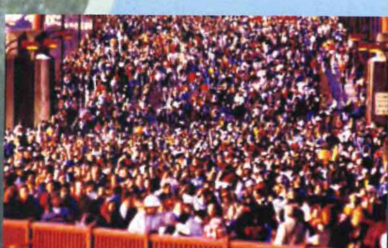
Diving Rod

Vol. XXXIII, No. 3 • November 2010

Page 5 Tom Maddock conducting research at WRRI



Page 6 2010 Water Research Symposium plenary talk

Page 11 Upcoming annual water conference program

Desalination Researchers See Community Use as Key Goal

By Will Keener, WRRI

New Mexico State University researchers are chipping away at the secrets of a promising water desalination technology for use in rural communities. Graduate students from NMSU's Chemical Engineering Department are cooperating on the project through the Institute for Energy and the Environment (IEE) and WERC, a consortium for environmental education and technology development. Most of the work has been accomplished at the U.S. Bureau of Reclamation's Brackish Groundwater National Desalination Research Facility (BGNDRF) in Alamogordo, New Mexico.

Researchers reported on the work this summer in Socorro, New Mexico, at the Water Resources Research Institute's (WRRI) annual Water Research Symposium. Several papers and posters addressed the effort to better understand the Electrodialysis Reversal (EDR) process for desalination of brackish waters.

NMSU graduate students work with a hybrid experimental Electrodialysis Reversal (EDR) unit at BGNDRF. The unit is designed so various inputs and components in the desalination process can be varied and results measured. (Photo by Karen Mikel)

"Treating native brackish water has the most potential for acquiring 'new water' for New Mexico," said Karl Wood, WRRI director. Brackish water in general contains more salts than freshwater, but fewer than in seawater. In New Mexico and other arid inland areas,

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Divining Rod

Published by
The New Mexico Water
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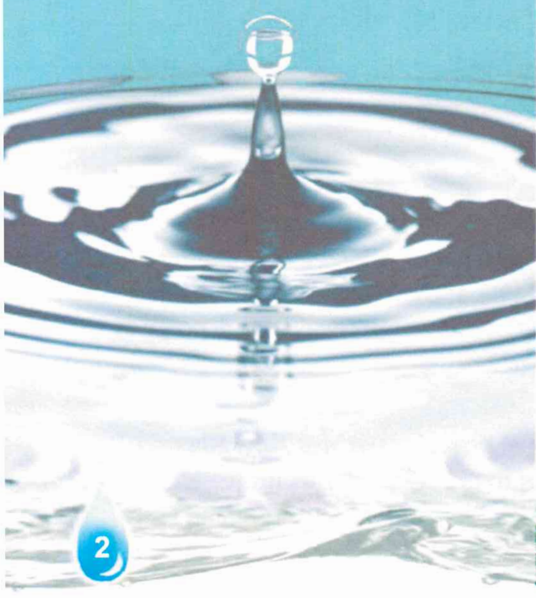

2010 Water Conference Tour and Reception

Brackish Groundwater National Desalination Research Facility, Alamogordo, New Mexico

Wednesday, December 1, 2010
1:00 – 5:00 pm

Tour participants will meet at the Fulton Center parking lot on the NMSU campus at 1:00 pm. The afternoon will begin on the NMSU campus where participants will have an opportunity to tour research plots on which brackish water is being applied to turf grasses. Buses will then transport participants to the facility in Alamogordo and will arrive back NMSU around 5:00 pm. A reception in the Barbara Hubbard Room at the Pan Am Center will follow the tour.

The Brackish Groundwater National Desalination Research Facility is a focal point for developing technologies for the desalination of brackish and impaired groundwater found in the inland states. This facility brings together researchers from other federal government agencies, universities, the private sector, research organizations, and state and local agencies to work collaboratively and in partnership. The mission is to pursue research into supply-enhancing technologies for brackish groundwater including solutions to concentrate management, renewable energy/desalination hybrids, desalination technologies for produced water, and small-scale desalination systems.

Participants will view and learn about the skid-mounted water purifier that was used for a hospital in Biloxi, Mississippi following Hurricane Katrina and that was on standby for Haiti. Water desalination apparatus being developed by entities such as NMSU, General Electric, the Bureau of Reclamation, and others will be highlighted.

Reception, Barbara Hubbard Room Pan Am Center, New Mexico State University

Wednesday, December 1, 2010
5:00 - 6:00 pm

Free Basketball Tickets

The WRRI has free women's basketball tickets available for the evening of December 1, 2010 when the NMSU Aggies take on the UNM Lobos. If you will be attending the annual water conference, just let us know that you'd like a ticket (575-646-4337). Be sure to join us at 5:00 pm that afternoon in the Barbara Hubbard Room at the Pan American Center for a reception that follows the conference tour. The game starts at 7:00 pm in the Pan American Center.

