the City's experience selecting, pilot planting, permitting, and constructing a water reuse system. Based on pilot plant data, the City of Alamogordo selected a 10-micron micro-filtration Disc-filter system to treat wastewater effluent to be used for irrigation of public lawns. The pilot plant data , which indicated that with addition of 1 mg/L polymer and pipeline mixing, the treatment plant effluent could be consistently treated to 3 NTU and zero fecal, will be presented. The pilot system, and the design, based on the pilot data, will be presented. Construction cost for the system, designed to treat 4 MGD with occasional peaks of 6 MGD, is approximately $500,000. The system is scheduled to be complete by the time of the conference. The presentation will tour the completed facility using digital images.

Presentation Abstract

FORWARD OSMOSIS: A NEW APPROACH TO WATER PURIFICATION AND DESALINATION

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Water shortages affect 88 developing countries that are home to half of the world's population. In these places, 80-90% of all diseases and 30% of all deaths result from poor water quality. Furthermore, over the next 25 years, the number of people affected by severe water shortages is expected to increase fourfold. Low cost methods of purifying freshwater, and desalting seawater are required to contend with this destabilizing trend. Currently, on a fuel basis, desalination technologies consume 10 to 30 times the theoretical minimum energy (about 3kJ/kg of fresh water) required to separate salt from seawater. Processes utilizing forward (or direct) osmosis have the potential to significantly reduce the energy costs associated with desalination, as well as provide low cost methods of purifying contaminated water.

Forward osmosis is a process in which water from one solution selectively passes through a membrane to a second solution based solely on the difference in the chemical potential (concentration) of the two solutions. This process is spontaneous, and can be accomplished with very little energy expenditure. Thus, forward osmosis can be used, in effect, to exchange one solute (e.g. NaCl in sea water) for a different solute, specifically chosen for its chemical or physical properties. This technology is currently gaining acceptance for concentrating solutions, such as fruit juices, that are sensitive to heat. In addition, "hydropacks" are being developed for military and emergency applications that allow the production of pure nutritional solutions (e.g. "Gatorade") from virtually any water source. In this presentation, we will review a number of forward osmosis processes and applications, and present our work in applying this phenomenon to desalination.

This work was supported by the United States Department of Energy under Contract DE-AC04-94AL850000. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

Presentation Abstract

THE SALT OF THE EARTH: USING ENVIRONMENTAL TRACERS TO QUANTIFY CAUSES OF SALINITY IN SEMIARID REGION BASINS, PRELIMINARY RESULTS FROM THE RIO GRANDE

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The salinization of surface and ground water presents a formidable threat to water quality in semiarid regions. Because the Rio Grande is characterized by a 50-fold increase in total dissolved solids content from its headwaters in Colorado to the U.S-Mexico border, it is an appropriate natural laboratory for assessing this problem. Along this ~1200 km of river, we utilized salt-burden calculations and environmental tracers including $d^{18}O$, $d^{2}H$, Cl^{-}, the Cl/Br ratio and the $^{36}Cl/Cl$ ratio to diagnose the causes of this dramatic salinization.

Evapotranspirative concentration of salts, indicated by enrichment of $d^{18}O$ and $d^{2}H$, is insufficient to account for the total salinization. An increase in the Cl/Br ratio from nearly 50 in the headwaters to greater than 1,000 at the southern end of the basin, in combination with a decrease in the $^{36}Cl/Cl$ ratio with flow distance, suggests significant saline subsurface water (commonly distinguished by high Cl/Br ratios and low $^{36}Cl/Cl$ ratios) contribution to the river. Furthermore, increases in Cl^{-} and the Cl/Br ratio are focused at the southern ends of sedimentary basins of the Rio Grande Rift, suggesting deep saline groundwater enters the river where it is forced to the surface by bedrock highs. A saline pool in San Acacia, representing deep groundwater discharge at the surface at the southern terminus of the Albuquerque basin, exhibits the high Cl/Br ratio and low $^{36}Cl/Cl$ ratio predicted by this hypothesis.

Presentation Abstract

TOXICITY EFFECTS OF DEPLETED URANIUM ON AMPHIBIAN GROWTH AND DEVELOPMENT

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Depleted Uranium (DU) is the by-product of an enrichment process to increase the percentage of the isotope uranium-235 in natural uranium ore. The primary release of DU to the environment occurred at Los Alamos National Laboratory when weapon components or munitions are explosively detonated or impacted against a target.

Although uranium has a low solubility, toxicity information is need regarding areas within the laboratory where runoff creates standing water that can be used as breeding pools by amphibians. Early life stages of amphibians have been used as sensitive indicators to environmental stress and are excellent models of contaminant exposure. A standardized test, Frog Embryo Teratogenesis Assay – *Xenopus* (FETAX), was employed to evaluate the developmental effects of DU in *Xenopus laevis*, the South African clawed frog. Preliminary results of short-term acute exposures (1.6 - 50.1 mg/L) resulted in neither mortality or a concentration-response effects. Although survivorship of *X. laevis* was not compromised, long-term low level exposures are currently being conducted to determine the degree of limb malformations.

Presentation Abstract

SPATIAL AND TEMPORAL VARIATIONS IN STREAMFLOW AND DISSOLVED SOLIDS 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 streamflow and the concentration of dissolved solids 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 solids loads, which were estimated by a multivariate linear regression model (ESTIMATOR2000), are also presented and discussed. Spatial and temporal variations in streamflow, dissolved solids concentrations, and dissolved solids loads were used to evaluate how surface-water and ground-water inflows to and outflows from the Rio Grande affect dissolved solids along the river.

Streamflow decreases from Del Norte, Colorado, to the mouth of the Conejos River because of diversions for irrigation. Streamflow increases from the mouth of the Conejos River to Otowi Bridge because of surface-water inflows (from the Conejos River, the Chama River, and other tributaries) and ground-water inflow in northern New Mexico. Streamflow decreases downstream from Otowi Bridge because outflows (due to agricultural use, leakage to ground water, and evapotranspiration) are greater than inflows.

