THE ARSENIC WATER TECHNOLOGY PARTNERSHIP

Abbas Ghassemi, WERC/NMSU, aghassem@nmsu.edu, 505-646-2357
Malcolm Siegel, Sandia National Laboratories, msiegel@sandia.gov, 505-844-5426

Presentation Abstract 1

This presentation will introduce Symposium attendees to the Arsenic Water Technology Partnership through its New Mexican affiliates, WERC: A Consortium for Environmental Education and Technology Development and Sandia National Laboratories. The Environmental Protection Agency's recent arsenic standard of 10 ppb will significantly impact an estimated 4000 water systems, the majority of which are in small and rural communities. Nationwide, annualized compliance cost estimates range from $195 M/yr to $675 M/yr. EPA estimates the compliance cost to consumers of small water systems (serving less than 3,300 people) to range from $59 to $327 per household/year.

The Arsenic Water Technology Partnership program was founded in 2003 and is supported with $7M in congressional appropriations through the Department of Energy, Office of Science. The program is expected to be a multi-year effort that moves arsenic-removal technologies from the bench-scale to demonstration, with assistance being provided to utilities on implementation. The Partnership will enable water utilities, particularly those serving small, rural communities and Indian tribes, to implement the most cost-effective solutions to their arsenic treatment needs.

The Partnership is composed of WERC, Sandia National Laboratories and the AWWA Research Foundation with the following three goals: 1) to conduct research and develop innovative arsenic removal technologies with a focus on reducing energy costs, minimizing operating costs, and minimizing quantities of waste; 2) to demonstrate the applicability of these technologies to a range of water chemistries, geographic locales, and system sizes; and 3) to evaluate the cost effectiveness of these technologies and provide education, training, and technology transfer assistance to the user communities.

The AWWA Research Foundation will manage the bench-scale research programs; Sandia National Laboratories will conduct the field-scale pilot demonstration program; WERC will evaluate the economic feasibility of the technologies investigated and conduct educational, public outreach, and technology transfer activities.

This presentation will provide updated information on the Partnership's field testing results, including a pilot project in Socorro, along with cost evaluations and current regulatory requirements in New Mexico.

Contact: Christopher Campbell, WERC/NMSU, chrisc@werc.net, WERC Resources Center
1155 University Blvd. SE, Albuquerque, NM 87106, 505-843-4251, fax 505-246-2891

VADOSE ZONE TEMPERATURE MEASUREMENTS: NEW EQUIPMENT AND SOME OBSERVATIONS FROM THE ALBUQUERQUE BASIN

Marshall Reiter, New Mexico Bureau of Geology, New Mexico Tech, Socorro, NM 87801
mreiter@nmt.edu, 505-835-5306

Presentation Abstract 2

A new temperature measuring system has been assembled to make temperature logs in the vadose zone. The temperature sensor is a small glass enclosed thermistor bead which has a much faster time response in air than most sensors. By lowering the sensor down a well at about 2 m/min one can acquire relatively accurate temperatures with a depth resolution of 1 m. The 1 m depth resolution allows observation and determination of fluid flow in the vadose zone (if the flow rates are sufficient) and ground surface temperature warming due to urbanization. Data from two piezometer sites in the Albuquerque Basin are presented. At Tome (southeastern Albuquerque Basin) a unique hydro-geologic situation is present where temperature data indicate upward fluid flow across the vadose zone with an unusually large specific discharge of 0.22 m/yr liquid water. At Lincoln Middle School (northwestern Albuquerque Basin), a large increase in ground surface temperature of ~3.7-3.8°C appears to have occurred ~20 years ago because of extensive urbanization at the locale. Continued temperature data collection in the vadose zone should also relate to possible ground surface temperature changes due to climatic changes.

Contact: Marshall Reiter, New Mexico Bureau of Geology and Mineral Resources, mreiter@nmt.edu, New Mexico Institute of Mining and Technology, Socorro, NM 87801, 505-835-5306, fax 505-835-6333

CAPACITIVE DEIONIZATION DESALINATION TECHNOLOGY FOR COAL BED METHANE PRODUCED WATER, TREATMENT AND RANGELAND REHABILITATION

Ryan Donahe, Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185-0755, rdonahe@sandia.gov, 505-284-6679
Emily Wright, Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM, 87185-0752, edwrigh@sandia.gov, 505-844-0342
Allan Sattler, Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM, 87185-0706, arsattl@sandia.gov, (505) 844-1019
Marc Andelmann, Biosource, Inc., 1200 Millbury Street, Worcester, MA 01607, dragonfly@flowtc.com, 508-363-2367

Presentation Abstract 3

Laboratory and field efforts are underway to use solar energy to power an emerging desalination technology - capacitive deionization - for brackish water produced by remote Coal Bed Methane (CBM) natural gas wells. Due to physical remoteness of many CBM wells in Southwestern U.S., this approach offers promise, not only for its effectiveness in removing salt from CBM water for various applications such as rangeland improvement, but for its potentially competitive energy consumption in regimes favorable to inland desalination.

Laboratory activities are providing information for optimizing effectiveness and energy requirements of a capacitive deionization unit. Early laboratory studies of this deionization technology show promise that, at common CBM salinity levels, this technology may provide better recovery of treated water, require less chemical pretreatment, and be less susceptible to fouling, with easier maintenance than equivalent reverse osmosis (RO) systems. This, coupled with thousands of remote wells, makes capacitive deionization more feasible for use with photovoltaic (solar, electric, PV) systems for treating CBM produced water.

This paper discusses the results of these laboratory studies and extends these results to energy consumption and design considerations for field implementation of produced water treatment using photovoltaic systems.

The environmental liability of much of the brackish coal bed methane produced water has the potential to become an asset, creating new water from impaired brackish water for agriculture in many regions, some of which are naturally quite arid.

Contact: Ryan Donahe, Sandia National Laboratories, rdonahe@sandia.gov, Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185-0755, 505-284-6679, fax 505-244-0968

UP- AND DOWN-SCALING BETWEEN EVAPOTRANSPIRATION MAPS DERIVED FROM LANDSAT 7 AND MODIS IMAGES

Sung-ho Hong, New Mexico Tech, 801 Leroy place, Socorro, NM 87801, hong@nmt.edu, 505-835-5466
Jan M.H. Hendrickx, New Mexico Tech, 801 Leroy place, Socorro, NM 87801, hendrick@nmt.edu, 505-835-5892
Brian Borchers, New Mexico Tech, 801 Leroy place, Socorro, NM 87801, borchers@nmt.edu, 505-835-5813

Presentation Abstract 4

Remotely sensed images of the Earth's surface provide information about the spatial distribution of evapotranspiration (ET). Since the spatial resolution of ET predictions depends on the sensor type, scaling transfer between images of different scales needs to be investigated. The objectives of this study are first to validate the consistency of SEBAL algorithms for satellite images of different scales and, second, to investigate the effect of up- and down-scaling procedures between ET maps derived from LandSat 7 and MODIS images.

Contact: Sung-ho Hong, New Mexico Tech, hong@nmt.edu, P.O. Box 3097, Socorro, NM 87801,
505-835-5466

MONITORING MOISTURE FLUX IN THE VADOSE ZONE- A COMPARISON OF THREE COST SENSITIVE METHODS

John T. Kay, Daniel B. Stephens & Associates, Albuquerque, NM, jkay@dbstephens.com, 505- 822-9400
James A. Kelsey, Daniel B. Stephens & Associates, Albuquerque, NM, jkelsey@dbstephens.com, 505-822-9400
R. Eric Pease, US Army Corp of Engineers, Albuquerque NM, Eric.Pease@spa02.usace.army.mil, 505-342-3317
Amy E. Ewing, Daniel B. Stephens & Associates, Albuquerque, NM, aewing@dbstephens.com, 505-822-9400

Presentation Abstract 5

Soil moisture flux in the vadose zone is an important component of the hydrologic budget; the volume, rate, and direction of soil moisture movement can be used to provide indirect estimates of dry soil evaporation, potential transpiration, and percolation of meteoric water to groundwater. A variety of instrumentation and methods for estimating moisture flux in the vadose zone have been used, including water content reflectometers (WCR), time domain reflectometers (TDR), heat dissipation sensors (HDS), heat flux plates (HFP), tensiometers, psychrometers, and lysimeters. Advantages and disadvantages have been noted for each method; the best method for a particular site depends upon a number of factors, including the soil type, amount of water present, desired accuracy, frequency of measurements, and available budget. Generally, budget constraints preclude the use of lysimeters and TDR. To enable comparison of several relatively common and inexpensive types of sensors, two different profiles of HDS, WCR, and HFP were installed at a single research site located within the Middle Rio Grande Bosque. The methods and calculations used to estimate flux for each sensor type are described. Data collected between December 2004 and August 2005 is presented and used to compare the results of each method. Key differences for each method, along with the advantages and disadvantages of each are described. Recommendations for selecting the best sensor based on site specific needs are made.