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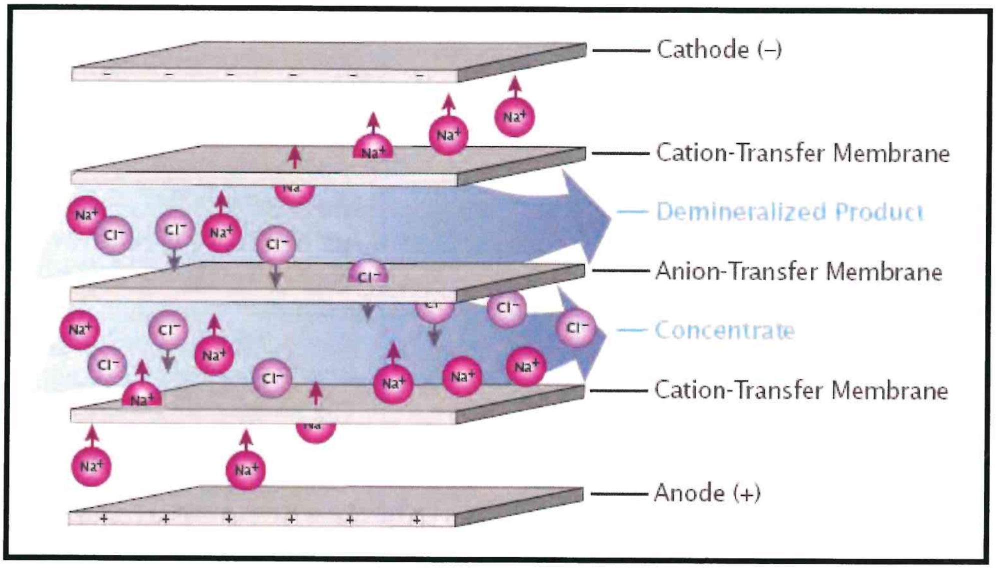
large underground reserves of water have not been tapped because of the salinity.

Brackish water is sometimes referred to as "new water," because it has been ignored in the past as unusable. In New Mexico, about 75 percent of all groundwater is brackish, according to one estimate from the Office of the State Engineer. The Tularosa Basin, anchored by Tularosa and Alamogordo, contains roughly one billion acre-feet of brackish water, enough to serve present municipal needs there for the next 2,000 years.

It costs about $3.00 per 1,000 gallons to treat brackish water in large municipal systems like El Paso, but for small communities, costs are many times greater because of many unknowns such as different water chemistries and the need to manage the salts, or concentrates, removed during treatment. "New technology is needed to make desalination affordable for small communities and individual homes, such as on ranches and tribal lands," said Wood.

"Our thought initially about any association with the Bureau of Reclamation was that the research should be dual use. It should be applicable to small communities as well as to any sponsor's needs," said Abbas Ghassemi, IEE director and faculty advisor for the research. "This technology (EDR) is not 100 percent commercially deployable at this time, but pre-deployable," said Ghassemi. "If we can get units with 7 to 30 gallons per minute to work with different water chemistries, the system can be used in community settings," he said.

Currently, reverse osmosis is the most common treatment method, but alternatives are needed, said Wood. When developed for various water chemistries, EDR has the potential to be a great addition for !brackish water treatment. It will potentially provide higher water pass-through, at lower operating costs and maintenance for small and medium size users interested in treating brackish water.



This diagram shows how a current moves dissolved salt ions through a "stack" of alternating positive and negative exchange membranes, where they are removed from the solution. At regular intervals, the direction of ion flow is reversed by reversing the polarity of the applied current.

EDR is based on the behavior of solutions with dissolved salts when subjected to direct current, explained Lakshmi Pradeepa Vennam, a graduate student in the project. EDR performance is evaluated by two measures: separation percentage (SP), the amount of salts removed from the feed stream to obtain potable water, and current efficiency (CE), the efficiency with which ions are moved across exchange membranes for a given current. Vennam studied the influence of temperature, flow-rate, and voltage on these two measures. Experiments were conducted at rates of 7, 9, and 11 gallons per minute, temperatures of 15 and 30 degrees C, and voltages of 15, 25, and 35 volts.

In her first round of experiments, she reported that higher temperatures led to improvements in both measures. Higher temperatures also prevent damage to the membranes and increase their lifetimes. On the downside, heating the water is expensive and creates more evaporative loss. Her flow-rate experiments show that lower rates reduced scaling and fouling. Higher flow-rates reduce the amount of salt removed, because of insufficient time for ion exchange. Voltage increases cause both salt removal and current efficiency to go up to a point, after which they drop. Current inefficiencies and higher power requirements present problems for the technology, she said.

