

# Currents

A Newsletter of the UC Center for Water Resources

## Groundwater Issues Take Center Stage

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Everything from arsenic to water reuse was on the agenda at the 23<sup>rd</sup> Biennial Groundwater Conference, "Managing California's Groundwater: The Challenges of Quality and Quantity," held October 30-31 in Sacramento. More than 300 people attended the conference, which was held in conjunction with the 10<sup>th</sup> annual meeting of the Groundwater Resources Association of California (GRA). In addition to GRA, conference sponsors were the University of California, California Department of Water Resources, State Water Resources Control Board and Water Education Foundation.

"What I think was unique about the conference and beneficial to so many people were the separate the policy and technical tracks, and the fact that they did overlap,"



*GRA President Tim Parker presents lifetime achievement award to Carl Hauge, chief hydrogeologist at DWR.*

said Rita Schmidt Sudman, Executive Director of the Water Education Foundation. "The general session speakers gave us some food for thought while we work on groundwater issues in our own lives."

Forty-eight speakers were featured on concurrent policy and technical tracks. Policy presentations focused on four

main areas: groundwater quality; groundwater quantity; new tools for groundwater management; and watershed effects on groundwater. Speakers on the technical track addressed these issues: emerging contaminants; development of groundwater in impaired water areas; groundwater treatment and

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Curtis Leopold

The UC Center for Water Resources is a multicampus research unit and special program within the University of California's Division of Agriculture and Natural Resources. The Center is charged with stimulating and coordinating research and information dissemination on a wide variety of issues related to California's water resources.



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## Director's Message *by John Letey*

### A New Perspective on Water

The opportunity to accompany the tour arranged for Minister Felip Puig and his delegation from Catalonia (see story page 3) was a valuable experience, and I want to share with you my personal reflections on this extraordinary event.

I was previously aware of almost everything that I saw and heard on the tour. Nevertheless, I achieved a new perspective by being exposed to a vast array of water resources issues and accomplishments compressed into a five-day tour. The water issues reviewed were pertinent to the urban, agricultural and wildlife communities, and the interaction between the three. I witnessed the utility of a vast array of water resource management tools to meet the challenges of water quantity and quality demands. Among them were examples of conjunctive water use, surface and sub-surface water storage, water exchanges, the most advanced water treatment technologies, water recycling and reuse, and water conservation. I developed a sense of optimism that we have the capability to positively address the never-ending future challenges related to water resources. The validity of the statement by William

E. Warne (Director of the California Department of Water Re-

sources, 1961-1966) is evident; "California's destiny is never, so long as the state grows, to resolve her water problems, but always to work on it."

One recurring theme at almost every stop was the importance of public relations, stakeholder involvement, and open communication as necessary elements toward the achieve-

ment of their goals. Upon hearing repeated experiences of how consensus was achieved, one Catalonian visitor was prompted to comment that the Californians must have less passion and argue less vehemently than Catalonians. He was promptly informed that although the end result appears positive, the process was slow and not always smooth. However, I do believe that in most cases emotional and hostile words were constrained. The concept "speak softly but carry a big stick" is well engrained in the minds of Californians involved in water resource issue debates. The big stick is the threat or actual use of a lawsuit.

As one participant in the Cal-Fed process observed, "Any party had

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A handwritten signature of John Letey in blue ink, written in a cursive style.

# Catalonian Minister of Environmental Affairs Tours Water Projects in California

By Dr. Henry Vaux, Jr.

The water problems of Catalonia and of Spain as a whole bear remarkable similarity to those of California. Issues of moving water from areas of plenty to areas of need and stretching seasonal precipitation to provide year-round water supplies are common to both California and Spain.

These similarities – and the resolutions to such issues – were the focus of a special five-day tour of California for a group of Spanish journalists and dignitaries, including the Honorable Felip Puig, Minister of Environmental Affairs of the Autonomous Province of



Spanish journalists interview Dennis Falaschi, General Manager of the Panoche Water District, during the tour.

