# DIVINING ROD

NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE

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# soil moisture-rainfall study published

Predicting summertime precipitation anomalies in New Mexico would be aided by a more complete understanding of how different components of the climate system contribute to rainfall variability. One source of persistent rainfall anomalies may be the soil moisture state. If soil moisture impacts are substantial, then soil moisture-rainfall feedbacks may contribute to the variability of summertime precipitation.

Because soil moisture reflects past precipitation and influences the state of the overlying atmosphere, it has been thought that a positive feedback may exist between soil moisture and rainfall. For example, above normal rainfall would yield high soil moisture, which in turn would lead to additional rainfall. If a positive soil moisture-rainfall feedback exists, then land surface memory due to soil moisture storage could prolong both floods and droughts.

The Sevilleta National Wildlife Refuge served as the laboratory to explore the nature of the soil moisture-rainfall feedback in semiarid regions. New Mexico Tech Professor Eric Small and research assistant, Shirley Kurc, set out to test whether a positive soil moisture-rainfall feedback exists.

The study produced four major results. First, changes in the evaporative fraction (the fraction of available energy transported from a surface in the form of latent heat) resulting from wet versus dry soil moisture conditions are dramatic. When the soil is dry, the evaporative fraction is typically 0.1, demonstrating that only 10% of the energy transferred from the surface to the atmosphere is via latent heating. In contrast, the evaporative fraction is about 0.5 when the soil is wet. This indicates that the surface energy balance response to rainfall, at least in terms of latent heating, is substantial and could yield a feedback to the atmosphere.

*New Mexico Tech students Eric Bhark and Shirley Kurc collect data from a Bowen Ratio station used to measure the surface energy and water balances at a research site on the Sevilleta National Wildlife Refuge. This photo demonstrates a nearly 100% grass site, whereas other sites contain 100% shrub or a mix shrub and grass spanning an ecotone boundary.*


**INSIDE**

**Rio Grande Drought Report Summarized** Page 3

**Winning High School Water Essays** Page 4

**46th Annual Water Conference Program** Page 8

Second, net radiation and available energy both increase when the soil is wet, in both grass and shrub environments. The researchers found that a volumetric water content change of about 5% yields an increase in available energy of about 50 W $m^{-2}$. If this is accurate, then the soil moisture-net radiation feedback would contribute to soil moisture-rainfall feedbacks in semiarid regions such as the Sevilleta.

Third, changes in the evaporative fraction and net radiation following rainfall events are short lived; they persist on the order of days. Therefore, a soil-moisture rainfall feedback will only exist if atmospheric conditions conducive for convective precipitation occur within several days after a rainfall event.

Fourth, the evaporative fraction and net radiation response to rainfall, and the persistence of anomalous conditions, are nearly identical across the grass-shrub environment. Small and Kurc concluded, therefore, that plant type does not influence the nature of soil moisture-rainfall feedbacks in semiarid regions. In these environments, the soil moisture-rainfall interactions appear to be dominated by the magnitude and timing of rainfall events.

*The Influence of Soil Moisture on the Surface Energy Balance in Semiarid Environments*, WRRI technical completion report number 318 by Small and Kurc has been published by the institute. Copies are available by contacting the WRRI at 505-646-4337. The report in its entirety also is available via the WRRI's homepage at wrri.nmsu.edu.

*This article is adapted from an earlier work appearing in Resource Law Notes, a publication of the Natural Resources Law Center at the University of Colorado. Dr. James F. Booker is Associate Professor of Economics and Environmental Studies at Alfred University in New York. The work described here was completed at Alfred, and during a sabbatical leave with the Natural Resources Law Center, and the Institute for Behavioral Science, both at the University of Colorado. His past work includes research on drought in the Colorado River Basin, on the sustainability of water resource use in Arizona, on future water supply paths for Las Vegas, and on instream flows for endangered species in the Platte River Basin.*

# Increased Water Demands and Limited Water Resources in the Upper Rio Grande

James F. Booker
Alfred University and the University of Colorado

The Rio Grande originates in the southern Colorado Rocky Mountains, flows through New Mexico, and forms the border between Texas and Mexico on its way to the Gulf of Mexico. Like many western rivers, the Rio Grande is both the dominant and limiting water resource throughout most of its watershed. Under dry conditions human claimants to basin water exceed the available supplies, and emerging demands for environmental protection (in the form of instream flows) further increase competition for access to scarce river flows.

*(continued on page 3)*

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A three-state (Colorado, New Mexico, and Texas) research team with legal, economic, and hydrologic expertise was formed to address the ability of the watershed and its institutions to cope with extended drought. My role has been one of integrating the disciplinary findings of the project researchers. I chose an optimization model incorporating the linkages between law, water flows, and economic impacts to perform the analysis. This modeling effort focuses on the Upper Rio Grande basin, from Colorado through New Mexico to Fort Quitman, Texas just below El Paso.

The Upper Rio Grande and its associated aquifers serves over one million acres of irrigated land and the municipal and industrial needs of Albuquerque and El Paso (and Ciudad Juarez in Mexico). Sixty years ago, the Rio Grande Compact was approved by Congress, dividing the annual water flow among the three states. In developing the Compact, the three states considered the likely flow regimes, and the capabilities and limitations of storage facilities in order to craft an operating agreement for the river which protected the water uses existing at that time. Conditions six decades ago could hardly have predicted the growth in the basin's demand for water associated with an explosion in population, nor new policies toward fish and wildlife habitat emphasizing endangered species. The formal modeling work incorporates these new realities in order to test the fundamental hypothesis of this research: that new institutions for coordination of surface water withdrawal, groundwater management, and reservoir operations, could reduce economic and environmental losses resulting from water shortfalls, particularly in periods of severe and sustained drought.