Dissolved solids concentrations generally increase in the downstream direction; however, dissolved solids concentrations decrease between the mouth of the Conejos River and Otowi Bridge due to surface-water inflows from the Conejos and the Chama Rivers and ground-water inflows in northern New Mexico.

In several reaches of the Rio Grande, decreasing streamflow and increasing dissolved solids loads indicate the presence of inflows with large dissolved solids concentrations (relative to those of the Rio Grande immediately upstream from that inflow); this occurs (1) between Del Norte, Colorado, and the mouth of Trinchera Creek, near Lasauses, Colorado (2) between Otowi Bridge and San Marcial, New Mexico, and (3) between Leasburg, New Mexico, and El Paso, Texas. Increases in streamflow occur along every reach of the Rio Grande between the mouth of Trinchera Creek, near Lasauses, Colorado, and Otowi Bridge. These increases in streamflow result in increases in dissolved solids loads regardless of changes in concentrations.

Presentation Abstract

EFFECTS OF SUMMER CLIMATE ON RESIDENTIAL WATER DEMAND IN ALBUQUERQUE, NEW MEXICO

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This project examines and characterizes climate and residential water demand in Albuquerque, New Mexico. The purpose is to determine what relationships exist between residential water demand and climate as represented by the North American Monsoon System (NAMS), an atmospheric circulation system responsible for summer precipitation in southwestern North America. The City of Albuquerque (CABQ) is the largest city and public water supplier in New Mexico. It has a population over six times the size of the City of Las Cruces, the next largest city in New Mexico, and it withdraws over 100,000 acre-feet of water per year. Albuquerque withdraws all of its water from groundwater, although it intends to divert San Juan-Chama Project water from the Rio Grande by the end of 2005 (CABQ, 2002). Water demand in Albuquerque is influenced by many factors and this investigation will compare the sensitivity of residential water demand to climate.

This study will first describe summer climate and its variability within Albuquerque and the Rio Grande Basin in New Mexico. Second, residential water demand in Albuquerque will be characterized and described. Third, linkages between residential water demand and climate will be studied with exploratory data analysis (EDA) and multiple regression techniques. Seasonality will be investigated by aggregating monthly data into both traditional and monsoon seasons, and monsoon seasons with identifiable characteristics will be grouped together and correlated with corresponding residential water demand. Similar analyses at a finer scale will be done on disaggregated water demand and climate data. Residential water demand will be related to NAMS and climate variability followed by a discussion of the implications of variability on residential water demand. Lastly, connections between climate and residential water demand will be evaluated for their applicability into water demand forecasting and drought scenario models. The results will enhance our understanding of NAMS and its impacts on residential water demand within Albuquerque and improve water management in the face of climatic variability and increasing demand.

Presentation Abstract

IN-SITU BIO-DENITRIFICATION OF GROUNDWATER: A FIELD-SCALE DEMONSTRATION

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Nitrate contamination in groundwater is of growing health and regulatory concern and nitrate contamination is a significant problem in both New Mexico and the Nation. In response to this problem, the University of New Mexico in cooperation with the New Mexico Environment Department and the USEPA is investigating enhanced in situ bio-denitrification (EISBD) technology on a field scale at the Mt. View site in Albuquerque's South Valley. At this location, an over-fertilized vegetable farm operated in the fifties created a one square mile nitrate plume with nitrate concentrations over 300 mg/L nitrate-nitrogen. Conventional nitrate removal processes, which include pump and treat, ion exchange, and reverse osmosis are costly and only concentrate the nitrate as a secondary waste stream whereas in situ bioremediation chemically transforms nitrate into harmless nitrogen gas. A method of enhanced in situ biological denitrification (EISBD) is being developed by the University of New Mexico, which promises to offer considerable advantages over conventional methods of nitrate treatment. The University of New Mexico has taken a leading role in developing and testing this technology over the past seven years. Two uniquely different amendment delivery systems were evaluated on a semi commercial scale (100,000 gallons treated) in order to determine the more effective methodology. Environmentally friendly sodium acetate served as the amendment (carbon source) to provide the needed electrons for the indigenous bacteria to reduce toxic nitrate from a plus five oxidation state to harmless zero-valence nitrogen gas.

The scientific bases for the EISBD technology is now well defined and understood; however, work is proceeding on the engineered deployment at the field scale. The EISBD approach offers considerable technical and economical advantages over conventional methods of nitrate treatment. Conventional nitrate removal processes, which include pump and treat, ion exchange, and reverse osmosis are more costly and only concentrate the nitrate contaminant thus producing a secondary waste stream whereas bioremediation uses bacteria to transform/convert nitrate into harmless nitrogen gas which escapes from the groundwater and returns to the atmosphere thus completing this stage of the overall nitrogen cycle.

Presentation Abstract

ASSESSMENT OF THE ABILITY OF THE ASIAN FRESHWATER CLAM, CORBICULA FLUMINEA TO REMOVE VIRUS FROM WATER

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The Rio Grande is a major source for drinking, agricultural and ground water for the Paso del Norte region yet may be highly impacted with enteric pathogens. Existing methods for the concentration and detection of pathogens from water tend to be technically cumbersome, expensive and time consuming. Previous research has demonstrated that many marine bivalves concentrate virus from water. This study examined the potential of using the Asian freshwater clam, Corbicula fluminea to assess viral pollution in the Rio Grande. To optimize the recovery of virus from clam tissue *C. fluminea* were directly injected with known concentrations of bacteriophages T1 and/or PP7. Mean recoveries of T1 and PP7 were 66.1 and 51.1% respectively. To determine the efficiency of viral concentration by *C. fluminea*, clams were placed in water seeded with bacteriophages T1 and/or PP7 at concentrations ranging from 1.5 x 101 to 5.0 x 103 PFU/mL for 24 hours. Clams from these experiments were homogenized and assayed for the presence of virus within the tissue. The greatest amount of virus recovered from a clam was less than 0.01% of the total plaque forming units in the tank. Water samples taken after 24 hours were also assayed for viral concentration. In all cases, there was no significant difference in the concentration of virus between the tanks with clams and the negative control tanks without clams. These results indicate that *C. fluminea* does not concentrate virus efficiently from water. To further support this conclusion, water challenges with protozoan Cryptosporidium parvum are being performed.