Using concentrated solutions of sodium, magnesium, and calcium, Vennam also noticed differences between bivalent and monovalent ion separation at

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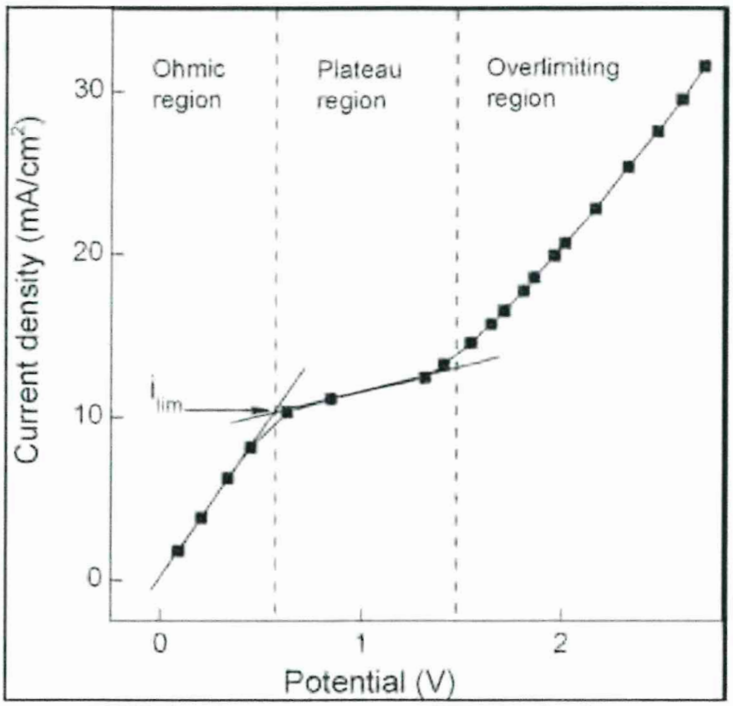
various temperatures. The separation of the doubly-charged, or divalent ions, increased probably because of a higher mobility of these ions in water, she said. After a second round of testing, she hopes to move to a pilot test of the technology.

Purnima Praturi, also a graduate student on the project, is using a mathematical model to predict energy consumption by EDR. Models developed previously were based on solutions with equal numbers of positive and negative ions, while Praturi's work makes use of experimental data using actual brackish groundwater. Praturi developed modeling equations to predict current, based on different concentrations of source water, and energy consumption. She validated these predictions with experiments at different current levels and different temperatures. One thing the models show, she said, is how important the spacers in the stack are for determining efficiency.

Graduate student Ramya V. Chintakindi is looking at optimal current levels for EDR. Although suitable voltages for removing salt can cover a wide range, costs and other factors dictate that power levels be optimized. Chintakindi's approach is to determine what current achieves maximum salt separation.

Using a pilot setup at the Bureau of Reclamation's Alamogordo facility, she varied concentration of salts, flow velocity, temperature of the feedwater, and applied voltages to study salt removal. She described a three-mode reaction curve (see diagram) of current climbing linearly, leveling, and then increasing again, as power (voltage) levels increased. This reaction curve has a deflection point marking the transition from the linear ohmic region to the plateau region; the density at this point is called the Limiting Current Density (LCD, labeled i_{lim} in the diagram), which is the focus of her studies. She is studying the effect of temperature, flow-velocity, and concentration changes



Typical example of a current-voltage curve, reflecting the relationship between the current through a membrane and the corresponding voltage drop over that membrane and its boundary layers. (P. Dlugolecki et al./J. of Membrane Science 346 (2010) 163-171)

on the LCD to better understand relationships among all the variables. Understanding these relationships is essential for end-cost reduction when operating at large municipal or industrial scales, she said.

The experimental results showing relations between temperature, flow-rate, and concentrations of feedwater were calculated empirically because there are no previous equations with these particular water conditions. Significant to these experiments is the fact that previous research was confined to lab-prepared samples with deionized water or seawater, while Chintakindi's work examined multi-salt solutions of brackish water.

In a related project, graduate student Venkat Ravi Kiran Paruchuri is addressing the question of what to do with concentrate removed in the EDR process. Paruchuri examined the possibility that some species of algae might be compatible with concentrates recovered in the EDR process. If so, the concentrate could be used to create biofuel stock or for other applications. Total dissolved solids in brackish waters can range from 1,200 parts per million (ppm) to 6,000 ppm, Paruchuri said. The concentrate from EDR has dissolved solids ranging from 3,000 ppm to 16,000 ppm. His initial screening compared the growth media of the algae species with the water chemistry of the concentrate to identify any growth inhibitors in the concentrate. His goal is to follow up the initial work with experiments.

"At the end of the day, we need a combination of answers to questions that will make this technology affordable and applicable for small users," said Ghassemi. "Communities with high calcium or sulfate will want to know the effects of temperature and pH on the system, or if pretreatment will help. These are the kinds of questions we're looking at."

Tom Maddock Spending Sabbatical at WRRI

By Will Keener, WRRI

At age 38, Tom Maddock made a career-changing decision, although he continued to surround himself with the mathematics of groundwater – creating better models of basin waters and their interactions with surface water and the environment. He made a break from an already accomplished path that was leading him toward an administrative role with the U.S. Geological Survey (USGS) on the east coast, and decided instead to pursue a career of research at the University of Arizona (UA).