Catalonia (Spain). Minister Puig and his delegation were hosted on the May tour of California water projects by Dr. Henry Vaux, Jr., Associate Vice President of the University of California. Minister Puig's delegation consisted of Sr. Ferran Falco, Chief of Cabinet; Sra. Marta Lacambra, Director of the Catalonian Water Agency; Professor Rafael Mujeriego, Chair of the Catalonian Water Commission and Professor of Environmental Engineering at Polytechnic University of Catalonia; and seven members of the Catalonian press. Dr. Lowell

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*L to R: Rafael Mujeriego, Professor of Engineering at Polytechnic University of Catalonia; Bill Mills, General Manager, Orange County Water District; and Conseller Felip Puig, Secretary of the Environment for the Autonomous Province of Catalonia.*

## MINISTER OF ENVIRONMENTAL AFFAIRS TOURS WATER PROJECTS

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Lewis, Associate Vice President Emeritus, University of California's representative in Barcelona, helped arrange the tour and also accompanied the delegation.

The purpose of the tour was to highlight the similarities between Catalonia and California and to view first hand the California water experience. The tour was designed around three themes. First, successful water planning, policy development and policy implementation requires the involvement of all stakeholders and transparent communications. Second, urban water managers who seek to acquire additional water supplies from the agricultural sector must understand the institutional and scientific bases of agricultural water use. Third, advanced water reuse technology provides opportunities "to stretch" developed water supplies.

The tour began on Monday, May 21 in Oakland where Associate Vice President Vaux provided an overview of the California water situation. Following a short trip to Sacramento, the group was formally greeted by University Vice President W.R. Gomes; DWR Director Tom Hannigan; Secretary Mary Nichols of the California Resources Agency; and CalFed Bay-Delta Program Director Patrick Wright. The group then received comprehensive briefings on the California State Water Project and the Bureau of Reclamation's Central Valley Project. Both of these projects are of

*Senora Marta Lacambra, Director of the Catalan Water Agency*



*Group in field.*



particular interest to the Catalonians since similar types of facilities have been proposed to help address water problems in Spain where the north is relatively moist and the south, where a majority of the population resides, does not have sufficient local or regional supplies to meet the growing demand.

Day two was devoted to a tour and review of issues surrounding the Sacramento-San Joaquin Delta and consideration of some of the problems of agricultural water management. The challenge of managing the Sacramento-San Joaquin Delta focuses on many of the same issues as does the management of the Ebro River Delta in Catalonia. Agricultural uses of deltaic lands, flood control, preservation of fish and wildlife and the problems of maintaining adequate flows in seasons were among the topics of discussion.

On the afternoon of day two the group visited the Panoche Water and Drainage District where the challenge is irrigation management under saline conditions. This is a problem faced in semi-arid areas around the world, including Spain. Panoche District Manager Dennis Falaschi characterized the water quality issues and highlighted various management options including: adoption of closed conduit irrigation technologies; improving water management; blending drain water with fresh water; drain water reuse and the utilization of desalting technology.

On day three the focus continued to be on the issues of agricultural

water management. The Minister and his associates visited the U.C. Kearney Agricultural Center where CE Specialist Dr. Dave Goldhamer provided an overview of the joint UC/Catalonia project on the deficit irrigation of trees and vines. This work has demonstrated how yield levels can be maintained during drought periods and will have important practical application to the culture of trees and vines in both Spain and California. The Minister inspected an experimental plot that has been the focus of much of the collaborative work.

In the afternoon the group visited Arvin Edison Water Storage District south of Bakersfield to inspect one of the world's most sophisticated conjunctive use programs. Arvin Edison acquires water in wet years and stores it underground for use in dry years. This conjunctive use program also provides water supplies to areas of the District that do not have access to surface water. The agreement between Arvin Edison and the Metropolitan Water District of Southern California, which includes arrangements for groundwater storage and water exchange, was highlighted. This agreement benefits both the agricultural users in Arvin Edison and the urban users in the great Los Angeles complex and is an excellent example of how urban and agricultural water users can work together to mutual benefit.

The final two days of the tour were spent in southern California where the focus turned to urban water issues. Day four included a

visit to Orange County Water District where General Manager Bill Mills provided a thorough briefing and led a tour of the District's various water reuse regimes. The tour of Water Factory 21 and the briefing on the new reuse facilities afforded the visitors an opportunity to see the most advanced wastewater treatment technologies.

Barcelona, Catalonia's largest city, has recently embarked upon an extensive wastewater reuse program and some collaborative efforts between Barcelona and OCWD may be but one outcome of the tour. The afternoon was devoted to a briefing at the Metropolitan Water District. The problems of matching urban supply and demand, interbasin water transfers and appropriate pricing policies were among the topics of discussion.