Presentation Abstract

A PILOT OPERATION TO DESALINATE OILFIELD PRODUCED BRINE, A DISCUSSION OF PRETREATMENT OPTIONS AND LESSONS LEARNED

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A pilot operation to desalinate oilfield-produced brine was conducted near Lovington, in Lea County, New Mexico, in the fall of 2001. The basic desalination was through the reverse osmosis process. The original basic requirement of this pilot study was to reduce the Total Dissolved Solids (TDS) of an oilfield produced brine from a concentration of 40,000 mg/L (ppm) to a concentration of 6000 to 8000 mg/L (ppm). The Challenge Water also contained Fats, Oil, and Grease (FOG) of 20 to 40 mg/L (ppm) and 300 to 400 mg/L (ppm) of Hydrogen Sulfide. The Challenge Water Silt Density Index had an initial value in excess of 25.0. The pretreatment of the Challenge Water was extremely critical and will continue to be extremely critical in future operation of this type. Through the utilization of several technologies from different water treatment applications, a Silt Density Index of 2.7 to 3.1 was achieved. TDS readings below 1000 mg/L were achieved. During the course of the operation it was found that settling tanks, with sludge removal and skimming, were extremely useful in this type operation, and generally should precede most other mechanical and chemical pretreatment methods insofar as possible. Adding aeration was also useful on the pilot scale.

Presentation Abstract

COOPERATIVE, TRANSBOUNDARY RESOURCE MANAGEMENT: A LINK BETWEEN ECOLOGICAL SUSTAINABILITY AND PEACE

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Poor natural resource management leading to resource scarcities, famine, and disease can destabilize regions, produce waves of refugees, exacerbate regional conflicts and contribute to military conflict. Military conflict, in turn, can have devastating impacts on local and regional ecosystem function, often leading to more resource scarcities, famine, disease and refugees. In this context, working for peace and working for ecological sustainability can both serve the same goals, and projects aimed at both these objectives can have much higher leverage and impact than those aimed at one or the other alone. One application of these ideas is the development of cooperative, transboundary freshwater resource management projects. Avoiding freshwater scarcities in transboundary basins demands collaborative, transboundary, whole-watershed approaches. These efforts, in turn, can contribute scientifically and socially to regional stability both by sustaining the delivery of ecosystem services and by building transboundary relationships, trust, confidence and cooperation. This presentation describes when decay of ecosystem services has contributed to regional instability; when wars have contributed to decay of ecosystem services; and a model for the development of transboundary resource management projects aimed at preserving ecosystem function and regional stability. The model includes cooperative, transboundary, collaborative project development with regional scientists and stakeholders; standardization of methods; data/GIS sharing; dynamic simulation modeling; and ultimately, establishment of both a social and scientific infrastructure for transboundary resource management. This model is most clearly illustrated in a transboundary river monitoring project in the Aral Sea Basin of Central Asia.

Presentation Abstract

COOPERATIVE TRANSBOUNDARY WATER RESOURCE DATA CENTER DEVELOPMENT FOR THE U.S./MEXICO BORDER REGION

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Transboundary water resource management on the U.S./Mexico border is becoming increasingly important for achieving and maintaining sustainable social, cultural, economic and political systems in the region. Numerous public and private institutions on both sides of the border have collected data on water resources, but in many cases the storage of these data is spread across the entire border region. It has been widely observed that a centralized, transboundary, web-based water resources data clearinghouse would be a strong step toward facilitating greater transboundary cooperation in regional water resources science and management. This presentation describes the early development of a virtual data center including not only water resources but also other water resource related parameters, including land use, climate, demography, etc. The data center includes four major data components: links to other existing data already on the web; catalogued and searchable data contributed by institutions in varying formats which are downloadable or transferable; catalogued and searchable data contributed by institutions and formatted consistently in a GIS/ArcHydro format, and ready for use in GIS applications; metadata on all catalogued data. To foster transboundary cooperation, transparency and trust, the data serving technology being developed by SNL/EDAC will be maintained on both sides of the border, with one server at Sandia National Laboratories (SNL), and with the other at the Instituto Mexicano de Tecnologia del Agua (IMTA). This project gains considerable leverage through its partnership with a transboundary, basin-wide resource management and modeling project headed by the Natural Heritage Institute (NHI) and the Instituto Tecnologico y Estudios Superiores de Monterrey (ITESM), which includes 17 partnering institutions from both sides of the border.

Presentation Abstract

HYDROLOGIC AND EDAPHIC EFFECTS OF CREOSOTEBUSH CONTROL

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During the past century, creosotebush encroachment into southwestern New Mexico grasslands has greatly reduced herbaceous cover on rangelands. As grasslands have been converted to shrublands, there has been a concomitant change in soil properties and hydrology. In an effort to control creosotebush, the Bureau of Land Management has treated 56,672 ha at 68 sites throughout southwestern New Mexico with the chemical tebuthiuron between 1981 and 1999. The objectives of our study are to ascertain the effects of both creosotebush proximity and creosotebush control on edaphic properties and hydrological processes. Study plots were established at 6 sites treated between 1981-1987 (mid-successional), 6 sites treated between 1993-1997 (early successional), and contiguous, non-treated areas (late successional). During the summer of 2001 our efforts focused on the edaphic component of the study. At the sites treated with herbicide (early and mid-successional), one transect was placed between a pair of live creosotebush and one transect was placed between a pair of dead creosotebush. Soil samples were taken at the canopy center, canopy edge, and interspace. Numerous soil properties were measured from each sample, including soil organic matter, polysaccharide content, aggregation, texture, bulk density, cation exchange capacity, and nutrient status (N, P, K, Ca, Mg). Most soil properties exhibited a strong response to creosotebush proximity and a relatively weak response to creosotebush control, particularly the physical properties that likely influence hydrology. We are currently conducting rainfall simulation experiments at the study sites to determine the effects of creosotebush proximity and creosotebush control on infiltration rates, sedimentation, and wetting front depth. Circular plots with an area of 1 m^2 are being used in the study, and at each site three plots encompass a creosotebush and three plots are placed in the adjacent interspaces. Rainfall simulation trials last thirty minutes and are conducted under antecedent moisture conditions and at field capacity. Runoff and sediment yield are measured at 5 minute intervals and the wetting front depth is measured after the second rainfall simulation. Vegetation cover, biomass, surface roughness, soil texture, soil organic matter, and soil aggregation are measured within each plot and the data will be used to develop regression equations to elucidate the variables most strongly influencing infiltration. Preliminary rainfall simulation trials indicate that infiltration rates are strongly influenced by creosotebush proximity, and that greater infiltration rates occur beneath creosotebush canopies than in the interspace. Herbicide treatments appear to reduce infiltration rates in the proximity of creosotebush.