Now, thirty-three years later, Maddock, who earned both his master's and PhD degrees at Harvard University, is a recognized member of the water research community throughout the Southwest. His ongoing research interests involve groundwater capture, including the hydrologic processes, the institutional implications, and the computational tools needed to better understand it.

Maddock has been called as an expert witness and served as a negotiator and advisor in water disputes involving Texas and New Mexico on the lower Rio Grande. He has served as co-director of the University of Arizona Research Laboratory for Riparian Studies and as deputy director of the National Science Foundation's Science and Technology Center for Sustainability of Semi-Arid Hydrology and Riparian Areas. He also continues to teach, is a past chair of UA's Department of Hydrology and Water Resources, and has helped numerous graduate researchers gain a footing in the field of groundwater modeling.

This semester Maddock is working in residence at the New Mexico Water Resources Research Institute to expand groundwater modeling of the lower Rio Grande basins across the international boundary into Mexico.

Maddock's father and grandfather both had ties to Arizona: his grandfather was State Engineer during the 1920s and his father was a world famous geomorphologist. Maddock quickly settled into his work at UA studying groundwater resources in several southwestern basins. He chose groundwater during his USGS days, when his father was also working for the agency in surface water. "Groundwater moves very slowly," he explains. "So I tell people that it will be 70 years before they find out I was wrong."

His research on the Rio Grande dates to 1985, when a Harvard classmate involved him in efforts to model the Hueco Bolson as part of a hearing process involving the state of New Mexico and the City of El Paso, which sought pumping permits in the New Mexico part of the basin.

He worked on a Mesilla Basin model in 1987 with two engineers and a half dozen grad students as well as a post-doctorate student to answer questions raised by the Elephant Butte Irrigation District and others. By the early 1990s, he was working on a new model for the New Mexico-Texas Settlement Commission that was eventually adopted for well permitting by the New Mexico Office of the State Engineer

(OSE). In 1996, he began an effort to extend the model to the Mesilla and Rincon basins. The model is still in use by the El Paso County Water Improvement District #1.

By the early 2000s, Maddock had become an advisor to the OSE and was involved with several committees. The OSE worked with a team to update the most recent model, using data from geologist John Hawley. "We removed a 'net irrigation' feature of previous models," Maddock said. Using knowledge of how much water would be needed for irrigation along with calculations of how much of it would be returned to the basin, the new model established historical supplemental pumping levels, breaking out for the first time amounts pumped to meet crop requirements.

As more legal battles between Texas and New Mexico brewed, following a successful Texas suit in a Pecos River case, Maddock found himself providing technical assistance and support for a new project. The total cost of the Pecos

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2010 Water Research Symposium Draws 120 Participants

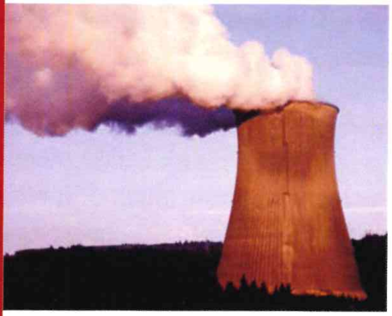
The annual New Mexico Water Research Symposium was held in August 2010 at New Mexico Tech. This year, 120 participants attended the day-long symposium, which included 45 students, many of whom presented papers and posters. All poster and paper abstracts are available online at http://wrri.nmsu.edu/conf/tc10/symposium.html.

The 2010 symposium was dedicated in fond memory of Dr. Bobby J. Creel, longtime staff member of the WRRI. Dr. Creel was instrumental in developing the annual symposium and was involved in all aspects of the WRRI for over 30 years.

This year's meeting opened with a presentation, included directly below, by Dr. Howard Passell, a member of the symposium planning committee since its inception in 2002. Dr. Passell is on the staff of Sandia National Laboratories, a cosponsor of the annual gathering. The theme for this year's symposium was "Resource Interdependence."

Resource Interdependence

Plenary Talk by Howard Passell, New Mexico Water Resources Research Institute Annual Symposium, Aug. 3, 2010



A guy is standing on the roof of his porch, flood waters up around his waist. A boat comes by and the rescuers say, "Come aboard, we'll take you to safety." But the guy on the porch roof says, "No, God will provide." A little while later the guy is up on the roof of the house, flood waters still rising, and another boat comes by and the rescuers say, "Come on, we'll take you to safety." But the guy on the roof says, "No, God will provide." Finally the guy is standing tippy toes on the top of the chimney, and a helicopter comes by and they yell, "Here, grab this, we'll take you to safety." You know what the guy says. So a little while later, the guy is standing at the Pearly Gates, and he says to the angel, "What happened? I thought God would provide?" And the angel said – "What do you want? We sent two boats and a helicopter!"

That story was told to me back in the early '80s by someone I thought of as a wise friend as I was heading off to live for a year in the rainforest of Borneo. It was a warning, an admonition to pay attention, and I've thought about it many, many times in the years since then. It has often reminded me to be attentive to the signs and messages that are out there, and to ask myself, what am I missing, and by extension, what are we, as a broader community, missing?