Contact: John T. Kay, Daniel B. Stephens & Associates, jkay@dbstephens.com,
6020 Academy NE Suite 100, Albuquerque, NM 87109, 505-822-9400, fax 505-822-8877

EFFECTS OF ATMOSPHERIC TELECONNECTIONS ON SEASONAL PRECIPITATION IN MOUNTAINOUS REGIONS OF THE SOUTHWESTERN U.S.: A CASE STUDY IN NORTHERN NEW MEXICO

Huade Guan, New Mexico Tech, Dept. of Earth & Environmental Science, 801 Leroy St., Socorro, NM 87801, hdquan@nmt.edu, 505-835-5465
Enrique Vivoni, New Mexico Tech, Dept. of Earth & Environmental Science, 801 Leroy St., Socorro, NM 87801, vivoni@nmt.edu, 505-835-5611
John L. Wilson, New Mexico Tech, Dept. of Earth & Environmental Science, 801 Leroy St., Socorro, NM 87801, jwilson@nmt.edu, 505-835-5634

Presentation Abstract 6

Atmospheric teleconnections of seasonal precipitation can be used to assist climate and hydrologic predictions. We examine the temporal and spatial patterns of seasonal precipitation anomalies associated with the El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) in a mountainous region in northern New Mexico. To examine the spatial variability of the precipitation anomalies, we use a new high-resolution precipitation mapping tool, known as ASOADeK (Auto-Searched Orographic and Atmospheric effects De-trended Kriging). ASOADeK employs a multivariate linear regression approach to auto-search regional and local climatic settings (e.g., gradient in atmospheric moisture, moisture flux direction) and local orographic effects (e.g., terrain elevation and aspect). We find that PDO is the more dominant teleconnection, compared to ENSO, with a larger influence on winter and spring precipitation (wetter for high PDO, drier for low PDO). Extreme ENSO effects are significant during the low PDO years, but not significant during the high PDO years. El Niño strongly dampens and La Niña slightly enhances low PDO effects on winter and spring precipitation anomalies. For certain ENSO + PDO combinations, summer precipitation variability is predictable, with different spatial patterns for two sub-regions of a NCDC climate division indicating different local climates. Elevation modulates ENSO and PDO effects on winter precipitation (but not other seasons), with larger anomalies at high elevations for wetter-than-normal winters, and larger anomalies at low elevations for drier-than-normal winters. The results are also consistent with a shift of PDO to its low phase in the late 1990s.

Contact: John L. Wilson, New Mexico Inst. of Mining and Technology, jwilson@nmt.edu,
Dept. of Earth & Environmental Science, New Mexico Tech, 801 Leroy St., Socorro, NM 87801
505-835-5634, fax 505-835-6436

Note: Presentation will be made by Enrique Vivoni.

USING OBSERVATION NETWORKS TO TRACK A MONSOON FLOOD EVENT IN THE RIO PUERCO AND ITS DOWNSTREAM EFFECTS

Enrique R. Vivoni, Department of Earth and Environmental Science, New Mexico Tech, 801 Leroy Place, MSEC 244, vivoni@nmt.edu, 505-835-5611
Robert S. Bowman, Department of Earth and Environmental Science, New MexicoTech
Robert L. Wyckoff, Department of Earth and Environmental Science, New Mexico Tech
Ryan T. Jakubowski, Department of Earth and Environmental Science, New Mexico Tech
Kate E. Richards, Department of Earth and Environmental Science, New Mexico Tech

Presentation Abstract 7

Although sporadic and infrequent, flooding events in ephemeral watersheds are a critical component to the water, sediment and biogeochemical cycles in arid and semiarid regions. In the Southwestern United States, intense thunderstorms during the summer monsoon season interact with landscapes characterized by topographic complexity and soils of low infiltration capacity to produce large magnitude floods and flash floods. In this study, we examine the hydrometeorological conditions and hydrologic response of an extreme monsoon flood event in the Río Puerco watershed of north-central New Mexico and its downstream effects in the Río Grande, a major continental-scale river basin. The summer storm in early September 4-11, 2003, generated flash flooding in headwater basins and river flooding extending through the semiarid basin and downstream into the Río Grande for several tens of kilometers. We characterize the hydrometeorological conditions prior to the flood event using precipitation estimates from rain gauge records, NEXRAD radar data, and synoptic weather conditions over the 18,000 km^2 Río Puerco basin. Then, we present the spatial and temporal variability in hydrologic response based on a set of nested stream gauges in river channels and irrigation canals as well as a network of instrumented well transects installed along the Río Grande alluvial aquifer. Our analysis illustrates the genesis, propagation, and attenuation of a large monsoonal storm through a semiarid ephemeral tributary into a regional river system from both a surface and groundwater hydrology perspective, including the water exchanges observed between the two systems. We discuss the importance of extreme flood events in semiarid tributary systems and their downstream effects in the surface and groundwater interactions of regional river basins.

Contact: Enrique R. Vivoni, New Mexico Tech, vivoni@nmt.edu, 801 Leroy Place, MSEC 244, Socorro, NM 87801, 505-835-5611, fax 505-835-6436

HISTORICAL SEDIMENT PLUG FORMATION ALONG THE TIFFANY JUNCTION REACH OF THE MIDDLE RIO GRANDE

Craig Boroughs, Senior Project Engineer, BH&H Engineering, Inc., P.O. Box 637, Dillon, CO 80435, 970-513-4459, Boroughs@BHandH.com
Robert Padilla, U.S. Bureau of Reclamation, 555 Broadway Blvd. NE, Suite 100, Albuquerque, NM 87102, 505-462-3626, RPADILLA@uc.usbr.gov
Steven Abt, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80523, 970-491-8203, sabt@engr.colostate.edu

Presentation Abstract 8

Sediment plug formation along the Tiffany Junction Reach of the Middle Rio Grande not only provides a challenge in regard to channel maintenance, but also could impact habitat for endangered species, efficiencies for deliveries to water users in the basin, and effectiveness of protection provided by the Tiffany Levee. A sediment plug is aggradation in the main channel of the river which completely blocks the channel and grows upstream by accretion. A review of historical plug formation was completed with focus on the short term phenomenon along the Tiffany Junction Reach during 1991 and 1995. The plugs initiated approximately 1.5 river miles upstream of the Burlington Northern and Santa Fe railroad bridge. After the plug formed in 1991, river flows were forced into the overbank areas and against the levee, and the levee breached in July of that year during a monsoon event. A plug formed again in 1995 at the same location and was eventually five miles long. While there were general qualitative conclusions as to why these plugs formed, little was known about the specific processes that caused plug formation. Research was completed that involved a review of site characteristics, processes, and associated parameters. After a review of literature, available data, and testimony from other researchers, a theory regarding plug formation was developed. As a result of this study, engineers and scientists not only have a better understanding as to how and why plugs formed along the Tiffany Junction Reach but can use this information to evaluate whether plug formation is possible in the future for different scenarios.

Contact: Craig Boroughs, Senior Project Engineer, BH&H Engineering, Inc., P.O. Box 637, Dillon, CO 80435, 970-513-4459, Boroughs@BHandH.com

PERCHLORATE BIOACCUMULATION IN LEAVES OF TAMARIX RAMOSISSIMA (SALT CEDAR) FROM THE RIPARIAN ENVIRONMENT OF LOST RIVER, WHITE SANDS NATIONAL MONUMENT, NEW MEXICO

G.F. Huff, U.S. Geological Survey, New Mexico State University, Dept. 3ARP, P.O. Box 30001, Las Cruces, NM 88003, gfhuff@usgs.gov
Bill Conrod, 2432 NE Holmes Road, Lincoln City, OR 97367, bcconrod@yahoo.com
Richard Daddow, U.S. Geological Survey, Denver Federal Center, Building 53, MS-421, Lakewood, CO 80225, rldaddow@usgs.gov

Presentation Abstract 9

A surface-water sample collected in March of 1999 from Lost River, upstream from White Sands National Monument, contained 18,000 µg/L of perchlorate leading to concern over possible elevated concentrations of perchlorate within the Lost River riparian environment on the national monument. The ephemeral nature and remote location of Lost River on the national monument makes traditional surface-water sampling impractical. Tamarix ramosissima (salt cedar), common along Lost River on the national monument, is known to incorporate perchlorate present in riparian environments.