Presentation Abstract

A GEOTHERMAL INVESTIGATION OF GROUND-WATER FLOW CHARACTERISTICS IN THE ALBUQUERQUE BASIN

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High precision temperature logs have been made at thirty sites in the Albuquerque Basin, twenty-seven of these logs are at sites in and near to the Albuquerque metropolitan area. From these data several fundamental characteristics concerning the ground-water flow pattern in the area are suggested. At sites in the inner valley and/or near the Rio Grande there is a shallow flow zone, from near the water table to depths $\leq$ 150 m, with a cooling horizontal specific discharge, derived from the river, typically of tens to more than a hundred m/yr. A similar shallow cooling flow component is present in the northeastern and east-central part of the study area as well, and also in the western part of the Albuquerque Basin near the floodplain (although the flow is typically a good deal less in magnitude than in the floodplain). The cooling component of shallow ground-water flow in the areas outside the inner valley is also believed to come ultimately from the river. Temperature data indicate a deeper flow zone occurs at many sites along the inner valley and in the bordering eastern and western highlands. Data indicate that the deeper flow can have a warming horizontal flow component less in magnitude than the shallower flow, and at some sites the warm flow comes from higher elevations where the water table is deeper and warmer. It appears that faults act as both conduits for downward ground-water flow or as seals restricting flows. Small specific discharge estimates indicating warm flow at some sites in the west mesa are consistent with the location of faults that are sealed, restricting flow from the Rio Grande. Hydraulic conductivity estimates show a statistical difference in the mean horizontal values between sites in the east and west mesas, consistent with faults acting to slow flow west of the Rio Grande and the past deposition of Rio Grande sediments in the eastern part of the Albuquerque Basin. Regional recharge to the Rio Grande from the bordering eastern highlands is probably small, taking hundreds to thousands of years to move from the Sandia Mountains to the Rio Grande.

Presentation Abstract

IMPACT OF MIXING CHLORINE WITH CHLORINE DIOXIDE ON TTHMS FORMATION IN DRINKING WATER

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The Surface Water Treatment Rule emphasizes the need for utilities to meet minimum levels of disinfection for surface waters, whereas the Disinfection-Disinfection By-Products Rule limits the disinfectant by-products levels. Therefore, utilities will have to implement a treatment approach that balances the benefits of disinfection against disinfection by-products. After the Cryptosporidium outbreak in Milwaukee during March 1993, many utilities began immediately investigating the use of more advanced disinfectants such as ozone and chlorine dioxide in order to combat the threat from the Cryptosporidium protozoan. Chlorine alone was not adequate to inactivate the new target organism. Most disinfectants have their consequences in terms of disinfection by-products causing a potentially long-term adverse health impact from cancer. Although chlorine has served the water industry well for about a century in safeguarding the public health, it is relatively ineffective against Cryptosporidium and can cause excessive trihalomethanes in distribution systems. THMs were limited in drinking water in 1979 to 100 ppb (THM Rule) because of their potential carcinogenic properties. Although ozone is the strongest and most capable disinfectant against Cryptosporidium, it can have its dark side by producing excessive bromates, a potential carcinogen, in high bromide water. However, chlorine dioxide does not cause bromates and is capable of inactivating Cryptosporidium but not as well as Ozone. However, there are concerns about its disinfection by-product, chlorites, identified as causing hemalytic anemia, especially in 13% of black males. In El Paso, Texas, the Umbenhauer/Robertson Water Plant is adding 2 mg/l of chlorine with 3 mg/l of chlorine dioxide in the same disinfection zone followed by ferrous chloride to reduce the chlorite by-product. This new treatment process has lowered TTHM formation in the distribution system while increasing the disinfection capability as compared to the same chlorine dioxide dose alone. Therefore, the purpose of this paper is to examine the impact of adding chlorine with chlorine dioxide on the formation of TTHMs. Laboratory and plant dose-response studies are presented to compare the impact of the addition of chlorine alone, chlorine dioxide alone and in combination with chlorine on the formation of TTHMs. The results presented provides a means for chlorine dioxide users to lower their chemical cost in meeting lower TTHMs' levels in the future. This research paper is part of a doctoral thesis entitled, *Impact of Cl^2 in the Generation of ClO^2 on DBPs in Drinking Water* by Douglas Rittmann, published at the University of Texas at El Paso in July, 1999.

Presentation Abstract

RISK ASSESSMENT METHODOLOGY FOR WATER UTILITIES

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The Environmental Protection Agency (EPA), in partnership with the American Water Works Association Research Foundation (AwwaRF) and Sandia National Laboratories, has undertaken a program to improve security at water utilities across the United States. At the national level, the responsibility for improving the security of the water infrastructure has been assigned to the EPA. Sandia's role has been to develop and refine a security risk assessment methodology that will assist in the reduction of risks associated with malevolent attack throughout the water infrastructure. Through the Risk Assessment Methodology for Water Utilities (RAM-W^{SM}), which provides a systematic, thorough evaluation of the water utility operations, a prioritized plan for security upgrades and consequence mitigation, modifications to operational procedures, and/or policy changes can be developed to reduce risk. This consequence-driven, performance-based risk-management program is designed to facilitate comparative analyses relying on relative rankings determined from a risk equation. The methodology aids in identifying system vulnerabilities, describing critical facilities and assets to protect, and determining the level of protection to which the security system should be designed. The goal of RAM-W^{SM} is to reduce risk by providing a balanced security protection system and consequence mitigation.