These days I think there is a very clear message being offered up to us, but we're not getting it. Let me take a few minutes to lay out some of the different parts to this message.

First, humanity is riding on three very important, large-scale, long-term trajectories. The first is increasing population, which is headed to 8 or 9 billion in the next few decades. The second is increasing resource consumption. Everyone in the world wants three cars in the garage and a TV in every room – and the health and security that goes along with wealth like that. The third is decreasing resource availability – whether that resource be freshwater, oil, wheat reserves, fertile soil, forests, fisheries, atmospheric resilience, ecosystem services in general, or even the ability of our bodies to carry loads of synthetic chemicals, endocrine disruptors, and carcinogens.

And all of these trajectories are interdependent.

For example:

- We can't feed the increasing populations without increasing water and energy consumption. Some of that water will be for irrigation, but some is for making the energy to pump the water. And we will need petrochemicals, energy, and water for producing fertilizer, pesticides and herbicides, and then yet more water for diluting the waste.

- Another interdependency: We will need to bring more land, some of it marginal, into cultivation for agriculture, which will have an impact on deforestation and soil erosion. Additional fertilization further increases the nutrient loading in rivers that in turn expands the area of hypoxic zones in coastal areas around the world – in those increasingly rare places where major rivers still have enough water to flow to the sea.

- Another interdependency: We will need more and more oil to power the farm machinery that helps grow the food, and the trucks, trains and planes that move it. All the easy oil has been found, so we will be drilling in more and more difficult and dangerous places, so we'll have more oil spills and more oil wars. (And if you think that the recent spill in the Gulf has been a disaster, look into the decades-long and ongoing spills continuing now in the Niger Delta and the Amazon Basin.)

- One more interdependency, related to renewable energy technologies: We may end up with more corn and sugar cane being grown for fuel than for food, placing upward pressure on global food prices and leading to more food riots. Or maybe we'll end up with our horizons and all our spare acreage filled with wind turbines and solar collectors, which won't be so attractive once the novelty wears off and we realize they are simply fueling overconsumption and utility company profits. And on top of it all, we may end up in regional or international conflicts over the rare earth minerals that are required for making all these technologies run.

These three interdependent trajectories – increasing population, increasing resource consumption, and decreasing resource availability – are the big drivers right now. They've been playing out for a long time, in an increasing number of places around the world, and they are hard to change. But they have brought us all to a very unique point in human history. For the first time we have sufficient scientific knowledge of the past, a sufficient view of the big trajectories and where we are on them, sufficient computing ability, and sufficient social/intellectual/professional approaches to make reasonable projections of those trajectories into the future. We can see where we have come from, and where we are headed, and how our efforts and activities may affect the future. This new vantage point has brought us great insights – but we're still missing some of the most important messages.

Climate change, for example, is a long-term trend we can now see and understand. It is a good wake-up call. But in my view climate change is only the crisis *du jour*. It's an instructive crisis, since it integrates so nicely across so many interdependent systems – population growth, energy demand, atmospheric chemistry – and in fact, it may be one of the most important challenges of our time. But it isn't an independent phenomenon, and we won't solve it, I believe, in any reasonable time frame, by carbon sequestration, or by burning ethanol or algal biodiesel instead oil, or by putting solar panels on 3,000 square-foot houses full of electronics and appliances. Climate change is a sign, and it's pointing at a fundamental problem, and I believe we won't solve climate change without addressing that fundamental problem first.

That fundamental problem, in my view, the message being delivered to us, is that we're all just using up too much stuff, too quickly.

I think one of the best examples of us not getting that message, not seeing the signs, is that we are feverishly trying to figure out how in the future we will meet projected water, energy, and food demands in what we project to be our ever expanding human economy. This, in my view, is foolishness, in the most literal sense of the word. How can we expect to meet an ever expanding demand in a world of limited resources? New Mexico water issues offer a great case in point. Our water is already over-allocated, but growth projections just keep pushing projected water demand up. That water, in the short term at least, will come from agriculture, whether we like that or not. The middle Rio Grande Valley was once food self-sufficient, as recently as the 1950s I have been told, but no more. If water scarcity in other regions (like California's Central Valley) keeps worsening, and rising transportation costs drive food prices up, then we may be facing our own kind of food security issues right here.

Fossil fuels offer another important example of us ignoring the signs. It seems abundantly clear that a very large part of the material wealth of the developed world – the roads, bridges, hospitals, high-rise cities and overstocked mega-stores, our food supplies, transportation and shipping, even our educational systems, colleges and universities, and health care systems – are all products of cheap fossil fuels. Sure, we can credit human ingenuity and human enterprise – but the power for industrialization, and research and development, and our skyrocketing population and consumption has come from cheap gas, coal, and oil. And now oil availability, like so many other resources, is on the decline. There is nothing, so far, that can replace oil, nothing so full of energy, so fungible, so easy to get out of the ground (at least up until recently), and so easy to move around and sell. The decline of oil availability – leading to ever deeper wells in ever more dangerous places is a sign.