Salt cedar leaves were collected in April and July of 2003 at five locations along Lost River on the national monument. Soil and shallow ground-water samples were collected in August of 2003 at three of these leaf-sampling locations. Perchlorate concentrations in leaf samples ranged from approximately 2.5 to 29.0 µg/kg and were systematically greater in the July samples than in the April samples. None of the soil samples and one of the shallow ground water samples contained a detectable concentration of perchlorate. The largest perchlorate concentrations in leaves (approximately 19.0 µg/kg in April samples and approximately 29.0 µg/kg in July samples) were present at the site of detectable perchlorate concentration (0.81 µg/L) in shallow ground water.

Detectable concentrations of perchlorate in leaf samples indicate the presence of perchlorate within the Lost River riparian environment on the national monument. Greater concentrations of perchlorate in July leaf samples are consistent with bioaccumulation of perchlorate in salt cedar leaves. More study is needed to quantify bioaccumulation rates of perchlorate in salt cedar leaves and to assess the potential of salt cedar as a bioindicator of perchlorate within riparian environments.

Contact: Rick Huff, USGS, gfhuff@usgs.gov, NMSU, 3ARP, 505-646-7950, fax 505-646-7949

USE OF TRANSBOUNDARY AND BORDER-WIDE WATER GIS TO EXAMINE SIGNIFICANT U.S-MEXICAN BINATIONAL WATER RESOURCE AND SECURITY ISSUES

Bob Currey, SCERP
D. Rick Van Schoik, SCERP
Richard Wright, SDSU
Fabian Lozano, ITESM
Christopher Brown, NMSU
Craig Forster, Utah

Presentation Abstract 10

Despite repeated initiatives, the development and use of a border-wide GIS for the U.S.-Mexican binational region has been limited in success to only a few media, a few locations, and a few concerns. The Southwest Consortium for Environmental Research and Policy (SCERP, a collaboration of five U.S. and five Mexican universities), is developing a roadmap for the development of such a capacity. Its use would, among other things, advance consideration of transboundary issues and impacts when conducting normal business on either side of border.

SCERP has a fifteen-year history of geo-referencing and reconciling data across the border on such features as transboundary watersheds, aquifers, wetlands, and rivers. Its products have included multimedia CDs, web-based datasets and map products, and atlases. These have been used to optimize treatment plant citing and design, plot and understand pathogen distribution and density patterns, describe and design river flood control architecture, and understand and prevent water supply vulnerabilities. SCERP has also performed GIS services for several border tribes.

Besides building a GIS to advance binational water resource management, SCERP is interested in exploring water, energy, air, ecosystem, health, economic, and hazards research through the tool of geospatial decision support systems. These will be used in conjunction with SCERP's Border Plus Twenty Years (B+20) temporal model. For example, the EPA recently completed a water quality report that needs to be interfaced with other border, water, and funding challenges. The degree to which GIS can provide such an interface will be determined by the extent that such an interface is regional and comprehensive.

Contact: D. Rick Van Schoik, SCERP, scerp@mail.sdsu.edu, 5250 Campanile Drive, San Diego, CA 92182-1913, 619-594-0568, fax 619-594-0752

DELINEATION OF CAPTURE ZONES IN TRANSIENT GROUNDWATER FLOW SYSTEMS

Velimir V. Vesselinov, Los Alamos National Laboratory, vvv@lanl.gov, MS T003 EES-6, 505-665-1458, fax 505-665-8737
Bruce A. Robinson, Los Alamos National Laboratory, Los Alamos, NM 87545, robinson@lanl.gov, 505-667-1910

Presentation Abstract 11

Capture-zone analyses are widely used to facilitate protection of groundwater supplies. Frequently, substantial transients exist in analyzed groundwater flow system, for example, due to variability in pumping rates of water-supply wells. However, the transients are commonly ignored in the capture-zone analyses assuming steady-state flow system, thereby producing a likely bias in the capture-zone estimates. Furthermore, advection-only flow paths commonly applied in capture-zone analyses might not provide an acceptable representation of mean plume behavior of potential contaminant transport. This can produce an additional bias in the capture-zone estimates based on advection-only flow paths.

In the case of transient flow towards water-supply wells, advective-dispersive transport simulation is required to represent impact of transient flow on the spatial distribution of contamination plume in the aquifer. Due to transients and dispersion, contaminants introduced in the aquifer by an instantaneous point release can arrive at more than one of the wells. Transient capture zones are delineated using multiple instantaneous point releases distributed in time and space. A transient simulation of groundwater flow and advective-dispersive transport is performed for each release predicting locations of contaminant capture. All these simulations are used to delineate capture zones that are time-dependent. There are overlaps in the capture zones associated with each of the wells. The time-dependency in the capture zones can be represented in terms of both time of contaminant capture at the wells and time of contaminant release. For each release point and for each release time within the capture zones we can estimate a range of possible travel times to the wells and partitioning of the contaminants between the capturing wells. In this type of analysis, it is very important to have accurate information about the temporal variability in pumping rates. If the variability of pumping rates is unknown (e.g., future pumping rates) or uncertain, stochastic analysis is applied.

Here we analyze both theoretically and numerically, the impact of the transients in the groundwater flow on the capture zone estimates for a series of synthetic cases. Capture zone estimates using advective-only and advective-dispersive transport simulations are compared. Conclusions are derived regarding the conditions for which transient advective-dispersive capture-zone analyses should be performed based on the properties of the transients (amplitude/frequency) and the medium (permeability/porosity/dispersivity). The need for advective-dispersive transient capture zone analyses depends on how fast the transients in the flow and transport propagate through the medium at the spatial and temporal scales of interest.

Contact: Velimir V. Vesselinov, LANL, vvv@lanl.gov, MS T003 EES-6, 505-665-1458, fax 505-665-8737

AMMONIA MODELING FOR ASSESSING POTENTIAL TOXICITY TO FISH SPECIES IN THE RIO GRANDE, 1989-2002

Howard Passell, Sandia National Laboratories, Box 5800, MS 0735, Albuquerque, NM, 87185
Clifford N. Dahm, Dept. of Biology, UNM, 87131
Edward J. Bedrick, Dept. of Mathematics and Statistics, UNM, 87131

Presentation Abstract 12

Increasing volumes of treated and untreated human sewage discharged into rivers around the world are likely to be leading to high aquatic concentrations of toxic, un-ionized ammonia (NH3-N), with negative impacts on species and ecosystems. Tools and approaches are needed for assessing these dynamics. In this study daily dissolved un-ionized ammonia (NH3-N) concentrations in New Mexico's Rio Grande at the City of Albuquerque's treated sewage outfall into the Rio Grande were modeled in a system dynamics platform for 1989-2002. Data for ammonium (NH4+) concentrations in the sewage, and data for discharge, temperature and pH for both sewage effluent and the river were used. We used State of New Mexico acute and chronic NH3-N concentration values (0.30 and 0.05 mg/L NH3-N, respectively) and other reported standards as benchmarks for determining NH3-N toxicity in the river and for assessing potential impact on population dynamics for fish species. A critical species of concern is the Rio Grande silvery minnow (*Hybognathus amarus*), an endangered species in the river near Albuquerque. Results show that NH3-N concentrations matched or exceeded acute levels 13, 3 and 4 percent of the time in 1989, 1991 and 1992, respectively. Modeled NH3-N concentrations matched or exceeded chronic values 97, 74, 78, and 11 percent of the time in 1989, 1991, 1992, and 1997, respectively. Exceedences ranged from 0-1 percent in other years. Modeled NH3-N concentrations may differ from actual concentrations because of ammonia and ammonium loss terms and additive terms such as mixing processes, volatilization, nitrification, sorbtion, and ammonium uptake. We conclude that ammonia toxicity must be considered seriously for its potential ecological impacts on the Rio Grande and as a mechanism contributing to the decline of the Rio Grande fish community in general and the Rio Grande silvery minnow specifically. Conclusions drawn for the Rio Grande suggest that un-ionized ammonia concentrations may be high in rivers around the world where sewage treatment capabilities are poorly developed or absent.