The tour concluded on day five with a visit to the West Basin Municipal Water Districts to examine water reuse. The production of water of different qualities for different industrial uses was showcased here and was followed by a briefing from the Los Angeles County Sanitation Districts. The visit concluded with a celebratory lunch.

Associate Vice President Vaux, John Letey, Director of the UC Center for Water Resources, Sergiu Guillen of DWR, and Tour Coordinator Kimberly Beard accompanied the delegation throughout the tour. Dr. Takashi Asano, 2001 Stockholm Water Prize Laureate, joined the delegation in Sacramento and then again in southern California. 💧



## New Staff



**Andrew C. Chang**

Professor Andrew Chang was appointed Associate Director of the University of California

Center for Water Resources effective June 1, 2001. Professor Chang has provided the University 30 years of superior service as an educator and researcher at the Riverside campus. In recognition of his professional accomplishments, he received the USDA Superior Service Award for Natural Resources and Environment in 1991 and the US EPA Sludge Beneficial Use Research Award in 1991. He was elected Fellow of the American Association for Advancement of Science in 1998.

Dr. Chang's research program focuses on water quality issues related to the land application of organic wastes, especially the chemical reactions and bioavailability of trace metals and phosphorus. He also studied the environmental sustainability of long-term reclaimed wastewater irrigation and, using the nuclear magnetic resonance techniques, studied hydraulic and pollutant retention properties of soils and other porous media. His recent projects included developing chemical guidelines for cropland application of reclaimed wastewater and sewage sludge for World Health Organization, assessing trace

element accumulation in cropland soils for California Department of Food and Agriculture, evaluating the bioavailability of metals in sewage sludge treated soils for Water Environment Research Foundation, and, in collaboration with Vivendi Water, developing a document on the management practices for nonpotable water reuse.

Professor Chang's teaching assignments have included courses on water quality, solid waste management, and the fate and transport of inorganic chemicals in soil and water systems. He will continue his research and teaching program as well as his newly assigned administrative responsibilities.



**Pamela Dick**

Pamela Dick became a member of the Center for Water Resources Administrative

staff on September 19, 2001. She comes to us from the Dean's Office of the College of Natural and Agricultural Sciences at UCR where she was the Administrative Assistant to Dr. Philip A. Roberts, Associate Dean, Agricultural Experiment Station and Cooperative Extension. Pamela replaces Cindy DeChaine who resigned to accept another position. ♠

## DIRECTOR'S MESSAGE

*Continued from page 2*

the opportunity to halt action in the Cal-Fed process." It was recognized that for any party to achieve their desires, the process had to move forward and reach some compromise. Recognizing that compromises and sacrifices among the stakeholder interests were required to make progress in addressing water quality and quantity problems associated with the Bay Delta, the Cal-Fed process of study and debate was initiated in the early 1990s. More than a dozen federal and state agencies, as well as agricultural groups, urban water districts and environmentalists participated. An historic consensus was reached in the summer of 2000, after several years of study and debate.

In the context of the present day recognition of the importance and value of stakeholder involvement and consensus, another statement was repeated during the week: "The State Water Project would have never been achieved in the present day political and social climate." The validity of that statement is subject to debate, but it is certainly plausible. Although there are some naysayers concerning the value of the State Water Project, I believe the general consensus would be that this project has been very positive in the overall optimal management of California water resources. The thought that the State Water Project would not be adopted in the present day climate casts a degree of concern that some valuable water

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## Salinity/Drainage Funded Research

The Salinity/Drainage Program has a directed goal of providing information useful for management

strategies that will sustain profitable agricultural production and preserve environmental quality in the western