The study of ecology and even of human history is replete with the stories of systems that expand, over consume resources, and then collapse. Ecologist Thomas Park in the 1940s showed that in beakers filled with flour the predator flour beetles would always consume all the prey flour beetles, and then go extinct themselves. Something like that happened on Easter Island, and it happens when microbial populations deoxygenate a eutrophied pond – and there are numerous other examples. We understand this boom and bust cycle now. And yet as a nation and as a global community we are hell-bent on continued economic expansion. Our addiction is not to oil. Oil is the enabler. We are addicted to increasing consumption.

There's no water crisis, there's no energy crisis, there's no climate crisis, there's no food crisis. We're facing an overall ecological crisis on this planet that is manifesting in the decline of all our resource systems, all at the same time, and all because of our general, long-term overconsumption of all resources. We are seeing declines in ecosystem services around the world. Ecosystem services are those provided free of charge by well functioning ecosystems to human systems, and in fact to all biological systems. They include the delivery of fresh water and fresh air, maintenance of soils, fisheries, forests, and the composition of our atmosphere. We're seeing declines in all of these specific systems, but if we focus on each of those systems independently, then we are missing the point.

There are lots of solutions. Let me identify a few.

Increasing women's rights and increasing education for women around the world reduces population growth. Family planning around the world reduces population growth. These are no longer solutions that we have the luxury to avoid, or marginalize, or politicize. Population growth and its concomitant consumption, fed by ever increasing material throughput of raw materials and other critical resources, increasing wastes, and the erosion of the natural capital with which we have been endowed – these are issues of U.S. national security, of global security, of our own personal well-being and that of our children.

More solutions: We need to be moving more strongly toward cradle-to-cradle design and production, so that everything that is designed and built can be taken apart later on, recycled, and reused, with close-to-zero waste streams. We need to be working hard on co-location technologies, so that waste streams from one process become feed stocks for the next. Using urban wastewater to grow algae as a feedstock for transportation fuel and other products is one application like that – although the viability of algae for those uses is still far from proven. Goods and services must be priced so that they reflect the true consequences of their production and consumption. We need to move beyond the corporate ethic in which capital pursues the greatest economic return, regardless of the consequences to ecosystems, social systems, indigenous populations, and cultures all around the world. And we must not allow corporations to take on the rights of individuals.

More solutions: We need to be actively working toward a steady-state economy, outlandish as that may sound – one that isn't constantly demanding more and more throughput of everything. Economist Herman Daly writes eloquently about steady-state economies. We need to figure out how to get by on less material wealth, less travel, less freedom to consume. Moving into the future with the idea that our economies can continue growing, that our consumption of all resources can continue to increase indefinitely, is absurd, and probably disastrous. The signs are all pointing that way.

This point of view, if you buy it, brings up all kinds of sticky, personal questions. Should we eat meat? (I do.) Should we fly across the country or around the world for work, or conferences, or vacations? (I do.) When my daughter wants me to drive her to a swimming pool half an hour away, should I take her, or tell her no? Should I buy a new, lighter mountain bike? At a higher level, how should we design and re-design our homes, offices, factories, cities, transportation systems? Should we be designing them like some technological breakthrough will allow us to continue constant growth, which is good wishful thinking – or should we be designing them with our eyes wide open to the large scale trends that will likely have impacts on ourselves, our children, and grandchildren?

Reducing consumption is not a popular idea. It might even be "un-American." What politician can run a campaign on the idea that we will be less materially prosperous in the future than we have been? We must 'transcend consumerism,' but that doesn't mean that we need to be worse off. This is the great challenge. Can't we all imagine a life with fewer LED lights glowing in the night, fewer miles driven or flown, less effort and stress over maintaining a life so far from thermodynamic equilibrium? I'm not talking about reducing our quality of life. I'm talking about breaking the link between increasing quality of life and increasing consumption. The two do not have to be correlated, but we are very used to thinking of them that way.

I'm not being self-righteous when I make all these arguments. My lifestyle is part of the problem, and I feel pretty locked into it. But I do believe that all together we shape the world we live in, everyday, and that for the world to change, our idea of it has to change. How do we get there? Do we have the imagination, and to what extent do we have the power and control to get ourselves there? Must we be victims of our own evolution? Are we nothing more than flour beetles that walk upright? In my view, these are the deepest issues associated with "resource interdependence" – the interconnections between resources, ecosystems, humans, and our view of the world. It seems quite likely that we are all moving into a future of less wealth. If so, will we make the move gracefully, and in a creative and peaceful fashion? Will we use all our humanity and our wisdom to anticipate it, and plan for it?