Contact: Howard Passell, Sandia National Labs, hdpasse@sandia.gov, Box 5800, MS 0735, Albuquerque, NM, 87185, 505-284-6469, fax 505-844-6023

ADSORPTION PROCESSES FOR ARSENIC AND FLUORIDE REMOVAL FROM GROUNDWATER

Daniel Candelaria, Department of Chemical Engineering, New Mexico State University, P.O. Box 30001, MSC 3805, Las Cruces NM, 88003, dancande@nmsu.edu, 505-646-1213
Shuguang Deng, Department of Chemical Engineering, New Mexico State University, P.O. Box 30001, MSC 3805, Las Cruces NM, 88003, sdeng@nmsu.edu, 505-646-4346

Presentation Abstract 13

One of the most serious problems along the U.S.-Mexican border is the lack of access to adequate quality drinking water. The groundwater from wells in Columbus, NM and Palomas, Mexico border region contains significantly high levels of fluoride (>7 mg/L) and arsenic (>40 μg/L) that could potentially cause many serious diseases for the residents, especially young children in this border region. Intake of arsenic can cause nervous system disorders, stomach and intestinal irritation, and skin cancer. For fluoride, skeletal fluorosis and teeth mottling in younger children are the main health concern. The current EPA regulations on arsenic and fluoride in dinking water are: MCL (maximum contaminant level) of 10 μg/L for arsenic, and 4 mg/L for fluoride. There is an urgent need for purifying the drinking water supplied by the municipals to protect the health of the residents in this border region. A research project is being carried out to evaluate and develop effective adsorption process for arsenic and fluoride removal from groundwater.

This presentation will review the status of adsorption technologies for combined arsenic and fluoride removal from groundwater. Techniques for drinking water purification include precipitation-coagulation, filtration, ion exchange, and adsorption. The focus of this literature is on adsorption and materials used in this technique. The cost and waste disposal is also a concern for each process. Adsorbents used for arsenic removal are: Granular ferric hydroxide (GFH), Iron Oxide Impregnated Activated Alumina (IOAA), Cerium ions doped with iron oxide (Ce IV) and lanthanum-impregnated silica gel. Red soil, charcoal, brick, fly ash, and serpentine are used for fluoride removal. Other materials used as fluoride absorbents are hydroxyapatite, fluorspar, calcite, and quartz. With this information, research will evaluate which process and adsorbent material will be best for removal of both arsenic and fluoride. Small rural communities are presented with these challenges of removing such contaminants and having feasible and reliable water treatment systems. The investigation of using various adsorbent materials is imperative for the removal of both contaminants. The literature review will provide information on the characteristics of each technique. Overall, this information will be vital for finding new and existing techniques for removal of arsenic and fluoride.

Contact: Shuguang Deng, New Mexico State University, sdeng@nmsu.edu, Department of Chemical Engineering, P.O. Box 30001, MSC 3805, Las Cruces NM, 88003, 505-646-4346, fax 505-646-7706

ADSORPTION PROCESSES SIMULATION FOR DRINKING WATER PURIFICATION

Shuguang Deng, New Mexico State University, sdeng@nmsu.edu, Department of Chemical Engineering, P.O. Box 30001, MSC 3805, Las Cruces NM, 88003, 505-646-4346, fax 505-646-7706

Presentation Abstract 14

Adsorption processes are widely used for drinking water purification because the adsorbents can selectively remove the contaminants while preserving the water chemistry. Typically the feed water enters a fresh adsorbent bed from the top, and the purified water is collected at the bed exit (bottom). The efficiency of the adsorption processes are usually determined by an adsorption breakthrough experiment in which the concentration front of the contaminants against time is measured by monitoring the effluent concentration. It is observed from experiments that a typical adsorption breakthrough curve for water treatment consists of two sections: 10% equilibrium zone and 90% mass transfer zone. The adsorption design principle requires that an adsorbent bed should cover the equilibrium zone plus 50% of the mass transfer zone.

Adsorption process simulation is being performed to identify the key parameters affecting the mass transfer resistance in the adsorbent bed. The objective of this work is to improve the adsorption process efficiency by reducing the mass transfer resistance, not simply increasing the adsorbent equilibrium capacity. The short-cut approach will be used to improve the scale up and design of adsorption process; the rigorous analytical or numerical solution of the mass transfer equations will be used to describe the entire adsorption breakthrough. Examples of adsorption processes simulation results from our previous research will be presented.

Contact: Shuguang Deng, New Mexico State University, sdeng@nmsu.edu, Department of Chemical Engineering, P.O. Box 30001, MSC 3805, Las Cruces NM, 88003, 505-646-4346, fax 505-646-7706

MODEL RESULTS OF WATERSHED MANAGEMENT ACTIVITIES ON WATER RESOURCES

Thomas H. Springer, South Central Mountain RC&D Council, P.O. Box 1361, Cloudcroft, NM 88317, tombarb@lookingglass.net, 505-682-3040

Presentation Abstract 15

A watershed management model, developed in the late 1990's by Sheperd-Miller (now MFG, Inc.) and recently updated and improved, has been used to investigate the effects on water resources of various forest and low-lands management activities such as tree thinning and prescribed burns. The model is general in its calculational processes, but is applicable (relative to the plants, precipitation, soil types, and topography) to the Rio Peñasco and the Rio Hondo watersheds---120,000 acres and 663,000 acres, respectively. The model results indicate, for example, that if the biomasses of the dominant tree and brush species on the Rio Peñasco watershed were to be reduced to 50% of their current values, the amount of groundwater recharge would increase by about 56,600 acre-feet per year. The change in recharge as a function of the fraction of biomass reduction, relative to the current conditions, has been estimated and is found to be non-linear.

The model also calculates changes in water runoff and sediment transfer on the landscape, if any, resulting from the various management activities that can be specified. In addition, the model was used to predict the rate of re-growth of the type of vegetation removed.

The model is based upon a mechanistic procedure in which the growth of individual plant species is tracked as a function of such factors as time-of-year, availability of water, precipitation, shading, and place in the life cycle of growth. Water balances in terms of precipitation, interception, transpiration, evaporation, runoff, and export (taken to be recharge) are calculated in order to understand the distribution of the water originating in the form of rainfall and snowfall.

Contact: Thomas H. Springer, South Central Mountain Resource Conservation and Development Council, tombarb@lookingglass.net, P.O. Box 1361, Cloudcroft, NM 88317, 505-682-3040, fax 505-682-1125

CALIBRATION OF THE SHUFFLED COMPLEX EVOLUTION METHOD FOR HYDRAULIC PARAMETER IDENTIFICATION PROBLEMS

Kay White Vugrin, Sandia National Laboratories, Performance Assessment and Decision Analysis Department, 4100 National Parks Highway, Carlsbad, NM 88220, kwvugri@sandia.gov, 505-234-0127
Randall M. Roberts, Sandia National Laboratories, Repository Performance Department, 4100 National Parks Highway, Carlsbad, NM 88220, rmrober@sandia.gov, 505-284-2766
John D. Avis, Intera Engineering Ltd., 1 Raymond Street, Suite 200, Ottawa, Ontario K1R 1A2 javis@intera.com, 613-232-2525

Presentation Abstract 16

The code nSIGHTS is a numerical well-test analysis code developed by Sandia National Laboratories that simulates the hydraulic response of a single-phase, radial/non-radial-flow regime to boundary conditions applied at a borehole located at the center of the modeled flow system. Multi-test simulations can include any combination of pulse/slug, constant/variable rate, and constant/variable pressure tests. nSIGHTS is configured to use optimization algorithms to perform nonlinear regression for parameter identification. Optimization algorithms vary parameter values with the goal of minimizing the difference between a set of measured data and the numerical model. nSIGHTS allows users to choose from four algorithms, including the Nelder-Mead Algorithm and Shuffled Complex Evolution Method (SCEM). The effectiveness of the optimization algorithms and the uncertainty in the estimated parameter values are affected by the presence of noise in the measured data set and inaccuracies in the model. The SCEM is a robust optimization algorithm in the presence of these kinds of errors. We investigate the performance and adjustment of the SCEM on numerically generated parameter identification problems. We also consider a well test parameter identification problem based on field data. The SCEM is found to perform very well when four algorithmic parameters are carefully calibrated, though the calibration procedure varies for each problem. We compare the SCEM optimization results with the Nelder-Mead Algorithm results. We also compare our calibration results with other investigations of the SCEM.