In modeling a basin such as the Rio Grande, I am most interested in working at the border of disciplines. I seek to demonstrate in a quantitative way the relationship between the rules governing allocation (the law) and the response of the physical system (hydrology). In between lies economics which helps us understand the reaction of water users to the incentives established by the law. That is, the law establishes the incentives under which water users operate; it is their actions in response to these incentives, however, which ultimately determine hydrology. It is within this framework in which I proceed to model the possibility of increasing the ability of the system to cope with drought.

**Conditions six decades ago could hardly have predicted the growth in the basin's demand for water associated with an explosion in population, nor new policies toward fish and wildlife habitat emphasizing endangered species.**

This work starts with the basic water supply, which includes all major tributaries, interbasin transfers, and hydrologically connected groundwater. The figure on page 15 illustrates typical river flows and depletions in the Upper Rio Grande. Water demands (current and projected up to 40 years into the future) include agricultural water uses (representing from 86 percent to 98 percent of surface, and 47 percent to 56 percent of groundwater use), municipal and industrial demands in Albuquerque and El Paso (the balance of the demand for consumptive use), recreation at the major basin reservoirs, and environmental demands for instream flow protection. Each component is represented in a yearly time-step over a forty-year planning horizon.

The institutions governing water allocation in the basin begin with the Rio Grande Compact. The Compact establishes schedules relating each states' obligation to the next on the basis of available water inflows to the state.

Colorado's total obligation to New Mexico ranges from only 20 percent of inflows at very low flow levels, to about 30 percent at the mean flow level; at about 50 percent above the mean flow level, all additional inflows must be passed

*(continued on page 14)*

In conjunction with last year's Annual Water Conference, the WRRI sponsored the Water Essay 2000 Contest. High school students from throughout New Mexico were encouraged to participate by writing a 1,500 word essay on the following scenario:

*The year is 2020, the era of the "water card." Individuals must have water cards that allow them to use only a certain amount of water every day. When people have consumed their allotment, alarms go off and the water card no longer activates faucets, toilets, water fountains, washing machines, and so on. Describe your life in the year 2020, using your knowledge of water concepts to write a brief science fiction thriller.*

Essays were judged in two categories: grades 9 and 10; and grades 11 and 12. First place in each category received $300 and second place received $200. Six essays in each category were also given Honorable Mention certificates.

The WRRI received 66 essays and assembled a committee of 6 judges to score the essays. Award-winning essays were read by students during the luncheon banquet at the Annual New Mexico Water Conference, where students also received their prizes.

In the April issue of the *Divining Rod* we published the second place essays in each category. This issue contains the first place essays.

Our congratulations to all students who participated in the competition. The WRRI will announce this year's competition in late August. Check the WRRI home-page (wrri.nmsu.edu) for details.

# High school essay contest winning entries

## First Place - Junior Division

*Jennifer Stone*
*La Cueva High School, Albuquerque*

# The Parched Earth: New Mexico 2020

The hot, arid, desert air poured through my car window like a blast furnace. A fine sweat beaded my brow, trickling into my red aching eyes and across my cracked lips; burning them with that familiar cruel salty taste. I weave my car through town, carefully dodging the people begging in the street and the useless fire hydrants. Past the once green lawns and trees, the burned out buildings, and the cracked parched earth that used to be a lush golf course. At least there were no water riots to avoid today...at least, not yet.

It is August 15, 2020, and there has been a huge water crisis. People have used too much water and it is running out. In a futile effort to conserve the last little bit of our water, the government has issued a water card to everyone as their daily ration for fresh, clean water. Once they use up their daily allotment, an alarm sounds and there will be no more water to operate such everyday necessities such as toilets, faucets, or washing machines. The allotment is very small, barely enough for survival. Bathing is a thing of the past. In this world of the water card, water wasting showers and dishwashers are few and far between. I cannot remember the last time I saw rain. I have heard that scientists from the New Mexico Water Resources Research Institute have been working on ways to make it rain, but I am not optimistic. Even a little would go a long way...now that we know to conserve.

This past July was my 35th birthday. I try hard to remember what life was like 10 years ago, when everything was normal, water was something I took for granted. I never thought that you could actually run out. It is a necessity for life. I guess too many others were just like me and took everything for granted. All it took were a couple of really dry years and the aquifer was emptied. People did not believe it could happen until it was too late. I work at the hospital as the chief emergency room pediatrician. I am

fortunate. This water crisis has hit many people a lot harder than it has hit me. Due to the unbelievably dry climate, we get more dehydration cases each day than anything else. For example, kids come in complaining of headaches and nausea just to get some water because they had already used all of the water their cards would allow. Everyday, when I leave the hospital to go home, I see the most beautiful fountain dedicated to the hospital's founder, bone dry. Unlike the homeless people I remember from my youth, those I see on the sidewalk are begging for water, not food. The children call them "waterless people". You used to be able to buy water in the stores because some coastal communities had their own desalinization tanks to convert seawater into drinking water. They shipped it to the west to sell at unthinkable prices. The water was so expensive parents would have their little kids walk out of the store with it under their shirts instead of paying for it. Often when it ran out, there would be riots and looting. The grocery stores don't sell water anymore because they lost so much money on it.

Things are a little bit better here now since the water wars of 2015. The northwestern states had dammed up the Rio Grande River to save the water for themselves. People in the southwest were almost totally without water. Children were dying in the streets. After negotiations failed, there were several bloody clashes between state militias. Finally the federal government stepped in and forced the states to honor their water agreements. At least we have learned to share.

I remember reading in the newspaper that a rich family who owned a mansion on the other side of town was caught buying water from a private desalinization plant, which was strictly forbidden after all were nationalized. Apparently, they had bragged to their neighbors that they would never run out of water. Recently, I heard more news of this couple, or rather their home. It had been broken into and ransacked. The police who were called to investigate stumbled upon a huge cellar of the forbidden desalinized water that the thieves had not found. Can you imagine the look on the thieves' faces when they read this in the newspaper. These water cards cause unbelievable havoc. When I am at the hospital, I often see nurses or orderlies searching a dead on arrival for his or her water card. I reprimand them, but it is useless. We are supposed to turn them in to the government, but it rarely happens. I just write on the chart, "Unable to find water card" and that is the end of it. I am very proud to say that I have never stolen a water card. It is against the law and just plain wrong to try to get more than your fair share when there are so many that are needy. I admit I have been tempted, but I hope I will never feel compelled to steal like some colleagues do.