We cannot wait for others to address these issues. I studied science because I felt like it is one of the most important drivers in the evolution of our material world. It is science and engineering that gives us some of the insight, some of the understanding, and some of the tools with which we can solve these problems. I am not advocating a new technological fix for the problems created by our last technological fix. Some technological fixes can help, but not by themselves. I remember 15 years ago a big issue in the field of conservation biology was whether or not scientists should be outspoken advocates for conservation – but as the loss of biodiversity continues unabated, as ecosystem function declines at all scales, that discussion has simply evaporated. We, the scientific community, must be pursuing solutions at all scales, communicating those solutions to policy makers and the public, and advocating for the visions and perspective that our work on resource management issues has given us. We mustn't be guilty of rearranging the deck chairs on a sinking ship.

We live in a world of disinformation, misinformation, deceptive advertising, political double speak and, excuse me, just plain bullshit. The world is in desperate need of truthful leadership. Where on Earth will that come from? The only answer I have is that it must come from all of us, from the bottom up. The responsibility falls on all of us.

I know that history has been full of prophets in sack cloth and ash forecasting gloom and doom, and this talk has had plenty of that – maybe too much. But I want to emphasize that the bleak terms in which I'm describing all these trajectories are certainly not set in stone. I and others who see them could be wrong, and even if we aren't, there could be technological advances, or spiritual or cultural advances, or other kinds of non-linear developments that change things very quickly in positive, creative, peaceful ways. But here's an important point. If we assume that all our future projected demands can and will be met, if we assume that our ever increasing conversion of natural resources into human goods and services can continue, if we assume that our economies can continue to grow indefinitely, and if we are wrong, then we may find ourselves in big trouble. If we work harder now to create more balance, then we will all be better off no matter what the future may bring.

So, in closing, perhaps we are at a momentous time in human history. We can look back, we can see the big trajectories, and we can look forward and see where we are headed. A myriad of crises are popping up at all scales all around the world, and we are treating them as if they are independent of each other, but they are not. In fact they are all signs and symptoms of our real ailment – and that's our dramatic overconsumption of all resources, and our blind faith that the economic bubble that has been expanding for the last hundred years or so can go on expanding indefinitely. If we think it can't, then is there any way to change the trajectory we're on – technically, socially, philosophically – or are we just along for the ride? To what extent can we take control of our future? It may be a very hard thing to do, but the least we can do is broaden the discussion.

Thank you all very much for letting me have this opportunity.

Howard Passell's work focuses on conservation, sustainability and resource management projects associated with water, energy and food resources, with an emphasis on the links between those and other systems, including ecosystems, demographics, economics, public health, and governance. His work has involved resource monitoring, modeling, management, capacity-building, and policy-related projects at various scales in the U.S., Central Asia, the Middle East, and North Africa. He works in the Energy, Climate and Infrastructure Security Center at Sandia National Laboratories, in Albuquerque, New Mexico. His undergraduate studies were in the liberal arts. He earned master's and doctorate degrees in conservation biology and hydrogeoecology at the University of New Mexico, and lives on a small farm with his wife and daughter in the Rio Grande valley north of Albuquerque.

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

55th Annual New Mexico Water Conference

Water Needs in the Next Decade: How Will Institutions Evolve to Meet Our Water Needs?

http://wrri/nmsu/edu/conf/conf10/conf.html

Wednesday, December 1, 2010

Tour of the Brackish Groundwater National Desalination Research Facility in Alamogordo. Hosted by WRRI Director **Karl Wood** and NMSU's Institute for Energy and the Environment Director **Abbas Ghassemi**

Reception at Barbara Hubbard Room, Pan Am Center, NMSU

Thursday, December 2, 2010

8:30 Welcome
Karl Wood, WRRI Director
Barbara Couture, NMSU President

8:45 Tribute to Bobby J. Creel
Associate and Interim Director
WRRI 1986-2010

9:00 The Future of Water Adjudications in New Mexico
Judge Jerald Valentine, Third Judicial District Court
Greg Ridgley, OSE

9:50 Sandoval County Plans for Future Growth: Rio Puerco Desalination Plant
Guy Bralley, Sandoval County

10:15 **Break**

10:45 Challenges When Combining Mutual Domestic Organizations to Meet Community and Colonias Water Needs
Martin Lopez, Lower Rio Grande Public Water Works Authority

11:15 Interbasin Transfer Projects: Impacts on Communities and Ecosystems
Bruce Thomson, UNM

11:45 How Santa Fe Plans to Meet its Growing Water Demands
Claudia Borchert, Sangre de Cristo Water Division

12:15 **Luncheon**

The Future of Our Water Agencies: Do We Have the Right Agencies Doing the Right Things?
Bill Hume, journalist and formerly with Governor Richardson's staff

1:30 Permanent Storage at Elephant Butte: Meeting the Needs of Recreationists
Neal Brown, Marina Del Sur, Rock Canyon Marina and Damsite Resort at Elephant Butte Lake

2:00 The Benefits of Restoring Our River Ecosystems
Beth Bardwell, Audubon Society