(Note: The SCEM code has not been qualified by the Sandia National Laboratories QA Program)

Contact: Kay White Vugrin, Sandia National Laboratories, kwvugri@sandia.gov, 4100 National Parks Highway, Carlsbad, NM 88220, 505-234-0127, fax 505-234-0067

EVAPORATION MEASUREMENTS AT ELEPHANT BUTTE RESERVOIR, NEW MEXICO

Christopher Almy, Civil and Geological Engineering Department, New Mexico State University, calmy@nmsu.edu, MSC 3CE, P.O. Box 30001, Las Cruces, NM 88003, 505-646-6044
A. Salim Bawazir, Civil and Geological Engineering Department, New Mexico State University, abawazir@nmsu.edu, MSC 3CE, P.O. Box 30001, Las Cruces, NM 88003, 505-646-6044, fax 505-646-6049
Nabil G. Shafike, State of New Mexico, Interstate Stream Commission, Steven Bowser, United States Bureau of Reclamation, Albuquerque Area Office

Presentation Abstract 17

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

An off-shore tower, 115 ft tall, was installed in October 2004 to mount sensors needed to measure reservoir evaporation. The eddy covariance technique is used to measure sensible and latent heat energy above the water surface at 10 Hz. Other micrometeorological measurements are also measured. The goal of this study is to develop a more accurate and precise method for estimating evaporation losses from Elephant Butte Reservoir in particular, and New Mexico reservoirs and lakes in general.

Evaporation from the reservoir is estimated to be 70 percent of pan evaporation. However, preliminary results indicate that measured evaporation is less than 50 percent of that estimation. It has also been observed that net radiation is not the driving force behind reservoir evaporation, as is the case with pan evaporation. This is due to the large amount of energy storage that occurs in a reservoir which is constantly available for the evaporation process. The driving forces have been found to be a combination of vapor pressured deficit and wind speed.

Contact: Salim Bawazir, Civil and Geological Engineering Department, New Mexico State University, abawazir@nmsu.edu, calmy@nmsu.edu, MSC 3CE, P.O. Box 30001, Las Cruces, NM 88003, 505-646-6044, fax 505-646-6049

SOLAR EVAPORATOR WITH A SOLAR-ASSISTED ABSORPTION REFRIGERATION SYSTEM

Veera Gnaneswar Gude, Civil, Agricultural & Geological Engineering, Box 30003 MSC 3CE, New Mexico State University, Las Cruces, NM 88003, john_us@nmsu.edu
N.N. Khandan, Civil, Agricultural & Geological Engineering, Box 30003 MSC 3CE, New Mexico State University, Las Cruces, NM 88003, nkhandan@nmsu.edu

Presentation Abstract 18

A continuous desalination process, with higher efficiency has been proposed. The system operates at near-vacuum level pressures promoting natural evaporation of saline water. By maintaining a saline water column of height equal to the local barometric pressure (about 31 ft), a vacuum is created naturally in the head space. By connecting the head space of a saline water column (maintained at a higher temperature than desalinated water) to the headspace of a similar desalinated water column, the vapors evaporating from the saline water can be condensed at vacuum in the distilled water column, yielding desalinated water. The concentrated brine is continuously withdrawn from the evaporator through a heat exchanger preheating the saline water feed entering the evaporator.

The novelty of the proposed system is a thermal storage system maintained at constant temperature by a solar-powered LiBr-H_2O Absorption Refrigeration System (ARS). This enables the desalination process to continue round the clock. A flat panel solar collector will be used to heat the generator. An integrated process model for the desalination-ARS-TES system will be presented. The use of the model in process optimization, design, and economic analysis will be presented.

Contact: N.N. Khandan, New Mexico State University, nkhandan@nmsu.edu, Civil, Agricultural & Geological Engineering, Box 30003 MSC 3CE, New Mexico State University, Las Cruces, NM 88003, 505-646-5378, fax 505-646-6049

TOWARDS A COMPLETE TREATMENT OF UNCERTAINTY IN HYDROLOGIC MODELING: COMBINING THE STRENGTHS OF GLOBAL OPTIMIZATION AND DATA ASSIMILATION

Jasper A. Vrugt, Los Alamos National Laboratory, Los Alamos, NM 87545, vrugt@lanl.gov, 505-667-0404
Bruce A. Robinson, Los Alamos National Laboratory, Los Alamos, NM 87545, robinson@lanl.gov, 505-667-1910

Presentation Abstract 19

Hydrologic models use relatively simple mathematical equations to conceptualize and aggregate the complex, spatially distributed, and highly interrelated water, energy, and vegetation processes in a watershed. A consequence of process aggregation is that the model parameters often do not represent directly measurable entities and must therefore be estimated using measurements of the system inputs and outputs. During this process, known as model calibration, the parameters are adjusted so that the behavior of the model approximates, as closely and consistently as possible, the observed response of the hydrologic system over some historical period of time. In practice, however, because of errors in the model structure and the input (forcing) and output data, this has proven to be difficult, leading to considerable uncertainty in the model predictions. This paper surveys the limitations of current model calibration methodologies, which treat the uncertainty in the input-output relationship as being primarily attributable to uncertainty in the parameters and presents a simultaneous optimization and data assimilation (SODA) method, which improves the treatment of uncertainty in hydrologic modeling. The usefulness and applicability of SODA is demonstrated by means of two case studies, (1) conceptual rainfall-runoff modeling using the Sacramento Soil Moisture Accounting Model and historical streamflow data from the Leaf River in Mississippi, and (2) subsurface solute transport modeling using data from an interwell reactive tracer test.

Contact: Jasper A. Vrugt, Los Alamos National Laboratory, vrugt@lanl.gov, Mail Stop T003
Los Alamos, NM, 87545, 505-667-0404, fax 505-665-8737

ASTER OBSERVATIONS OF THE ELEPHANT BUTTE RESERVOIR

Max Bleiweiss, Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, mbleiwei@taipan.nmsu.edu, 505-640-8092
Tom Schmugge, College of Agriculture, New Mexico State University, Las Cruces, NM 88003-8003, schmugge@nmsu.edu, 505-646-5651

Presentation Abstract 20

Since the launch of NASA's Terra satellite in December 1999, the ASTER instrument has made a number of observations of the Elephant Butte Reservoir. The first observations were in June 2000, and the most recent were in May 2005. This period includes the recent drought conditions and the earlier full water conditions. The area of the reservoir was estimated for each of these scenes and compared with known water levels. The ASTER observations include both the visible reflectance and the thermal infrared (surface temperature). Both spectral regions provide good contrasts between water and surrounding land. This contrast makes the area estimation straightforward.

Contact: Max Bleiweiss, mbleiwei@taipan.nmsu.edu, Department of Entomology, Plant Pathology and Weed Science, P.O. Box 30003, MSC 3BE, New Mexico State University, Las Cruces, NM 88003-8003, 505-640-8092

WATER USE CHANGES RESULTING FROM SALT CEDAR ERADICATION IN THE MIDDLE RIO GRANDE BASIN

Katherine Fleming, Earth and Environmental Sciences, New Mexico Tech, flemingk@nmt.edu, 505-838-3065
Sung-ho Hong, Earth and Environmental Sciences, New Mexico Tech, hong@nmt.edu, 505-835-5466
Jan M.H. Hendrickx, Earth and Environmental Sciences, New Mexico Tech, hendrick@nmt.edu, 505-835-5892

WITHDRAWN

Presentation Abstract 21

The availability and management of the water supply in the semi-arid Southwestern U.S. is an issue of increasing interest and concern. Salt cedar, or tamarisk, is a non-native plant introduced in the Southwest in the early 1900s. Salt cedar grows aggressively along the riparian corridors of New Mexico and has the potential to use large amounts of water; therefore, in recent years, salt cedar stands have been removed through both chemical and mechanical means in a number of areas in the Middle Rio Grande Basin. Salt cedar grows under a variety of conditions, and not all of it may be using a great deal of water. We evaluate how growing conditions and the method of removal affect the results of salt cedar removal. Our method consists of determining the crop coefficient of a salt cedar site before and after eradication. The crop coefficient is determined using remote sensing and meteorological measurements. The Surface Energy Balance Algorithm for Land (SEBAL) is used to estimate the actual evapotranspiration rate over the salt cedar site 30m resolution from LandSat images. The meteorological measurements from standard weather stations are used to calculate the reference evapotranspiration. The crop coefficient is obtained by dividing the actual evapotranspiration rate by the reference evapotranspiration. Results of this study could be useful for optimizing salt cedar eradication programs.