RAM-W^{SM} is based on Sandia's more than 25 years of experience employing the security risk assessment process for designing and evaluating physical protection systems (PPS) known as the Design and Evaluation Process Outline, or DEPO. This approach has been utilized in a wide range of applications, from high-consequence government facilities to critical public infrastructures, and is in the final stages of being adapted for use in the water infrastructure. The presentation will include the basis for, a description of, and an abbreviated example of the RAM-W^{SM} process.

Presentation Abstract

FLOODING REGIME AND RESTORATION OF THE MIDDLE RIO GRANDE RIPARIAN ECOSYSTEM

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Over the past fifty years, volume and timing of the Rio Grande's flow, including the annual flood pulse, have been altered due to damming and diversion of the river. As a result, the river is largely isolated from its riparian forest, or bosque, and the native cottonwood forest is aging, not regenerating, and invaded by exotics. Restoration of native bosque requires the use of managed floods; however, there is limited scientific data to assess this management activity. To provide information about ecological implications of overbank flooding and restoring hydrologic connectivity between the river and its floodplain, we are investigating how four flood and four nonflood sites within a 160 km stretch of the Middle Rio Grande differ ecologically. Ecological indices of the cottonwood canopy, forest floor, soils, and groundwater were chosen to provide a picture of ecosystem condition. These indices include: litterfall, carbon to nitrogen ratio in litterfall, reproductive status/flowering of trees, nutrient characteristics of new leaf tissue, abundance and type of ground-dwelling arthropods, leaf decomposition, net nitrogen mineralization, soil moisture, forest floor respiration, root growth and biomass, soil texture and chemical characteristics, groundwater levels, and groundwater chemistry. We have completed two full field seasons measuring these variables and can compare data from 2001, during which there was a managed flood, and 2002, during which drought conditions have prevailed.

Presentation Abstract

ESTIMATE OF SEEPAGE LOSSES FROM CANALS IN THE PASO DEL NORTE REGION USING PONDING TESTS

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The El Paso Del Norte Region, composed of the cities of El Paso, TX and Las Cruces, NM in the United States; and Ciudad Juarez, Chihuahua, in Mexico, is facing a severe drought and as a result, a significant reduction in surface water allotments is forecasted for the upcoming irrigation season. Water conservation strategies have become even more urgent. Preliminary studies have shown that there is a great potential for improvement of water delivery efficiency (water savings or reduction in water diversions for a given level of surface water diversion) through lining of canals within this region. Through canal lining, water losses in the conveyance system due to seepage losses will be minimized, thereby maximizing delivery to farms for the available diversion amount. Since canal lining is a project that requires a significant investment of money, water losses need to be determined prior to the execution of the project. This paper presents a study of seepage losses in Elephant Butte Irrigation District (EBID) and the El Paso County Water Improvement District No. 1 (EPCWID). This study was conducted by TA&MU and NMSU scientists and engineers in collaboration with El Paso County Water Improvement District No. 1 in Texas, and with the Elephant Butte Irrigation District, in New Mexico

Authors first selected several canal sections with large seepage losses based on the Districts' operation experience and previous studies. Three ponding tests were conducted in Franklin Canal, El Paso, Texas. The canals were blocked into several sections by earth dams, and water was fed into the blocked sections. Canal banks were allowed to saturate for over 48 hours before the measurement of water level started. The water level was measured with a pre-installed staff gage. Water level measurements were taken for 2 or 3 days. The water levels in the ponding sites dropped at a rate ranging from 0.11 ft/day to 0.35 ft/day, which includes an evaporation rate of 0.006 ft/day on average. Based on geometry of the canal and water level changes, seepage rates were estimated. The results indicated that the seepage rate for the Franklin Canal ranged from 0.85 to 3.03 gal/sq. ft/day (0.11385 to 0.40261 cubic feet per day per square feet of the wetted area). The results also indicated that seepage rates changed from one location to another, and the seepage rate tended to reduce with drop of water levels in the canal. Authors concluded that there would be a great potential for improvement of delivery efficiency by lining canals. Preliminary results from inflow-outflow tests in EBID's main canals indicate losses of 3 to 7 cfs per mile. Work is continuing to provide replication, greater detail, and to measure additional canals.

Presentation Abstract

CONSERVING WATER IN THE LANDSCAPE THROUGH TURFGRASS SELECTION AND IRRIGATION SCHEDULING

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Due to rapid population growth and urban development in the southwestern United States, present water allocations, coupled with expected future demands, may soon exceed the supply required to satisfy per-capita water-use rates. Accordingly, to preserve the quality of life and welfare of their citizenry, most municipalities in the region have developed water conservation plans to insure adequate water availability for essential purposes. One of the first actions taken to conserve water during potential deficits is to impose restrictions on landscape irrigation, which may represent up to 50% of the total domestic water-use during the summer months in some of these municipalities. The potential adverse effects of these restrictions on landscape quality, however, can be mitigated if drought tolerant turfgrass cultivars are selected for planting and if irrigations are carefully scheduled to just satisfy plant water needs. The objective of this study was to identify the minimum water requirements for acceptable quality of various cool season and warm season turfgrasses in northwestern New Mexico. This was accomplished by evaluating the growth and quality of each grass at various levels of irrigation as provided by a line-source sprinkler during 1998, 1999, and 2000. Actual crop water-use or evapotranspiration (ET) was measured at each irrigation level using the water balance approach. We found that overall, the cool season grasses (bluegrass, tall fescue and perennial ryegrass) required about 48% more seasonal water than the warm season grasses (bermudagrass, buffalograss and blue gramagrass) to maintain an acceptable turf quality (37 inches vs. 25 inches, respectively). While approximately 40% of this water savings could be attributed to a shorter active growing season of the warm season grasses than the cool season grasses, the average daily water-use rates of the warm season grasses during late spring and summer averaged 25% less than those of the cool season grasses. The ET data collected during this study were correlated with potential ET to formulate seasonal crop-coefficients that can serve as a baseline for development of a turfgrass irrigation scheduling program applicable to the entire southwest.