*Jennifer Stone reads her award-winning essay during the luncheon at the 45th Annual New Mexico Water Conference.*

One day last week, my family had a little get together at my parent's house. My brothers and sisters were there along with their children. We ate my mother's wonderful cooking and watched a little television together. Even though we all have very serious problems in our lives, we like to take a night out of the month to come together and relax and not worry about whether there is going to be enough water to live on next week. This night, however, was different, and one of my sister's daughters kept asking me questions about what my life was like 20 years ago. She is only 5 years old, so she knows nothing of how great life was back then. She considers this water crisis to be normal. It is all she has ever known, and it could be all she will ever know. I tell her how I would wash my new car every weekend without giving a thought to a stupid water card. I don't think she has ever seen anyone wash a car. I also told her how my friends and I would go to the pool almost each day of the summer and how I had a lot of friends who had pools. She looked at me blankly and asked what a pool was. My heart dropped to my knees. I felt so bad for her. My father piped up and told her that, in this region, we used to use evaporative coolers to cool our homes meaning we constantly pumped water through a machine that had fans and the water made the air cooler. Now we don't use anything to keep our houses cool. We have learned to live with the heat.

Practically every day I set off the alarm that doesn't allow me to have any more water. The only time I don't is when I have to work for more than 24 hours at the hospital. I rarely get to wash my clothes. Most of the time I try to get

the people at the hospital to wash my scrubs. The government hasn't put a limit yet on the amount of water the hospital can use. It is unheard of to wash your car. I rarely bathe, because showers use up too much of precious water. Why wash your hair if you can put it up in a ponytail? Lately, there have been brownouts nationwide due to the lack of water for hydroelectric power. If it weren't for the brilliant minds that have managed to keep them running and come up with alternate power sources, we wouldn't have power at all.

As I think about how my life has changed over the past 20 years with the water crisis and invention of the water card, I wonder how life will be in the future. I hope it will be filled with far less worries and more happiness to make up for the recent past. I don't have a cure for this crisis, and I don't know if anyone ever will, but I certainly hope it doesn't get worse. At least people have learned that nothing should be taken for granted, especially water, because water is not an inexhaustible resource.

What is that? On my windshield! Could it be? My heart pounds wildly. Yes! Yes! Raindrops! Beautiful raindrops! Smearing the dust on my windshield into a myriad of muddy asymmetrical shapes as I push my head out the window to catch a few precious drops on my swollen tongue. Children on the street are screaming in fear at their first rain while their parents are silent with awe. How could this be? Have the scientists prevailed? Is this another chance? Will we get it right this time?

## First Place - Senior Division

*George Ross*
*Santa Fe High School*

# Going to Bed with Smelly Feet

It's 4:00 a.m., I have a huge presentation tomorrow for my telepathic communication systems, and I am still awake. Why can't I sleep you may ask? Well, to sum it up quickly, my feet smell like old mushroom pizza left in an overnight dumpster. That is why I can't sleep. Oh, is that not enough explanation? Am I being too vague? Alright, here is the whole story. If you want to start from the beginning, I can do that. Basically, for a good 100 years, if not longer, humans have been carelessly using water for the most pointless of tasks; washing their car every week, watering their golf courses twice a day, running the faucet while the toothbrush is in their mouth. Even little things like letting the showerhead drip throughout the night has culminated and built up to our current water state.

Somewhere around 2016 congress passed a bill stating that by 2020 each resident of the United States was going to be issued a "water card." This water card was to limit the amount of water each household was to use. The government set aside 12.6 billion dollars of the surplus in 2016 to make sure at least 60 percent of the population would be equipped with showerheads, faucets, sprinklers, toilets, and any other random water-pumping household appliances that would only work with the "water card." Once the water card was used up for the day, that household could not use anymore water. The cards and the technologically advanced water systems were distributed at random, and lo and behold, I was chosen as an initial user of the water card. I got the card in 2017, and I had a few mix ups at first. I had trouble regulating my water use. Many a night I would find myself brushing my teeth and having to rinse with milk or apple juice because I accidentally used up my "water credit" for the day. Of course, with the new water restrictions, the price of juice began to sky rocket, so milk was usually my choice for rinsing (unfortunately). Finally, after about 6 or 7 months, I got on to a pretty steady schedule - shower for six minutes, one pot of coffee, water grass on Thursdays, laundry on Mondays, use the bathroom only twice a day, wash hands very quickly once a day, drink three-fourths cup of water daily, brush teeth once in the morning without toothpaste, once at night with toothpaste and water, and a few drops at night to wash my contacts.