Contact: Katherine Fleming, Earth and Environmental Sciences, New Mexico Tech
flemingk@nmt.edu, P.O. Box 2631, Socorro, NM 87801, 505-838-3065, fax 505-835-6436

WATER RESOURCE MODELING USING SYSTEM DYNAMICS: A MODULAR SIMULATION APPROACH

Brad D. Wolaver, Department of Geological Sciences, Jackson School of Geosciences, The University of Texas at Austin, 1 University Station C1100, Austin, TX 78712-0254, brad_wolaver@mail.utexas.edu, 512-922-9152
Vincent C. Tidwell, Flow Visualization and Process Laboratory, Sandia National Laboratories, Geohydrology Department, P.O. Box 5800, Mail Stop 0735, Albuquerque, NM 87185, vctidwe@sandia.gov, 505-844-6023
John M. Sharp Jr., Department of Geological Sciences, Jackson School of Geosciences, The University of Texas at Austin, 1 University Station C1100, Austin, TX 78712-0254, jmsharp@mail.utexas.edu, 512-471-3317

Presentation Abstract 22

Continued economic development requires access to adequate water supplies; however, disparate users often compete for increasingly scarce water resources around the globe. A system dynamics simulation model comprised of modules representing the distinct physical components of a river, associated aquifer, and ancillary systems was developed to permit water resource stakeholders to quantify the implications of basin-scale water resource policy decisions. The modular simulation approach utilizes dynamic feedbacks and changing interrelationships of water flows between surface water (including river, reservoir, and canal), groundwater, and vegetation (like agricultural crops and riparian vegetation) modules. Simulations tailored to individual user needs can easily be created by changing input climate data (including precipitation, stream flow, and temperature) and physical parameters (such as reservoir capacity, resource demand, and aquifer thickness) and the number and type of simulation modules. Graphical user interfaces permit stakeholders to investigate the impacts of water use scenarios, such as changes in population, irrigated crop acreage, minimum river flows for environmental and recreational needs, or variations in precipitation and stream flow due to wet or dry climatic periods on reservoir levels, stream flow, groundwater levels, crop irrigation, and municipal water supplies. While the simulation model was originally developed for the Middle Rio Grande near Albuquerque, New Mexico, the model has been generalized to allow stakeholders in other rivers basins in the United States and around the globe to quantitatively evaluate water resource policy options in their own basin.

Contact: Brad Wolaver, Department of Geological Sciences, Jackson School of Geosciences, The University of Texas at Austin, brad_wolaver@mail.utexas.edu, The University of Texas at Austin, Geol Science Dept, 1 University Station C1100, Austin, TX 78712-0254, 512-922-9152

RESTORATION VALUATION OF THE ALBUQUERQUE RIO GRANDE BOSQUE

Matt A. Weber, Hydrology and Water Resources, University of Arizona,
maweber@hwr.arizona.edu, 505-284-4748
Steve Stewart, Hydrology and Water Resources, University of Arizona,
sstewart@hwr.arizona.edu, 520-626-8829

Presentation Abstract 23

River restoration efforts often receive broad public support, and many different types of projects come under the restoration heading. Whereas most projects attempt to measure success by natural or ecological goals, a critical and often absent component is quantification of how the well-being of society will be improved via various restoration options. This detail becomes more important as public funds dispersed on restoration projects climb. Over $10 billion has been spent nationally on over 35,000 such projects (NRRSS 2005). Standing questions include whether restoration efforts are "worth it" in the sense that the benefits as perceived by the public outweigh the costs, whether some types of restoration are perceived to be more beneficial than others, and how restoration projects were ultimately received by the public they serve.

Planned restoration by the US Army Corps of Engineers of the Albuquerque Rio Grande Bosque, New Mexico, is used as a vehicle to investigate these public values. Focus groups helped define four categories of restoration: fish and wildlife habitat rating; vegetation density; native vs. non-native plants; and natural river processes. A mail-survey administered to Albuquerque-area residents will center on a choice experiment, allowing value estimates for each facet of restoration. Follow-up questions will partition responses amongst direct and indirect values and georeference applicable sites of value. The survey will also investigate to what degree a healthy bosque affects participants' choice of residence within Albuquerque, or between Albuquerque and other potential locations. This begins to assess the importance of environmental amenities, as well as second-order impacts of restoration, on the regional economy. The long-range goal associated with this work is addressing data needs for a dynamic simulation model of total riparian value, a component of a larger watershed decision support tool pursued by an inter-disciplinary, multi-institution research team.

Contact: Matthew A. Weber, Dept. of Hydrology and Water Resources, University of Arizona, maweber@hwr.arizona.edu, 408 Lafayette Pl. NE, Albuquerque, NM, 87106 (until end of August, 2005); long-term: 1133 E. North Campus Drive, Harshbarger Building, P.O. Box 210011, Tucson, Arizona 85721, 505-284-4748, fax 505-844-6023

MULTIVARIATE STATISTICAL METHODS APPLIED TO INTERPRETATION OF HYDROLOGICAL DATA

Arturo Woocay, UTEP, 500 West University Avenue, CERM, Burges Hall, El Paso, TX 79968, awoocay@utep.edu
John C. Walton, 500 West University Avenue, CERM, Burges Hall, El Paso, TX 79968, walton@utep.edu
Mike King, The Hydrodynamic Group LLC, 16711 76th Avenue West, Edmonds, WA 98026, hydrodynamics@rconnect.com

Presentation Abstract 24

The Multivariate Analysis statistical methods of Principal Component Analysis (PCA) and Cluster Analysis are used to provide new insight into the overall groundwater flow system, forms of recharge, and evolution of groundwater chemistry of the Death Valley region. PCA is applied to major ion data from this region reducing the number of variables and allowing for better interpretation of the system's variation. The resulting principal axes are rotated and presented as biplots, allowing for discernment of variables and samples similarities. A Cluster Analysis is then applied to the PCA results to group wells and springs with a similar geochemical composition. Derived groups are overlain on a digital elevation map of the region providing a visual picture of water types, evolution, and potential interactions, and localized recharge centers.

Contact: Arturo Woocay, UTEP, awoocay@utep.edu, 500 West University Avenue, CERM, Burges Hall, El Paso, TX 79968, 915-525-6633, fax 915-747-5145

AQUIFER REPLENISHMENT IN NM THROUGH ARTIFICIAL RECHARGE DURING WET YEARS

Carl L. Axness, Dept. 6874, Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185-0779, 505-844-0084, claxnes@sandia.gov
Phillip I. Pohl, Dept. 6143, Sandia National Laboratories, P.O. Box 5800-0720, Albuquerque, NM 87185-0720, 505-844-2992, pipohl@sandia.gov
Jon J. Clark, Dept. 6143, Sandia National Laboratories, P.O. Box 5800-0720, Albuquerque, NM 87185-0720, 505-284-8054, jjclark@sandia.gov
Rebecca M. Moss, Dept. 6143, Sandia National Laboratories, P.O. Box 5800-0720, Albuquerque, NM 87185-0720, 505-845-9627, rmmoss@sandia.gov
Brandon P. Gutierrez, Dept. 6143, Sandia National Laboratories, P.O. Box 5800-0720, Albuquerque, NM 87185-0720, 505-284-4254, bpgutie@sandia.gov

Presentation Abstract 25

New Mexico has experienced drought conditions on at least five occasions since 1900, the most recent beginning in 1996. Artificial recharge is the introduction of recharge through human activity to an aquifer. It has been used successfully both in the US and internationally to alleviate both water supply and water quality problems (i.e., seawater intrusion). We explore the possibility of using artificial recharge during "wet" years to replenish NM aquifers.

We focus on the option of well injection of surplus river water. We briefly review the results of the implementation of artificial recharge using well injection at a few US and international sites. We present a survey of possible river/well combinations showing candidate wells along the Rio Grande and other NM rivers where surplus conditions are possible during wet years. We develop criteria to screen these candidate wells and examine the more promising river/well combinations by evaluating the cost of installing a temporary feed, pump and tank to transfer and lightly treat water before injection. Injection and retrieval energy costs are also evaluated and simple analytical aquifer models are used to analyze the maximum injection/retrieval rate under some wet/dry year scenarios. A few candidate wells are evaluated and compared in terms of total cost per volume of water retrieved during a dry year. Finally, we discuss water quality issues and the possibility of pumping excess river water into wells with high arsenic concentrations to help meet 2006 drinking water standards though dilution.

Contact: Carl L. Axness, claxnes@sandia.gov, Sandia National Laboratories, Dept. 6874, P.O. Box 5800, Albuquerque, NM 87185-0779, 505-844-0084, fax 505-844-2348

IDENTIFYING BY STATISTICAL METHODS, ARSENIC MOBILIZATION FACTORS IN THE GROUNDWATER OF THE EL PASO REGION

Elia B. Marquez, Environmental Science and Engineering Program, University of Texas at El Paso, 1700 Hawthorne 309, El Paso, TX 79902, eliab@utep.edu, 915-241-1883
Patrick L. Gurian, Department of Civil, Architectural, and Environmental Engineering, Drexel University, 3141 Chestnut St., Philadelphia, PA 19104, pgurian@drexel.edu, 215-895-2889
Philip Goodell, Department of Geological Sciences, University of Texas at El Paso, goodell@geo.utep.edu
Alberto Barud-Zubillaga, Center for Environmental Resource Management, University of Texas at El Paso, albertobz@utep.edu, 915-747-7632

Presentation Abstract 26

The new Maximum Contaminant Level (MCL) of 10 µg/l for arsenic is currently exceeded in approximately 20% of the water supply wells of the El Paso region. In this work, the factors associated with high arsenic concentrations in ground water in the El Paso region are statistically analyzed from over 300 supply wells in parts of the Hueco and the Mesilla Basins.