Presentation Abstract

LINKING SCIENCE AND TECHNOLOGY TO GLOBAL WATER SECURITY

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Water resources are under increasing stress globally. Decreasing water quality and quantity impact populations and ecosystems all over the world. The scientific community has, for many years, warned about the future sustainability of the planet's water resources. Water availability and water quality has become a major stress point between regions and nations, and has contributed to armed conflict between nations in the past.

The concept of water security as an element of a secure, sustainable future for our planet has been considered as a vital part of fostering cooperation instead of conflict between regions and nations. Encouraging regions and nations to work together to solve water-related problems of mutual interest can lead to more positive relationships in other politically charged areas.

Water-related science and technology can contribute significantly to non-political solutions of politically charged issues on water quality and quantity between regions or nations. If the science and technology sector becomes directly involved in trying to solve water-related problems on a global scale, it has the potential to increase domestic benefits and protect the United States' national and international interests.

Expanding the knowledge base of addressing the basic science elements of the water cycle, such as accurate hydrological cycle prediction or contaminant flow and transport throughout a system are still beyond the current understanding of the physical systems and the integration of those systems across scales.

We will explore some methods to increase water security nationally and internationally by examining science and technology gaps and how filling those gaps can produce a more sustainable and secure world.

Presentation Abstract

VEGETATION, SOIL, AND RUNOFF RESPONSES TO DAIRY SOLIDS APPLIED ON A BLUE GRAMA RANGELAND IN NEW MEXICO

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A major challenge facing dairy producers is disposal of manure that is produced at their dairies. It has been suggested that manure from these dairies be applied to rangelands as a biosolid fertilizer to increase production and enhance the state of these rangelands. Manure was applied (June 2000) at two rates to a blue grama rangeland in New Mexico. The rates were chosen according to the phosphorus content: the recommended (light) rate (54 kg ha^{-1} P) to enhance blue grama growth and a gross over-application (heavy) or disposal rate (493 kg ha^{-1} P) to determine the environmental impacts that would occur. The soil on the site was a sandy loam. There were 12 plots, 4 each of a control, recommended rate, and disposal rate. The slope of the study site was approximately 10%. Broom snakeweed (*Gutierrezia sarothrae* (Pursh) Britt. & Rusby), an undesirable and invasive plant, was suppressed by the heavy application of the manure. After the first growing season there was a decrease in total herbaceous production from 1,225 kg ha^{-1}in 1999 to 688 kg ha^{-1} in 2000, on the heavy treatment, due to the smothering of the existing plants with the biosolids. After the second season of growth, however, the production on both the light (2,211 kg ha^{-1}) and heavy (2,994 kg ha^{-1}) treatments was significantly greater than it had been in the 2 previous years. Total herbaceous production on the light treatment was not suppressed or enhanced (1384 kg ha^{-1} in 1999 and 1372 kg ha^{-1} in 2000) during the first growing season after application. Forb production greatly increased on the heavy treatment by the end of the second growing season (257 kg ha^{-1} in 1999 to 1,108 kg ha^{-1} in 2001). Species richness remained constant. Soil salinity symptoms (7.76 ds m^{-1}) were noted on the heavy treatments following application. Runoff amounts and sediment yield were not affected by the manure application. Runoff water quality of the properties tested returned to background levels by the end of the first growing season on the light treatment and by the end of the second growing season on the heavy treatment. Gopher diggings were more prevalent in the heavy treatment than in the control or light treatments.

Presentation Abstract

IMPACT OF THE CERRO GRANDE FIRE ON INTERMEDIATE-DEPTH PERCHED-WATER QUALITY - - PRELIMINARY RESULTS FROM THE LOW-HEAD WEIR SITE, LOS ALAMOS NATIONAL LABORATORY

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A low-head weir, constructed by the U.S. Army Corps of Engineers in Los Alamos Canyon mitigated offsite transport of contaminant-laden sediments following the Cerro Grande fire. However, temporary ponding of water behind the structure enhances the potential for downward migration of contaminants and fire products. Thus, a vertical well for sampling perched water and two angled boreholes for sampling soil water under the pond area behind the weir were installed in 2001/2002. The vertical well is 281.5 ft deep and encountered two zones of perched water in Cerros del Rio basalt, as at nearby characterization well R-9i. These zones are tapped by four 10-ft screens which are sampled by a flexible liner with ports at 88, 163, 193, and 268 ft bgs. A third zone of saturation was also noted at 80 ft bgs. This shallow saturation was short lived and apparently associated with water ponded behind the weir during drilling. The angled holes were drilled at 43 and 34 degrees from horizontal and are constructed with flexible liners deployed through scalloped or perforated PVC shields because the highly fractured basalt is unstable. Analysis of a sample from 163 ft bgs in the well in December 01 showed an elevated concentration of total organic carbon: 330 mg/L. This confirms that 1) there is good communication between the stream in Los Alamos Canyon and intermediate-depth perched water in the basalt and 2) a fire product has already percolated into the subsurface along the canyon. A tracer test was initiated by applying a potassium-bromide solution to the dry pond area before the 2002 summer monsoons. A storm on 22 June 02 produced the first ponding of the season. By 1 July there was a slight increase in bromide content at 163 ft bgs in the well and electrical-wire pairs associated with liners in the angle boreholes showed an increase in moisture content. Modeling of the tracer-test data will improve our understanding of 1) the impact of the fire on ground-water quality, 2) the impact of the weir on ground-water quality, 3) surface water/ground-water interaction and 4) the hydraulic properties of the Cerros del Rio basalt underlying the eastern Pajarito Plateau.