This schedule worked fine. I still had occasional problems like those emergency bathroom trips, or falling asleep in the shower, but life was alright. Don't get me wrong, not a day went by when I wished we could have just been more responsible on an earlier date (like, I dunno, the year 2000 and 2001) but this was the life I now had to live and I was living it to the best of my ability. But the situation soon got worse. About 2 months ago, roughly 3 years after I first received my card, the government decided that after much research they had to reduce the amount of water each card holder used by half. "Are you out of your mind?" I screamed at the top of my lungs when I heard the news. This meant taking 3 minute showers, a half a pot of coffee, one bathroom trip a day, no washing hands, never watering the grass, laundry every other week, brushing teeth every other day, and drinking only three-eighths cup of water. I was furious, and it only escalated from there. For the past 2 months I have been struggling. Prices for any type of drink or food that uses water as an ingredient or as an element to clean it (like fruits and vegetables) are through the roof. Of course my pay at work isn't going up any time soon since the economy is in such chaos due to this water crisis. I can't make ends meet. No longer is my only worry getting out of the shower fast enough, it is now wondering if I will be able to eat dinner. Things have gotten out of control. And that leads me to today. I got up this morning, hungry as can be. I jumped in the shower and proceeded to jump right back out. I brushed my teeth and used very little water to rinse (still had that burning mint sensation under my tongue), and got myself a sip of orange juice. I went to work, got together my equipment for tomorrow's presentation, and had a very small salad for lunch with a sip of water to wash it down. By the time I got home, I was starving, and I had to (God forbid) use the bathroom for a second time in one day. I had a decision to make. I could either not use the toilet when relieving myself, and save some water to wash my hands and face before I went to bed tonight, or I could sit on the toilet comfortably and not worry about washing my face and hands at night. I elected the second choice, without considering my intense hunger that was building up. By 8:00 p.m. I could not stand it anymore. I was so incredibly hungry. I kept on having memories of the days that I could eat when I wanted to eat, and didn't have to worry about the price of food being ridiculous because of our own irresponsibility regarding water usage. I looked over the amount of money I had, and with gas, rent, and credit card bills to pay off, I didn't have enough money to purchase food. I decided I needed to eat anyway. I put on my worn our sneakers with holes on every side of them and went to Pappio's Pizza Parlor. Like a bum, I sifted through the overnight dumpster in the back. I found some loose pieces of food, and it at least held me over. Meanwhile, I didn't notice that I was standing on an old mushroom pizza. The smell leaked through my worn out sneakers before I could jump out of the dumpster to safety. I got home, and prayed to the water Gods to give me more water on my water card. I ran the card under the faucet's censor, hoping to get but a few drips just to wash off my horribly smelling feet. But instead, I got those sirens and those warning lights telling me I used up all my water for the night. That brings me back to the present. It is now 4:35 am, and I can't go to sleep directly because of my smelly feet, but indirectly because of human's inconsiderate use of water in history's past. If only we would have taken control earlier, or if we would have prioritized a bit better, maybe we could have salvaged the water supply. But I guess looking at "what could have been" is pointless. I have a presentation tomorrow displaying my telepathic communications system, yet I can't wash my feet. How ironic, isn't it?

# 46th Annual New Mexico Water Conference

# NEW MEXICO WATERSHED MANAGEMENT: RESTRORATION, UTILIZATION, AND PROTECTION

**November 5-7, 2001**
**La Fonda, Santa Fe**

Sponsored by
New Mexico Water Resources Research Institute
and co-sponsored by
New Mexico Watershed Coalition
New Mexico Riparian Council

## Preliminary Program

### Monday Afternoon, November 5

2:00-5:00 pm — Tours:
Cerro Grande Fire Site -OR- Bernalillo Watershed
**(meet at La Fonda's Front Desk at 1:45 pm)**

### Tuesday Morning, November 6

7:00 am — Registration Begins - La Fonda lobby

8:15 — Welcoming Remarks - Lumpkins Ballroom
Karl Wood, Director, WRRI
Larry Delgado, Mayor of Santa Fe

**Session 1**
Moderated by Eileen Grevey Hillson

8:45 — Keynote Address: (speaker to be announced)
*The Bush Administration's Agenda for Water*

9:30 — Robert Hirsch, Associate Director, U.S. Geological Survey

10:00 — Eleanor Towns, Regional Forester, Southwestern Region, U.S. Forest Service

10:30 — BREAK

**Session 2**
Overview and History of New Mexico Watershed Management

11:00 — Rosendo Trevino, State Conservationist Natural Resources Conservation Service

11:30 — Toby Martinez, Director New Mexico Department of Forestry

12:00 — LUNCH - Lumpkins Ballroom (box lunches)
High School Essay Competition Winners

### Tuesday Afternoon, November 6

**Session 3**
Riparian and Grazing Management

1:30-3:00 pm

Karl Wood, Director, WRRI
*Grazing Management for Healthy Watersheds*

Alexander "Sam" Fernald, NMSU-Alcalde Experiment Station
*Groundwater/Surface Water Interactions*

Bill Zeedyk, Riparian Restoration Consultant, Retired U.S. Forest Service
*Physical Feature Manipulation in Riparian Restoration*

Terrel "Red" Baker, NMSU Range Improvement Task Force
*Management of New Mexico's Riparian Areas*

3:00 — BREAK

**Session 4**

3:30-4:45 Inside New Mexico: Statewide Watershed Issues
Moderated by Ernie Mills
Julia Davis Stafford, CS Ranch
Steve Harris, Rio Grande Restoration
Debbie Hughes, Soil and Water Conservation Dsts.
Fidel Lorenzo, Acoma Pueblo
Gary Cunningham, NM Watershed Coalition
John Miera, Santa Fe National Forest
David Propst, New Mexico Dept. of Game & Fish

5:00-6:30 Reception - La Terreza (cash bar)
NM Riparian Council Awards (5:00-5:30 pm)

6:30-8:30 Dinner Banquet - Lumpkins Ballroom
Utton Memorial Lecturer Dan Tarlock
Introduced by G. Emlen Hall

## Wednesday Morning, November 7

**Session 5**

Logging and Fire Management Issues
Moderated by Debbie Hughes

8:00 am Hollis Fuchs, Natural Resources Conservation Srv.
*The Changing Faces of Lincoln County Watersheds*

8:30 Bill Hornsby, Bureau of Indian Affairs
*Forest Management Practices on the Mescalero Apache Indian Reservation*

9:00 Jim Paxon, U.S. Forest Service
*Prescribed Fire: Why, How, and Results*

9:30 Jim Davis, NM Environment Dept.
*Watershed Protection Program*

10:00 BREAK

**Session 6**

New Mexico Legislative Issues Panel
Moderated by NM Representative Pauline Gubbels

10:30-12:00 Sue Wilson, NM Senator
Joe Stell, NM Representative
Carlos Cisneros, NM Senator
Senator Jeff Bingaman (invited)
Ann Kathryn Ziehle, Senator Domenici's staff
Raul Alvillar, Representative Udall's staff

12:00 Closing Remarks: Karl Wood, WRRI

### Optional Conference Tours

**Cerro Grande Fire Site** In the spring of 2000, a prescribed burn at Bandelier National Monument got out of control, consuming more than 46,000 acres, and burned through Los Alamos, destroying more than 200 structures and displacing 435 families. Erosion control throughout the burn area is underway and includes the use of log-erosion barriers, contour falling, wattles, raking, seeding and mulching as well as stream channel stabilization. This is a cooperative effort with the city, county, Los Alamos National Laboratory, the U.S. Park Service, San Ildefonso and Santa Clara pueblos, and the U.S. Forest Service.