In the Hueco, positive and significant correlations with arsenic suggest that competitive desorption of arsenic from iron hydroxides may be a factor contributing to arsenic mobilization. A positive correlation between solid phase iron and arsenic also supports this mechanism. Evaporation and upwelling from deeper waters are mechanisms that may produce the high solute concentrations that lead to competitive desorption. Also in the Hueco, the positive correlations with sodium, negative with Mg, and slightly negative with Ca indicate that more heavily cation-exchanged waters have higher arsenic concentrations, possibly because they are older and have had more opportunities to dissolve arsenic. The average concentrations of arsenic observations (aggregated by well) are 7.6 µg/L in the Hueco and 12.4 µg/L in the Mesilla Basin. The higher levels in the Mesilla may be due to the presence of higher proportions of volcanic sediments in the Basin, as well as influence of neighboring geothermal systems. The lower arsenic concentrations found in shallow ground water in the Mesilla Basin are probably the result of dilution from surface water as these wells are under the influence of the Rio Grande River.

Contact: Elia B. Marquez, Environmental Science and Engineering Program, University of Texas at El Paso, eliab@utep.edu, 1700 Hawthorne 309, El Paso, TX 79902, 915-542-4281, fax 915-241-1883

DIURNAL GROUNDWATER FLUCTUATIONS IN RESPONSE TO RIVER TEMPERATURE ALONG THE BOSQUE RIPARIAN CORRIDOR, NEW MEXICO

Ryan T. Jakubowski, New Mexico Institute of Mining and Technology, Department of Earth and Environmental Science, 801 Leroy Place, Socorro, NM 87801, ryanj@nmt.edu, 505-835-5484
Robert S. Bowman, New Mexico Institute of Mining and Technology, Department of Earth and Environmental Science, 801 Leroy Place, Socorro, NM 87801, bowman@nmt.edu

Presentation Abstract 27

Water allocation conflicts and interstate compact demands have motivated intense hydrologic characterization along a 50-mile section of the Bosque Riparian Corridor in central New Mexico. Hourly head measurements in the Rio Grande and nearby monitoring wells provide high-resolution data for understanding surface and groundwater interactions. We have identified diurnal (24-hour), sinusoidal groundwater fluctuations that commence during early- and mid-May and cease in October. In addition to a coincidental relationship with vegetative cycles, patterns in head during no-flow conditions in the Rio Grande suggest groundwater recharge from the river contributes to the diurnal head change in the aquifer.

Studies in other riparian systems demonstrate that diurnal oscillations in river water temperature influence streamflow loss. Diurnal changes in stream temperature can significantly affect the fluid viscosity, and to a much lesser extent fluid density, consequently modifying the streambed hydraulic conductivity. Near Escondida, New Mexico, a diurnal water temperature change from 17 to 24 ºC would result in nearly an 18% increase in streambed hydraulic conductivity. The modification of hydraulic properties is presumed to generate a transient pressure wave that is transmitted through the aquifer. While diurnal fluctuations in head are usually associated with evapotranspirative demand alone, it appears that streamflow loss recharging the aquifer may explain a significant proportion of the variation. These observations suggest that stream temperature should be evaluated during coupled simulations of hydrodynamic interactions between rivers and riparian corridors in semi-arid regions.

Contact: Ryan Jakubowski, New Mexico Institute of Mining and Technology, ryanj@nmt.edu
801 Leroy Place, Department of Earth and Environmental Science, Socorro, NM 87801, 505-835-5484

THE USE OF THE CITY OF SANTA FE'S WaterMAPS MODEL FOR WATER RESOURCE DECISION SUPPORT

Claudia Borchert, City of Santa Fe Sangre de Cristo Water Division, 801 W. San Mateo, Santa Fe, New Mexico, 87505, 505-955-4203, ciborchert@santafenm.gov
Enrique Lopez-Calva, CDM, 1925 Palomar Oaks Way Suite 300, Carlsbad, CA 92008, 760-438-7755, lopezcalvaE@cdm.com
John Rehring, CDM, 1331 17th Street, Suite 1200, Denver, CO 80202, 303-298-1311, rehringjp@cdm.com

Presentation Abstract 28

From municipal policy-level decision-makers to operations staff, water providers are faced with difficult decisions in water resource management. One of the difficulties in making decisions is the moving-target nature of the water picture. The City of Santa Fe has been working closely with CDM to develop Santa Fe WaterMAPS, a STELLA-based water system simulation model that characterizes the relationship between water resource attributes. The model allows for easy manipulation of the highly-variable attributes (e.g., surface water supply, demand), so that the effects on the behavior of different sources of supply can be assessed. Santa Fe's WaterMAPS will be used to inform water resource managers, decision makers, and the public about how to reliably and sustainably manage the City's complex water resources within the system constraints while managing costs.

The model informs both daily operational and long-range planning decision and gives utility managers and operators the unique ability to test the implications of operations decisions before implementation. In daily operations, the model can help operators choose which source to prioritize for use – particularly in lower demand seasons – based on factors such as historical hydrology, operation and maintenance costs, demand, wholesale delivery agreements, availability and best use of imported water, and effects of groundwater pumping. The model will be a tool for the long-range planning and will be used to evaluate the tradeoffs between often-conflicting objectives such as cost, reliability, and sustainability in evaluating future water supply options.

Contact: Claudia Borchert, City of Santa Fe Sangre de Cristo Water Division, ciborchert@santafenm.gov, 801 West San Mateo, Santa Fe, NM 87505, 505-955-4203, fax 505-955-4352

HYDROLOGICAL MODELING TO SUPPORT CONJUNCTIVE USE AND MANAGEMENT: CASE STUDIES FROM TWO WESTERN RIVER BASINS

James T. McCord, Hydrosphere Resource Consultants, 115A Abeyta Street, Socorro, NM 87801, jtm@hydrosphere.com, 505-835-2569
Jennifer Smith, Hydrosphere Resource Consultants, 115A Abeyta Street, Socorro, NM 87801, jls@hydrosphere.com, 505-835-2569
John C. Carron, Hydrosphere Resource Consultants, 1002 Walnut Street, Suite 200, Boulder, CO 80302, 303-443-7839jcc@hydrosphere.com
Lee Rozaklis, Hydrosphere Resource Consultants, 1002 Walnut Street, Suite 200, Boulder, CO 80302, ltr@hydrosphere.com
Ali Elhassan, New Mexico Interstate Stream Commission, Battaan Memorial Building, Santa Fe, NM 87501, ali.elhassan@state.nm.us
Veronica Sperling, Moses, Wittemyer, Harrison & Woodruff PC, 1002 Walnut Street, Suite 300, Boulder, CO 80302, vsperling@mwhw.com

Presentation Abstract 29

This paper describes conjunctive surface water – groundwater management approaches to water allocation and administration on two western river basins: the Pecos in New Mexico and the South Platte in Colorado.

As part of the Lower Pecos Adjudication Settlement, the State of New Mexico is acquiring groundwater rights from willing sellers. The overall intent of the acquisitions is to bring the basin back into hydrologic balance within the terms of the Pecos River Compact through retirement of the rights. In addition, the State will also on an as-needed basis exercise all or part of the acquired water rights to help "firm-up" Carlsbad Irrigation District water supplies while at the same time improving the State's ability to meet its Compact delivery obligations.

On the lower South Platte River in Colorado, to facilitate maximal beneficial use of available water supplies, junior groundwater pumpers are allowed to divert unallocated winter river flows and recharge that water to the alluvial groundwater system at the edges of the alluvial valley. This recharge water flows toward the river in a lagged fashion, and the accretions to the river caused by the recharge is used to replace depletions to the river caused by well pumping. Prior to receiving a water right decree, the groundwater pumpers must file an application with the State that demonstrates that senior water right holders will not be injured by the juniors' pumping.

As described in the paper, in both cases the water rights accounting and evaluations associated with the lagged accretions and depletions is accomplished through application of transient surface water – groundwater interaction modeling.