San Joaquin Valley. The following projects were funded effective July 1, 2001. ♠

<u>TITLE</u>	<u>PRINCIPAL INVESTIGATOR</u>	<u>CAMPUS</u>
Algal Community Assessment Under Different Nutrient and Grazing Intensity Regimes: Selenium Volatization and Ecotoxic Risk	<i>Eliska Rejmankova &amp; Teresa Fan</i>	<i>UC Davis</i>
Biochemical Characterization of Microphyte Composition in Relation to Se Biogeochemistry and Bioavailability	<i>Teresa Fan</i>	<i>UC Davis</i>
Conceptual Modeling of Salt Management Problems in the Western San Joaquin Valley of California	<i>William Jury</i>	<i>UC Riverside</i>
Management Effects on Selenium Fractionation, Speciation and Bioavailability in Sediments from Evaporation Basins	<i>Sudan Gao &amp; Randy Dahlgren</i>	<i>UC Davis</i>
Mass balance of water and Se in the TLDD flow-through wetland cells	<i>Kenneth Tanji &amp; Sudan Gao</i>	<i>UC Davis</i>
Mitigating Selenium Ecotoxic Risk by Combining Foodchain Breakage with Natural Remediation: Physical-Chemical Nature of Sediment Selenium with Implications for Bioavailability	<i>Richard Higashi &amp; Robert Flocchini</i>	<i>UC Davis</i>
Removal of Selenium from Drainage Water in Lined Reduction, Attachment, and Open Oxidation Channels: A Field Study	<i>William Frankenberger</i>	<i>UC Riverside</i>
Transformation of Selenium Species in Sediment and Wetland Management Approaches for the Enhancement of Selenium Volatilization and Remediation Efficiency	<i>Norman Terry</i>	<i>UC Berkeley</i>
Water and land management in irrigated ecosystems	<i>Wesley Wallender</i>	<i>UC Davis</i>

### *Prosser Trust Funds*

*Joseph G. Prosser and his son developed the tensiometer, soil water-sensing devise. He provided the University an endowment to support the development of efficient irrigation practices. Income from this trust fund is distributed for research and extension activities pursuant to the terms of the trust. The following projects were funded effective July 1, 2001.*

<u>TITLE</u>	<u>PRINCIPAL INVESTIGATOR</u>	<u>CAMPUS</u>
Contrasting Irrigation Application Methods for Soil Salinity and Drainage Reduction	<i>Dan Munk</i>	<i>UC Davis</i>
Improving Water and Nutrient Management Practices on Dairies in the Southern San Joaquin Valley	<i>Larry Schwankl</i>	<i>UC Davis</i>
Potential for using blended drainage water for irrigating West Side, San Joaquin Valley Pistachios	<i>Louise Ferguson</i>	<i>UC Davis</i>
Using EM and VERIS Technology to Assess Land Suitability for Orchard and Vineyard Development in Non-saline Environments"	<i>Allan Fulton</i>	<i>UC Davis</i>
Validation of Protocols for Using Trunk Diameter and Tree Water Potential Measurements in Orchard Irrigation Scheduling	<i>David Goldhamer</i>	<i>UC Davis</i>

**T**hese research highlights represent findings from a few of the projects funded by the Salinity/Drainage Program. Progress reports on all funded projects were published in the 2000-2001 Salinity/Drainage Report. Free copies of the Annual Report can be downloaded via our website at [www.waterresources.ucr.edu](http://www.waterresources.ucr.edu) or requested by calling us at (909) 787-4327.

for early-warning indicators in a given watershed. Unfortunately, no such indicators are known due to many complicating factors such as extensive biogeochemical transformations, food chain bioavailability, and unknown toxicity mechanism(s) of Se.

For these reasons, total waterborne Se – while readily analyzed – is widely considered to be an unreliable indicator of ecotoxic risk to upper food web organisms such as fish or birds. The complex biogeochemistry – including biotic and abiotic transformations, food chain composition, and biomagnification of the currently unknown ecotoxic form(s) of Se – is the underlying reason for site dependence of Se impact in contaminated aquatic systems, and therefore, the need for site-specific criteria. Despite the complexity, it is possible to have a reliable assessment of Se impact, if the ecotoxic mechanism of Se is understood for relevant top predators. It is reasonable to assume that the most useful Se risk indicator would be one that is both biomagnified and associated closely with toxicity in top predators.

Since Se is expected to be transformed into proteins by primary producers, and considering that proteins are highly available to consumers and predators, we have hypothesized earlier that

## Proteinaceous Selenium: A More Reliable Indicator of Se Ecotoxic Risk?

*Teresa Fan*

Selenium (Se) contamination has negatively impacted aquatic top predators such as waterfowl and fish in a number of watersheds, and may have threatened key fish species in the Bay-Delta, such as the splittail and sturgeon. The historical lessons of Se pollution around the world underscore the urgent need



proteinaceous Se is biomagnified through the food chain. We have since tested this hypothesis on food web organisms (including fish) collected from the San Joaquin Valley agricultural drainage systems. We found that proteinaceous Se appeared to be biomagnified up the food chain and better correlated with symptoms observed in fish reproductive systems, than total biomass or waterborne Se concentrations. Therefore, proteinaceous Se of fish reproductive organs may prove to be a more reliable indicator of Se ecotoxic risk than the total Se parameters generally relied upon for risk assessment. We are conducting further laboratory and field studies to substantiate this finding.