**Bernalillo Watershed** Along with personnel from the Sandia Ranger District and many other local fire-fighting organizations, researchers at UNM and the Rocky Mountain Research Station are studying the use of fire in restoring/maintaining grasslands in the Bernalillo Watershed. Using a randomized block study design, studies are measuring: composition and abundance of plant species, including spring ephemerals, perennial grasses and woody vegetation; soil potentially mineralizable N; sediment yield; and changes in soil surfaces associated with the first two applications of prescribed fire. Fragmentation of the desert grassland vegetation will be addressed using line transect data. These data will assist land managers in making decisions about the time and frequency of prescribed fire on semiarid grasslands.

### Hotel Information

A block of rooms has been reserved at La Fonda for conference participants. The rate for a single room is $90 and $110 for a double. Participants must indicate that they are attending the Water Conference to get the conference negotiated rates. The cut-off date for the block of rooms is Friday, October 5, 2001 so be sure to make your reservations early. Reservations should be made by calling La Fonda at 1-800-523-5002 and then choosing #1. Faxed reservations can be sent to (505) 995-2324. The La Fonda website is www.lafondasantafe.com.

### Information on WRRI's Homepage

Check our Homepage for updated information about the conference. You can also register for the conference using our Homepage at wrri.nmsu.edu. Choose the Water Conference link and follow the instructions. Purchase order or payment must be received by mail to confirm registration. We accept credit cards (Visa, Mastercard and Discover) for payment.

# WRRI awards science fair projects

Middle school and high school students from throughout New Mexico gathered in Socorro in April for the 49th New Mexico Science and Engineering Fair. The WRRI awarded certificates and savings bonds to top water-related projects. Award winners have been invited to display their projects at this year's 46th Annual New Mexico Water Conference, in Santa Fe on November 5-7, 2001.

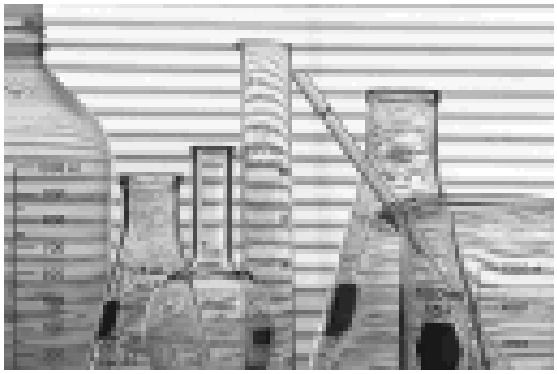
High school WRRI awards:
First Place: Nathan Tooker, Los Lunas High School
*A River Runs Through It: A Study of the Riparian Ecosystem Along the Rio Grande Bosque, Phase III*

Second Place: Sue Andra White, Manzano High School, Albuquerque
*Grasslands versus Woodlands: Change During the Last Century Using Remote Sensing*

Honorable Mention: Ashley Hester, Alamogordo High School
*Rio Penasco: Healthy or Unhealthy?*

Verna Patel, Deming High School
*You're All Wet!*

Middle school awards:
First Place: Jason Castillo, Bernalillo Middle School
*The Distribution of Radionuclides after the Cerro Grande Fire*



Second Place: Ben Gutzler, Taft Middle School, Albuquerque
*Sources of Arsenic in Surface Water along the Jemez River System*

Honorable Mention: Matthew Dent-Coleman, Roosevelt Middle School, Tijeras
*Can a Stream's Sinuosity be Restored by Using Simple Baffles?*

Rachel Glass, Jefferson Middle School, Albuquerque
*Which Soil Covering is Best for Conserving Water?*

# Upcoming Conferences

August 9-10, 2001 - CLE International, New Mexico Water Law, La Fonda, Santa Fe

September 10-11, 2001 - CLE International, Endangered Species - The ESA and Habitat Conservation Planning, Hyatt Regency, Austin

September 26-29, 2001 - New Mexico Geological Society 52nd Fall Field Conference, Tucumcari

October 29-31, 2001 - New Mexico Environmental Health Conference, Albuquerque Convention Center

October 29-November 1, 2001 - National Water Resources Association Annual Conference, Little America Hotel, Salt Lake City, Utah

**November 5-7, 2001 - 46th Annual New Mexico Water Conference, New Mexico Watershed Management: Restoration, Utilization, and Protection, La Fonda, Santa Fe**

November 12-15, 2001 - American Water Resources Association Annual Water Resources Conference, Hyatt Regency, Albuquerque

December 6-8, 2001 - New Mexico Stockman's Convention, Albuquerque

# Meet the Researcher

## Dr. Eric Small

Assistant Professor of Hydrology, Department of Earth and Environmental Science, and Research Hydrologist, Geophysical Research Center, New Mexico Tech since January 1999

**Research Focus**
Research focuses on monitoring and modeling the processes that regulate the water and energy budgets of the Earth's land surface, particularly in semiarid environments. Key processes act across a wide range of spatial and temporal scales - from the influence of plants on the redistribution of surface water during convective rainstorms to the effects of land-atmosphere interactions on decadal rainfall variability. The atmosphere, plants, and soil strongly influence surface water processes, and therefore are all important components of this research.