Contact: James T. McCord, Hydrosphere Resource Consultants, jtm@hydrosphere.com, 115 Abeyta Street, Suite A, Socorro, NM 87801, 505-835-2569, fax 505-835-2609

COORDINATED DATABASE AND GIS FOR THE PASO DEL NORTE WATERSHED MANAGEMENT

Zhuping Sheng, **Ari Michelsen, J. Villalobos** and **R. Srinivasan**, TAMU
Christopher Brown, **Bobby Creel**, **Phillip J. King**, **John Kennedy**, **Sue Tillery**, **Marc Bourdon**, and **Matt Rich**, NM WRRI, NMSU
Alfredo Granados, Universidad Autonoma de Ciudad Juarez
Nancy Hanks, Paso del Norte Watershed Council
Bob Gray, formerly with the University of Texas at El Paso
Michael Fahy and **Ed Fierro**, El Paso Water Utilities
April Sanders and **Gail Stockton**, U.S. Army Corps of Engineers

Presentation Abstract 30

Through collaboration of university scientists and cooperation of Federal and State agencies, irrigation districts and water management and user organizations, the Paso del Norte Watershed Council has developed a Coordinated Water Resources Database & GIS website to coordinate, compile and provide timely Internet access (http://www.pdnwc.org) to information for use by water management organizations, stakeholders and scientists. The majority of these databases exist on servers in other agencies, and the Coordinated Database and GIS Project (Project) website acts as a portal to these databases. To provide access to these distributed datasets, the Project uses a GIS-based user interface to provide spatial area-of-interest tools that employ GIS maps to allow users to click on spatial features of interest. These map features then link either to off-site URLs of websites that contain data or to files housed internally on the server. Through this interface, users are able to view and download a range of hydrological and hydrogeological data including gauged river flow, diversions, return-flow from drains, well information, groundwater levels, pumpage, and groundwater quality. Additional enhancements to the website have been accomplished including creation of historical data digital records, facilitating sharing of real-time data, provision of more data, upgrading links to sources and access to information through the Coordinated Database website, assisting in coordination of water resources measurements and reporting (QA/QC), and development of conceptual model design and configuration of Riverware for the PdN Watershed. Workshops were held for regional stakeholders to share the project findings and to gather ideas for future development from them.

Contact: Zhuping Sheng, TAMU, z-sheng@tamu.edu, 1380 A&M Circle, El Paso, TX 79927, 915-859-9111, fax 915-859-1078

USE OF REMOTE SENSING TO QUANTIFY IRRIGATED ACREAGES IN THE LOWER RIO GRANDE VALLEY

David Jordan, INTERA Incorporated, One Park Square, 6501 Americas Pkwy NE, Suite 820 Albuquerque, NM 87110, djordan@intera.com, 505-246-1600
Nabil Shafike, NM Interstate Stream Commission, 121 Tijeras NE, Suite 2000, Albuquerque, NM 87102, nabil.shafike@state.nm.us, 505-768-3880

Presentation Abstract 31

Landsat data were used to quantify irrigated acreages in the Lower Rio Grande Valley (LRG) from Elephant Butte dam to the NM-TX state line. The purpose of the study was to evaluate irrigated acreage over the course of the 2003 and 2004 growing seasons in the LRG using a remote-sensing based methodology. The methodology used analysis of Landsat imagery to evaluate irrigated areas at three time periods during each growing season. The results for all three seasons were combined to produce a composite picture of irrigation over the entire growing season. The method is based on calculating the normalized difference vegetation index (NDVI) from Landsat data. The NDVI provides a measure of the degree of vegetation at the land surface. In arid areas such as the LRG, where native vegetation is sparse, the NDVI methodology works well to quantify irrigated acreage, since the majority of healthy plant cover can be assumed to be irrigated. In addition, a masking technique was used to subtract riparian areas from the analysis so that these are not counted as irrigated. Results compared well with published values and allowed an independent check of some of the published values.

Contact: David Jordan, INTERA, djordan@intera.com, One Park Square, 6501 Americas Pkwy NE, Suite 820, Albuquerque, NM 87110, 505-246-1600, fax 505-246-2600

RAINFALL-RUNOFF MODELING IN NEW MEXICO – WHERE ARE WE AND WHERE DO WE GO?

Elvidio V. Diniz, Resource Technology, Inc., 5501 Jefferson Blvd. NE, Suite 200, Albuquerque, NM 87109
Michael D. Smith, Resource Technology, Inc., 5501 Jefferson Blvd. NE, Suite 200, Albuquerque, NM 87109

Presentation Abstract 32

Increasingly rapid development is occurring in the rainfall-runoff modeling arena. Observations of where we are in rainfall-runoff modeling will be presented with case studies, and a look at where we are going will be presented with new programs for data retrieval and modeling.

A brief history of surface runoff model applications in New Mexico identifies the development of modeling procedures and how these procedures responded or were adapted to local conditions. Focusing on the two most used programs, AHYMO and HEC-1, the algorithms used to model peak flow generating processes such as precipitation, rainfall losses, unit hydrographs, flow routing, and peak flow/ total volume are described and compared. The efficacy and efficiency of each modeling approach and limits of application are also reviewed.

Model development using these procedures for Boca Negra and La Cueva Arroyos in Bernalillo County and Rio Hondo in Chaves County are reviewed, and peak flow results are compared to the USGS Regional Flow Frequency Equations. Possible explanations for any major differences are offered.

Potential for the new generation of models using distributed parameters is investigated in the context of New Mexico applications, but more particularly, how they could be adopted by New Mexico users. HEC-HMS with its graphical user interface is replacing its predecessor HEC-1, and the number of GIS based rainfall-runoff modeling applications is rapidly expanding.

High density distributed rainfall has been difficult to access because NEXRAD radar based data requires extraction using customized programs running on mainframes. However, a new Java based program from NCDC is in BETA phase testing for exporting this NEXRAD data to a GIS environment.

Contact: Elvidio V. Diniz, rti@nm.net, Resource Technology, Inc., 5501 Jefferson Blvd. NE, Suite 200, Albuquerque, NM 87109, 505-243-7300, fax 505-243-7400

MOVEMENT OF FLOOD IRRIGATION SEEPAGE INTO SOIL AND SHALLOW GROUNDWATER

Carlos Ochoa, New Mexico State University, Box 30003 MSC-3I, Las Cruces, NM 88003, carochoa@nmsu.edu, 505- 646-5558
Sam Fernald, New Mexico State University, Box 30003 MSC-3I, Las Cruces, NM 88003, fernald@nmsu.edu,505-646-1041
Steve Guldan, New Mexico State University, P.O. Box 159, Alcalde, NM 87511, sguldan@nmsu.edu, 505-852-2668

Presentation Abstract 33

This study builds on previous investigation of irrigation ditch seepage effects on shallow groundwater at the Alcalde Science Center in north central New Mexico. Impoundment and inflow-outflow tests on the Alcalde Ditch yielded a 5% seepage rate at the Alcalde Science Center and a 16% seepage rate over the 8-km irrigated length of the ditch. Water level measurements in three transects of wells showed that within 3-4 weeks of the onset of ditch flow in the spring, shallow groundwater levels near the ditch and in the middle of the irrigated corridor rose 0.5-1.0 m, and all groundwater flow paths oriented towards the river. In addition to the effect of ditch seepage on shallow groundwater, we found short duration increases in shallow groundwater levels that were clearly attributed to flood irrigation seepage events. In 2004, we initiated this study to investigate effects of seepage from flood irrigation on shallow groundwater levels. We measured water application to the field with an insertion flow meter, and manually measured standing water depth. We tracked water seepage into the soil using vertical nests of two soil moisture probe technologies: time domain reflectometry (TDR) and frequency domain reflectometry (FDR). Volumetric water content, soil porosity, and field capacity were used to calculate total seepage below the 1-m rooting zone. We used the Root Zone Water Quality Model to simulate crop seepage along with other hydrology and evapotranspiration variables. Fluctuations in the water table below the alfalfa field were measured hourly in four wells. The total amount of water applied during a seven hour irrigation event was 1498 m^3 with a maximum standing water depth of 9.4 cm. At least 5% of the total applied water percolated to shallow groundwater within 24 hrs after irrigation. Preliminary modeling showed similar responses for simulated and field-measured seepage. Water level increases of up to 30 cm after the irrigation event were attributed to flood irrigation seepage. This study indicates that along with seepage from irrigation ditches, seepage from flood irrigation is a significant source of shallow groundwater recharge in a northern New Mexico irrigated valley.

Contact: Carlos Ochoa, NMSU, carochoa@nmsu.edu, Box 30003 MSC 3-I, Las Cruces, NM 88003, 505-646-5558, fax 505-646-5441