2:30 Sustaining Rivers through Instream Flows
Steve Harris, Far Flung Adventures and Rio Grande Restoration

3:00 **Break**

3:30 Environmental Flow Issues and Science
Tom Annear, Wyoming Game and Fish Dept

4:00 Innovations in Rural Wastewater Management - Decentralized Approach
Graham Knowles, New Mexico Environment Dept

4:30 My Perspective on How Institutions Will Evolve to Meet Our Water Needs in the Future
Mike Hamman, Bureau of Reclamation, Albuquerque Office

Friday, December 3, 2010

8:30 Increasing Institutional Resilience for Water Conservation
Frank Ward, NMSU

9:00 Agriculture in New Mexico
Aron Balok, Pecos Valley Artesian Conservancy District

9:30 Rainwater Harvesting and Recharge Techniques for Flood Control and Improved Stormwater Quality
Vaikko Allen, CONTECH Construction Products, Inc.

10:00 **Break**

10:20 Role of Artificial Recharge in Conjunctive Water Management
Daniel B. Stephens, DB Stephens and Associates

10:50 How Do We Deal with Our Aging Structures?
Bruce Jordan, U.S. Army Corp of Engineers

11:10 Dealing with Aging Tribal Water Infrastructure
Derrick Lente, Middle Rio Grande Conservancy District, Pueblo of Sandia

11:30 Water Rights Settlement Agreements in New Mexico: Institutional Change Underway
Elizabeth Richards, Sandia National Laboratories

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River suit, $200 to $300 million dollars to New Mexico, motivated New Mexico and Texas irrigation districts to create an operating agreement on the Rio Grande as a better alternative to a court settlement. Even though the negotiations languished at some points, technical staff on both sides continued to share information, Maddock said.

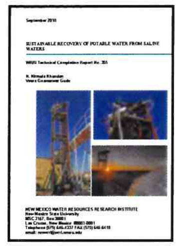
The result ultimately was a compromise that aided both states. Texas won the right to carry over some of its storage in New Mexico reservoirs. For New Mexico, the agreement established the right to pump groundwater to make up needed demand. A key feature of the agreement is the use of the "D2 curve," a calculation based on data gathered from the 1950s to the 1970s. "The curve was a blessing to New Mexico in terms of determining how much water could be pumped," said Maddock. "There were a lot of complaints, but it saved as much as a billion dollars for New Mexico," he estimated.

Now Maddock is expanding the OSE model into Mexico. "We are looking at the effects of substantial water pumping in Mexico, New Mexico, and Texas," he said. The work is also introducing a new technique to improve understanding of subsurface water storage using gravity measurements. With the help of USGS measuring equipment, estimates of the storage quality of an aquifer can be made by studying mass changes: higher mass indicates the possibility of increased pumping, while lower mass suggests the need to reduce pumping. An added benefit of the technique, developed at the U of A, is the ability to determine storage on the basis of data from a single well, rather than having to use multiple observation wells.

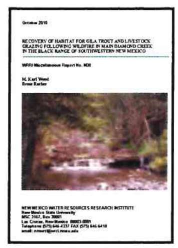
While at WRRI, Maddock is studying the depletion of surface water by groundwater pumping, a process called capture. The calculations for groundwater capture "are not a simple process," said Maddock. The calculations actually require groundwater and surface water models, groundwater historical pumping data on the system, and another groundwater "base case" model so researchers can calculate the difference between the two models. Much work remains to define capture accurately, he said. "The base case uses little data and may be fictional or artificial, based on negotiations or conditions imposed by a court," said Maddock. The calculation of the capture process is a paramount issue to water managers throughout the West," Maddock warned. "Nearly all U.S. Supreme Court water cases in the western United States, directly or indirectly, involve issues of capture."

WRRI Recent Publications

The WRRI has published one technical report and one miscellaneous report since the last issue of the *Divining Rod*. These reports are peer-reviewed reports and are available online at: **http://wrri.nmsu.edu/publish/publications.html**.

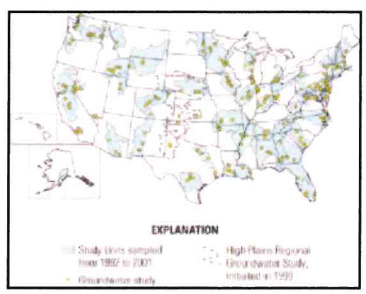


Sustainable Recovery of Potable Water from Saline Waters
September 2010 – Report No. 355 by N. Nirmala Khandan and Veera Gnaneswar Gude



Recovery of Habitat for Gila Trout and Livestock Grazing Following Wildfire in Main Diamond Creek in the Black Range of Southwestern New Mexico
October 2010 – Report No. M30 by M. Karl Wood and Brent Racher

USGS Recent Publication



USGS Circular 1350: Nutrients in the Nation's Streams and Groundwater
National Water-Quality Assessment (NAWQA) Program - A comprehensive national analysis of nutrients in streams and groundwater from 1992 through 2004.