**Education**
Ph.D. in earth sciences, University of California Santa Cruz, 1998
Dissertation entitled *Regional climatic and hydrologic changes in the Aral Sea region, 1960 to present*

B.A. in geology, summa cum laude, Williams College, 1993
Honors thesis entitled *Controls of ice stagnation in retreating Pleistocene valley glaciers, San Juan Mountains, Colorado*

Post-doctoral Research Associate, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1998

Post-doctoral Research Associate, Climate and Global Dynamics Division, National Center for Atmospheric Research, Boulder, Colorado, 1998

**Graduate Student Opportunities**
Support for new graduate students was provided during 2001 for applicants seeking M.S. or Ph.D. degrees in hydrology who were interested in the following research topics:
- Influence of land-atmosphere interactions on variability of the North American monsoon system
- Response of semiarid grass and shrub ecosystems to multiyear drought
- Runoff, soil erosion, and desertification; the influence of plant-water interactions
- Research associated with a new NSF Science & Technology Center on Sustainability of Water Resources in Semiarid Regions, focusing on basin-scale water balance studies, land-atmosphere interactions, or climatic variability

**Teaching**
Hydrology of the Rio Grande Basin
Surface Hydrology
Hydroclimatology

**Current Research Projects**
- Response of semiarid ecosystems to multiyear drought
- Plant-soil moisture feedbacks and desertification
- Water and energy balance of semiarid uplands
- Land surface variability and the North American Monsoon System
- Land-atmosphere interactions and summertime precipitation
- Reconstruction of "1950s drought" in the southwest

**Publications**
Small, E.E. and S. Kurc. 2001. *The Influence of Soil Moisture on the Surface Energy Balance in Semiarid Environments*. NMWRRI report no. 318, Las Cruces, NM.

Small, E.E. 1999. News and Views: Global cooling reduces relief. *Nature*. 401:31-33.

Small, E.E., F.Giorgi, and L.C. Sloan. 1999. Regional climate model simulation of precipitation in Central Asia: Mean and interannual variability. *Journal of Geophysical Research*. 104:6563-6582. Abstract.

Small, E. E., L.C. Sloan, S. Hostetler, and F. Giorgi. 1999. Simulating the water balance of the Aral Sea with a coupled regional climate-lake model. *Journal of Geophysical Research.* 104:6583-6602. Abstract.

Small, E.E., R.S. Anderson, and G.S. Hancock. 1999. Estimates of the rate of regolith production using $^{10}$Be and $^{26}$Al from an alpine hillslope. *Geomorphology*. 27:131-150.

Small, E.E. and R.S. Anderson. 1998. Pleistocene relief production in Laramide mountain ranges, western United States. *Geology*. 26:123-126.

Small, E.E., R.S. Anderson, J.R. Repka, and R. Finkel. 1997. Erosion rates of alpine bedrock summit surfaces deduced from in situ $^{10}$Be and $^{26}$Al. *Earth and Planetary Science Letters*. 150:413-425.

Small, E.E. and R.S. Anderson. 1995. Geomorphically Driven Late Cenozoic Rock Uplift in the Sierra Nevada, CA. *Science*. 270:277-280.

# USGS releases water-quality reports

The U.S. Geological Survey has released sixteen summary reports covering various river basins and aquifers under its NAWQA program. According to Timothy Miller, Program Chief, "Each assessment describes the occurrence and distribution of pesticides, nutrients, industrial and petroleum-based compounds, metals, and radon, as well as the condition of aquatic habitat and fish, insect, and algal communities. Contaminant sources, land and chemical use, and natural factors are related to water-quality conditions, aquatic life, and stream habitat. Results help to determine what these conditions may imply for the protection and safety of drinking water, for the health of aquatic ecosystems, and for resource management."

Copies of the reports are available online at http://water.usgs.gov/nawqa or call (703) 648-5715. For more information contact Timothy Miller, timiller@usgs.gov or (703) 648-6868.

# NM Tech Professor Baolin Deng awarded NSF Career Award - focus on arsenic removal -

Baolin Deng, assistant professor of environmental engineering at New Mexico Tech, recently was named a recipient of one of the National Science Foundation's (NSF) renowned 2001 Faculty Early Career Development (CAREER) Awards.

The NSF grant of almost $375,000 will provide funding for Deng and his fellow Tech researchers to conduct a five-year study on "Integrating Research and Education on Arsenic Removal from Drinking Water."

The CAREER Award is NSF's most prestigious honor for junior faculty members teaching and conducting research in colleges and universities throughout the nation. Deng's research proposal was one of only 350 or so picked for federal funding from a pool of about 2,000 proposals submitted for consideration.

"Through this new research project, I'm hoping to develop a new, innovative method for arsenic removal from drinking water," Deng says, "one which, hopefully will be very efficient, as well as cost-effective."

In addition to having at least two Tech graduate students help with his study, Deng foresees implementing an educational component to his research work by also involving state science teachers enrolled in New Mexico Tech's Master of Science Teaching degree-granting program.

"Since science and engineering are best taught to the K-12 science teachers and their students through hands-on, inquiry based experiences, laboratory and field projects on arsenic measurements and treatment will be implemented as part of the program," Deng explains.

Upon being named a recipient of a CAREER Award, Deng and his fellow awardees may become eligible to receive the Presidential Early Career Awards for Scientists and Engineers, the White House's highest honor for scientist and engineers in the early stages of their careers.

*George Zamora, New Mexico Tech*

# Scientists at UNM developing an integrated water model

A pilot project, being developed by an interdisciplinary team of scientists at the University of New Mexico, will allow the volume of water in the Rio Grande to be determined at any place and point in time. The model will be used to determine the impacts and tradeoffs between different water management and policy decisions.

Because citizens and managers are uncertain how water reallocation will impact water users, the public, or the environment, resistance to change is common. UNM's pilot project will couple physical, environmental, behavioral and economic models in an integrated Geographic Information System (GIS) framework to simulate interactions and changes within the Rio Grande watershed in New Mexico. The approach will permit the evaluation of impacts if any component of the model changes as a result of natural or human causes, for example, drought that impacts an endangered species.