Presentation Abstract

COMPARISON OF BIOLOGICAL SCREENING TESTS FOR MANAGEMENT OF INDUSTRIAL WASTEWATER

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Elimination of industrial outfalls and increasing waste disposal costs have favored the development of creative wastewater treatment so that industrial wastes can meet the acceptance limits of sanitary wastewater plants. Research at Los Alamos National Laboratory generates a variety of dilute volumes of wastewater that can be treated to meet acceptance limits and discharged to the sanitary wastewater plant without harming its biological treatment system. Toxic shocks to the sanitary plant have been minimized by offering generators free industrial wastewater characterization and proposing treatment options. Johnson Controls of Northern New Mexico environmental protection personnel have used oil sorption and separation, pH modification, removal of suspended solids, and product substitution to decrease discharge toxicity and minimize waste disposal costs.

The three tests we use to measure toxicity are the Strategic Diagnostics Microtox biomonitoring system, dissolved oxygen uptake rate, and the Hach Corporation BOD-Trak system. The microtox system represents our primary biological evaluation. It is convenient and provides economical data in about 15 minutes. It also overestimates the toxicity of surfactants in cleaning supplies. By using aeration basin microorganisms as a seeding material, we have used the Hach Corporation BOD-Trak system to learn if industrial discharges that exceed COD and microtox waste acceptance limits can be metabolized by the biomass without deleterious effects. The systems have also been useful in comparing cleaners and floor strippers that are advertised as environmentally friendly. We are interested in comparing our wastewater management screening tests with those used by other facilities.

Presentation Abstract

ESTANCIA BASIN DYNAMIC WATER BUDGET

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The Estancia Basin lies about 30 miles to the east of Albuquerque, NM. It is a closed basin in terms of surface water and is somewhat isolated in terms of groundwater. Historically, the primary natural outlet for both surface water and groundwater has been evaporation from the salt lakes in the southeastern portion of the basin. There are no significant watercourses that flow into this basin and groundwater recharge is minimal.

Since the 1930s, agriculture has grown to become the major user of groundwater in the basin. In addition to agriculture, as population from Albuquerque spills eastward, the non-agricultural population of the basin is increasing significantly. Significant declines in groundwater levels have accompanied these increased uses.

The Estancia Basin Dynamic Water Budget was developed by Sandia National Laboratories to assist the Estancia Basin Water Planning Commission in determining and implementing the Water Plan for the Estancia Basin. A dynamic water budget is a simulation model based on the concept of system dynamics, which allows for the simulation of complex natural and social systems which are seldom in equilibrium and are often in a state of continuous change.

This Water Budget model keeps track of the water balance within the basin. The model considers the amount of water entering the basin and leaving the basin. Since there is no significant surface water component within this basin, the balance of water in the groundwater aquifer constitutes the primary component of this balance. Inflow is based on accepted hydrologic assumptions for recharge. Outflow from the basin is the summation of the depletion from all basin water uses. The model user can control future water use within the basin via slider bars that set values for population growth, water system per-capita use, agricultural acreage, and the types of agricultural diversion. The user can also adjust recharge and natural discharge within the limits of uncertainty for those parameters.

The model runs for 100 years beginning in 1940 and ending in 2040. The first 60 years are a historical calibration period. The last 40 years are predictive.

Results of model runs show that the only significant factors that influence the future of water use within the basin are those that affect agricultural use. In 2040, after a period of declining agricultural use and increasing use by domestic wells and water systems, agricultural is still responsible for over 98% of basin depletion.

*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

Presentation Abstract

BINATIONAL WATER MANAGEMENT PLANNING: OPPORTUNITIES, COSTS, BENEFITS, AND UNINTENDED CONSEQUENCES: SECURE AND SUSTAINABLE WATER BY 2020 - Conclusions and Recommendations of Border Institute IV

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Water has emerged as a first-tier issue between the United States and Mexico, a situation that has potentially severe national security and international relations implications. Border Institute IV, held in Rio Rico, Arizona, from May 6-8, 2002, was successful at initiating the binational dialogue on border water issues, a necessary first step toward long-term planning and regional sharing of water and water-related resources.

"Water management in many ways exemplifies the challenge of sustainable development," Víctor Urquidi (El Colegio de México) said in his introductory remarks at the Institute. As population explodes in the border region, demand for large quantities of clean water increases, intensifying competition among the various users, including the economy, communities, and the environment itself. The challenge is to balance the needs of natural resources which represent the future with current demands from the two nations' economies and citizens. Jesús Román Calleros (UABC) succinctly summed up the challenge of planning while faced with dwindling resources: "As time, populations, economies, and affluence change, only the flow of water remains the same."

The consensus among the Institute participants was that **the federal governments need to take a leadership role in the discussion over water**. The New York Times reported on May 24 that even top-level decision makers recognize the need for long-term planning, stating "President Fox says Mexico has spent decades squandering what it has 'without planning, without sense'." However, long-term planning to meet demand is confounded by states' rights over groundwater, necessitating a well-thought out, high-level resolution by the two countries.

Recognizing the need for a binational forum to discuss issues of environmental policy within the complex framework of Border XXI and seeing real potential to translate the results of scientific investigation into solid environmental policy, the Southwest Center for Environmental Research and Policy (SCERP) has held its annual Border Institute since 1998. The purpose of the Institute is to convene academics, policy makers, industry leaders and other border stakeholders in a collegial, yet highly work-intensive atmosphere, in order to formulate policy recommendations and devise potential solutions to pressing border environmental problems. Participants are encouraged to focus on **the region as a whole and on "a year plus twenty" horizon, a conceptual two-decade window and landscape-scale that fosters the development of long-term policy recommendations.**

Each Border Institute focused on a specific issue within border environmental policy. It must be emphasized, however, that the Institutes are not a series of isolated conferences. Rather, the thematic focus of the Institutes seeks to address border environmental policy problems in a programmatic way. Border Institutes I through III investigated:

- Demographics and economic development asymmetry across the border;
- Environmental infrastructure, natural capitalism, and environmental accounting;
- Energy and its interdependencies in the border region, respectively.