The modeling structure is designed to allow an infinite number of process specific resolutions on an as-needed basis, that is, finer cells where detail is required, coarser cells where data limitations preclude the finer scale or where processes operate on a coarser scale. Because water law and economics will be integrated with environmental components, it will eventually be possible to determine how a change in the amount of available water will impact the various water users in the region.

Representative water users (stakeholders) will participate in focus groups to discuss issues and create future water use scenarios. The cumulative effects of individual stakeholder decisions will be simulated using the GIS model. By having stakeholders identify the issues, a more realistic evaluation of management and policy decisions is possible.

The interdisciplinary team plans to complete the pilot project in three years. The team consists of faculty members and graduate students from UNM's Department of Geography, Department of Economics, Department of Earth and Planetary Sciences, and the Water Resources Program. Faculty members involved in the project are: Olen Paul Matthews, Louis Scuderi, Kirk Gregory, Seth Snell, Bradley Cullen, David Brookshire, Janie Chermak, Kate Krause, and Michael Campana. The Environmental Protection Agency and the National Science Foundation are providing funding.

*Paul Matthews, University of New Mexico*

# NMSU works to improve irrigation

New Mexico State University's Water Task Force will begin research and educational programs to improve irrigation efficiency in agriculture and urban landscaping in the Rio Grande Basin this fall as part of a joint program with Texas A&M University.

"We want to reach out to public decision makers, agricultural water users and even municipal-water users to improve irrigation efficiency," said Craig Runyan, water quality specialist with NMSU's Cooperative Extension Service. "This initiative will help better define current irrigation practices in the Rio Grande Basin and generate new information to improve efficiency. We will disseminate all our findings to the public in practical ways that directly impact water use in the region."

Runyan said the initiative will focus on five areas: water reuse, water conservation practices, water quality, ecological water uses that impact irrigation and use of satellite imagery and remote sensing technologies.

The U.S. Department of Agriculture approved a three-year, $2.6 million grant to finance the projects under the initiative in New Mexico and Texas, with about $800,000 earmarked for New Mexico. New Mexico's share will be divided between research conducted by NMSU's Agricultural Experiment Station and educational outreach through its Cooperative Extension Service. Awards for specific projects will be chosen from NMSU faculty proposals in August and work will begin in the fall, Runyan said.

A broad variety of projects are under review. Some proposals include research and education about municipal wastewater treatment plants to irrigate farms and turf on golf courses and parks, efficient irrigation scheduling based on water requirements for specific crops, and studies of water rights policies to recommend incentives for conservation.

Other proposals include efforts to reduce water salinity to improve crops, promote integrated pest management techniques that lower the risk of contamination from fertilizers and pesticides, and research on the water needs of endangered species such as the silvery minnow to determine potential benefits and disadvantages of instream flow requirements.

The projects will be administered independently in each state, but NMSU and Texas A&M will cooperate wherever possible.

*NMSU University Communications*

(continued from page 3)

on to New Mexico. The Compact schedules thus specify a right for Colorado which is not too dissimilar to a senior right for about 70 percent of the Rio Grande inflows to Colorado.

New Mexico's obligation is to water users below Elephant Butte Reservoir. While flows to satisfy these downstream uses are typically called "Texas" water, the majority is actually used by irrigators in the state of New Mexico. The upstream water right for New Mexico starts at 43 percent of inflows, but rapidly decreases with inflows, reaching a maximum "right" of 395,000 acre-feet at approximately the mean inflow level. Thus New Mexico's rights under the Compact are very similar to a senior water right of about 400,000 acre-feet annually. (In addition, New Mexico has the sole right to use imported San Juan - Chama inflows of nearly 100,000 annually).

... increasing these conjunctive use capabilities in the state of New Mexico could play a role in reducing losses during drought, though the costs of developing and maintaining the necessary additional pumping capacities may not in all cases justify benefits.

The Rio Grande Compact does not specify the disposition of "Texas" water. Bureau of Reclamation contracts for use of water from Elephant Butte Reservoir lead, however, to water users in the state of Texas receiving about 43 percent of available supplies, while those in the state of New Mexico (Elephant Butte Irrigation District) receive about 57 percent. In addition, Mexico receives, by treaty, 60,000 acre-feet annually.

A baseline is needed to address the basic research hypothesis, that new institutions for coordination of surface water withdrawal, groundwater management, and reservoir operations, could limit damages during drought conditions. I term this baseline the "Law of the River." It incorporates not only the operation of the Rio Grande Compact, but equally importantly water allocation, including the use of groundwater, within each of the three states. Modeled impacts of drought under the baseline then serve as a basis of comparison for the performance of alternative institutions.

I will briefly discuss four alternative institutions, and the general performance of each in comparison to the baseline "Law of the River." I will restrict myself here to institutions consistent with the Compact. While damages from water shortages could perhaps also be reduced through Compact changes, any alteration of the negotiated Compact would be exceedingly difficult at best. I am most interested here in addressing the more likely innovations which are possible at the state, or even local level.

The first alternative looks at increasing coordination of surface and groundwater usage. The Upper Rio Grande has extensive groundwater resources. These include both large quantities of deep groundwater (present but only lightly used in the San Luis Valley of Colorado, and present and used by Albuquerque and El Paso), and extensive regions of shallow groundwater. This latter type of groundwater is successfully utilized in the San Luis Valley to mitigate the impacts of limited surface water storage; in low flow years it is extracted to supplement surface supplies, and in high flow years the aquifer is intentionally recharged by surface water. This conjunctive use capability is partially developed by New Mexico's Elephant Butte Irrigation District, and to a much lesser extent by the Middle Rio Grande Conservancy District in central New Mexico, and by Albuquerque. I can demonstrate that increasing these conjunctive use capabilities in the state of New Mexico could play a role in reducing losses during drought, though the costs of developing and maintaining the necessary additional pumping capacities may not in all cases justify benefits. Conjunctive use strategies may also involve aggressive use of Albuquerque and El Paso deep groundwater resources during drought, with corresponding increases in surface water use during high flow periods. A word of caution, however: with increased groundwater pumping capabilities in place, there would be incentives to use and draw down groundwater even during normal years, leading to reduced return flows to the river during drought years – exactly when those flows are most needed!

A second alternative addresses increasing the efficiency of irrigation practices. For example, it is often noted that diversions to satisfy irrigation in the Middle Rio Grande Conservancy District may exceed 10 acre-feet per acre annually. With a consumptive use demand by crops of only 2-3 acre-feet annually, the proportion of diverted water actually supporting crop growth is very small. Diverted water not consumed by crops either percolates to the shallow groundwater, or returns through drains to the river. I find that a general increase in irrigation efficiency which

*(continued on page 15)*

reduces the annual diversion to 8 acre-feet per acre does little to reduce overall drought damages. The reasoning is clear: percolation to the shallow groundwater causes increased river flows within a period of only a few years, while return flows through drains are immediately available to satisfy downstream demands. I do find that increased irrigation efficiency can substantially increase instream flows under very specific circumstances. First, for short time periods reductions in diversions would make available for instream flows water (temporarily) lost to percolation. Second, if drains bypass a river reach where instream flows are critical (as with the endangered Silvery Minnow above Elephant Butte Reservoir), then reducing diversions will tend to increase flows in these reaches.


*Figure1. Typical annual flow changes, and off-stream depletions to river flows along the course of the Upper Rio Grande.*

The third alternative considers management or structural changes to increase carryover storage. This alternative is found to provide few benefits during the flow sequences which we examined. The primary limitations on New Mexico use in particular is the Compact limitation on use of inflows in any particular year. Adequate storage capacity is available in Elephant Butte Reservoir to capture deliveries for use downstream. While there may be some advantage in reduced evaporation losses to transferring storage from Elephant Butte to upstream reservoirs, this was not examined due to its difficulty of implementation under the Compact.

The fourth alternative considered an expansion in the use of water markets, particularly under anticipated future demand conditions (resulting from population growth). Under the baseline scenario, Albuquerque satisfies future demand growth through construction of facilities to utilize its right to consumptively use 48,200 acre-feet of San Juan-Chama water annually, plus a modest increment of native Rio Grande water currently used for irrigation. Otherwise, Albuquerque is limited to groundwater use. In the baseline "Law of the River" El Paso utilizes future purchases to increase surface water capacity, an element of the city's stated water development planning, and a strategy already demonstrated by market purchases of surface water from the local irrigation district. But these purchases do not provide for a secure senior right; instead the purchases provide El Paso with a proportion of irrigation district supplies. A water market policy alternative considers both Albuquerque purchases of additional (senior) surface water supplies, and El Paso purchases to upgrade its rights to senior rights. In each case, such market purchases result in a reduction in reliance on pumping nonsustainable, deep groundwater at modest cost.

In each case, such market purchases result in a reduction in reliance on pumping nonsustainable, deep groundwater at modest cost.

The approach of integrating the legal, economic, and hydrologic environments in a quantitative model allows me to demonstrate that substantial reductions in drought damages are possible for the Upper Rio Grande. While losses may be inevitable in a region of scarce and highly variable water supplies, the level of these losses can be greatly reduced. Most important in the Upper Rio Grande Basin is expansion of coordinated conjunctive use, and the selective use of markets to address municipal reliance on nonsustainable groundwater.

A report on the full project, *Institutional Adjustments for Coping with Prolonged and Severe Drought in the Rio Grande Basin*, New Mexico WRRI Technical Completion Report No. 317, is available from the institute. The report includes the model on CD-ROM. The report also is available via WRRI's homepage at wrri.nmsu.edu. The authors of this collaborative effort are Frank Ward, Robert Young, Ronald Lacewell, J. Philip King, Marshall Frasier, J. Thomas McGuckin, Charles DuMars, James Booker, John Ellis, and Raghavan Srinivasan. Funding was provided by the U.S. Geological Survey, with supplemental support by the Water Resources Research Institutes, and the Agricultural Experiment Stations of the three states.

# 46th Annual New Mexico Water Conference Registration Form

To register for this year's Water Conference, please complete one form for each person. Make check payable to NMWRRI. Return this form with payment to:

Water Resources Research Institute
NMSU - MSC 3167
Box 30001
Las Cruces, NM 88003

For the Early Bird **best** rate, registration must be received by **September 21, 2001**. Registration after September 21 until November 1 is $175. After November 1 and at the door, registration is $200. The registration fee will be refunded if written notice of cancellation is received by October 26, 2001. A $25 cancellation fee will be charged.

The full registration fee includes the day-and-a-half conference, optional tours on Monday, all breaks, box lunch on Tuesday, Tuesday evening's reception and banquet, and a copy of the proceedings to be published after the conference.

Please check the following boxes that apply:

- ❒ Registration $125 before September 21, 2001
- ❒ Registration $175 from September 22 to November 1
- ❒ Registration $200 after November 1 and at the door
- ❒ Student registration $40 before September 21, 2001
- ❒ Student registration $50 from September 22 to Nov. 1
- ❒ Student registration $60 after Nov. 1 and at the door
- ❒ Luncheon ticket(s) for guest(s) $20/guest
- ❒ Banquet ticket(s) for guest(s) $40/guest

Choose ONE of the following optional tours scheduled for Monday, November 5, if you are interested. Transportation from La Fonda to the tour sites will leave at 2:00 pm and should return to La Fonda by approximately 5:00 pm.

- ❒ I will not be attending a Monday afternoon tour.
- ❒ I would like to attend the Cerro Grande Tour
- ❒ I would like to attend the Bernalillo Watershed Tour

Name _____

Affiliation _____

Mailing address _____

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email _____

- ❒ Tuesday evening's banquet is included in the registration fee. **Please check the box if you plan to attend**.
- ❒ Check enclosed payable to NMWRRI
- ❒ Purchase order number _____ enclosed
- ❒ Charge my credit card no: _____

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