Recommendations from the Border Institute, in the form of executive summaries and a volume in the SCERP Monograph Series, are widely disseminated to decision-makers and other border stakeholders. The Border Institute series is co-sponsored by the Southwest Center for Environmental Research and Policy, U.S. Environmental Protection Agency Office of International Affairs, Border Trade Alliance, and the U.S.-Mexico Chamber of Commerce.

Presentation Abstract

APPLICATION OF STRONTIUM AND CARBON ISOTOPE RATIOS TO UNDERSTANDING SALINITY PROCESSES AND SOURCES IN THE MESILLA BASIN, NEW MEXICO

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Conservative chloride and bromide (Cl/Br) ratios, strontium isotope ($^{87}Sr/^{86}Sr$) ratios, and carbon isotope (delta $^{13}C/^{12}C$) ratios of Mesilla basin thermal and non-thermal ground water are used to identify sources and processes of salinity in these waters. Thermal waters show strontium ratios greater than 0.713, reflecting a flow path through Paleozoic and Precambrian reservoir host rocks. Non-thermal waters show strontium isotope ratios less than 0.712, indicating flow path through Tertiary rocks or only partial equilibrium with the arkosic litharenite aquifer mineralogy. The Cl/Br ratio of thermal or upwelling deep basinal waters is greater than 1,000. Non-thermal Cl/Br ratios are less than 600. Carbon isotope ratios of thermal water are between -3.0 and 2.2 and reflect the Paleozoic limestone and dolomite host rocks. Non-thermal waters show carbon isotope ratios less than -5.0. Plots of Cl/Br versus Cl delineate waters that are mixes of thermal and non-thermal water from waters resulting from other salinity processes. The Cl/Br versus strontium isotope ratios and a plot of carbon isotope ratios versus strontium isotope ratios also indicate mixing of thermal and non-thermal water and other salinity processes. Dissolution, ion exchange, evaporation, and mixing with upflows of deep-seated basinal or geothermal waters are all important sources of salinity or mineral content in the Mesilla basin.

Presentation Abstract

WETLAND EVALUATION AND RESTORATION ALONG RINCONADA CREEK, PUEBLO OF ACOMA, NEW MEXICO

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The Haakú Water Office at the Pueblo of Acoma is working in conjunction with the US Environmental Protection Agency (EPA) under a wetlands grant to enhance the riparian area along Rinconada Creek. Riparian investigations and improvements include:

- Developing a restoration plan
- Restoring riparian, stream channel, and wetland areas
- Enhancing wildlife habitat
- Establishing day-use facilities for education and recreation

The Pueblo of Acoma is located in Cibola County in west central New Mexico. Rinconada Creek, which is a tributary of the Rio San Jose, lies on the north side of the pueblo along the southwestern flank of Mt. Taylor. Rinconada Creek is an ephemeral stream that is recharged by precipitation, snowmelt and springs as it flows through lava flows from Mt. Taylor, Cretaceous sandstones, and colluvium. Elevations vary from about 6650 to 7100 feet above mean sea level.

The Rinconada Creek corridor is a healthy and unique riparian system as evidenced by the health and composition of the riparian vegetation, the condition of the stream banks, and diversity of wildlife. Initial assessments of the site noted the invasion by non-native species such as Siberian Elm and Tamarisk, but native species are abundant and healthy. The riparian corridor lacks large stands of typical riparian vegetation such as cottonwood and willow, but does include an abundance of Thinleaf alder. Water and stream quality is generally very good and reflects a healthy watershed. The creek is an important wildlife corridor as noted by the variety of wildlife signs from elk, deer, black bear, mountain lions, and numerous birds. Site assessment activities have included:

- Surveying property boundaries, channel length and cross sections
- Observing flora and fauna
- Monitoring water quality
- Performing a Stream Visual Assessment

Restoration activities will emphasize habitat enhancement and improvement. Following the removal of invasive species, the riparian corridor will be enhanced with native species of grasses, wildflowers, and trees to create a multi-tiered canopy. Pools and riffles will be created using boulders and woody debris in conjunction with plantings to provide habitat and shade along the stream's course. Ultimately, the area will become an outdoor classroom for educating children and adults about hydrology, geology, wetlands and wildlife conservation.

Presentation Abstract

WATERSHED MANAGEMENT: USE OF CONIFER MULCH TO MITIGATE ALKALINE POLLUTION OF WATERSHED SOIL

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Groundwater and soil pH in the high deserts of northern New Mexico tend to be alkaline, ranging from about pH 7 to pH 9. Industrial discharges containing calcium compounds such as those found in cement and calcium oxide increase alkalinity beyond the range tolerated by some watershed plants. Bench-scale tests conducted at the Johnson Controls of Northern New Mexico (JCNNM) Environmental Lab suggest that natural mulches of conifer needles and conifer forest slash mitigate the effects of these pollutants.

JCNNM personnel are replacing utility poles on a 115-kilovolt power line installed 50 years ago to Los Alamos National Laboratory from the Norton Substation in Santa Fe. A portion of the line crosses basalt in an archeological area belonging to San Ildefonso Pueblo. In place of using explosives in this area, JCNNM used an expansive mortar, "Fract.AG", in boreholes drilled into the basalt. In contact with water, the mortar heated, fractured the basalt, and creating several plumes of dust and mortar downwind. JCNNM has discontinued use of this product, which will be reevaluated. A grid of soil samples near the borehole demonstrated a pH 10 to pH 12.5 near the boreholes. In the lab we were surprised to learn that macerated piñon, ponderosa, and juniper needles mixed about 10% by weight with the alkaline soil dropped the pH to neutrality within 5 hours. It was more effective as the same concentrations of sulfur and organic acid.

San Ildefonso leaders agreed to JCNNM's proposal of spreading chipped conifer mulch over the area affected and placing a check dam in the small arroyo with mulch to mitigate any alkaline runoff from the project. Rainwater samples and run-off samples before and after the dam will be collected if possible to compare the effect of the field mitigation to our findings in the lab.