## Agricultural Evaporation Ponds – Source of Marketable Brine Shrimp

*R. Rofen*

Subsurface drainage water from much of the agricultural lands on the southwest side of the California Central Valley is stored in thousands of acres of evaporation ponds. Because of this water's selenium content, government regulations will not allow this water to be released into natural waterways. These drainage waters have generally been considered a natural hazard to water birds, and a total loss for reuse or economic development.



In 1998 Novalek, Inc., a research and development company (led by Dr. Robert Rofen), and the Tulare Lake Drainage District (TLDD) with over 180 farmers and landowners, (Doug Davis, manager), challenged that view. They cooperated in the development of hypersaline aquaculture farming of Artemia Brine Shrimp (*Artemia franciscana franciscana*). This native species of California naturally occurs in ponds hypersaline with sodium and chloride salts that are above approximately 40-80 ppt salinity. (The ocean is approximately 35 ppt salinity.) Brine shrimp are a highly desired tropical and ornamental pond fish food worldwide.

Brine shrimp can accumulate selenium, however, all indications are that the levels of selenium currently found, is not a hindrance to brine shrimp culture. In fact, brine shrimp fortified with selenium from TLDD is a beneficial food

source for non-food fishes, with no effects seen to their reproduction, growth, and general health. Currently, the brine shrimp from TLDD are rated in the commercial market as among the best quality in the world.

Brine shrimp aquaculture in agricultural evaporation ponds may have ecological as well as economic benefits. Selenium becomes bioconcentrated in organisms as it moves up the food chain. Harvesting the shrimp, and possibly other invertebrates, interrupts the natural food chain by which selenium becomes concentrated. Additionally, brine shrimp removal appears to be accelerating the harmless volatilization of selenium by algae. Algae are the natural food for the shrimp.

Investigators at the University of California, Davis, and the Crocker Nuclear Laboratory (Dr. Teresa Fan and Dr. Richard Higashi, respec-

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## WRC RESEARCH HIGHLIGHTS

*Continued from previous page*

tively, and their colleagues) have been monitoring the brine shrimp operations and aquatic conditions in the TLDD evaporation basin ponds. They are particularly interested in the aquatic food chain. Their investigations have indicated that volatilization of selenium by algae in the water may be a significant factor in selenium reduction in the ponds. Therefore, the combination of aquatic farming and algal volatilization may be a practical way to minimize selenium and associated ecotoxins in the wastewater ponds in the Central Valley.

## Proper Timing of Deficit Irrigation Saves Water

*Dave Goldhamer*

Regulated deficit irrigation (RDI) is being tested on tree and vine crops in the Central Valley. The goal of RDI is to purposely deprive plants of water during specific periods of the season without damaging production. We have evaluated RDI in pistachio, peach, olive, citrus, almond, and walnut orchards and have a wine grape trial underway. We were able to save water from 20-25 percent of potential ETc with little or no significant negative impact on the yield of marketable product in most of these studies.

An added benefit of RDI was achieved with navel oranges. Each



season, over a three- year period, RDI significantly reduced the incidence of creasing; a peel disorder that lowers the fruit grade (from fancy to choice or juice). This disorder is apparently due to rapid cell expansion of the layers that comprise the peel when the fruit is small causing microscopic fissures between certain cells. These fissures manifest themselves as creases as the fruit approaches harvest. We believe that stress early in the season slows fruit growth during the critical period and limits the fissure development. Returning the trees to full irrigation following the deficit irrigation period results in accelerated fruit growth such that

harvest fruit size is not affected.

Over a three-year period, we decreased creasing from 29.8 to 9.7 percent of the fruit load (full irrigation and RDI, respectively). This resulted in fancy fruit production increasing from 22.1 to 38.0 percent and juice fruit production decreasing from 20.0 to 12.0 percent . Applied water was reduced from 31.6 to 23.7 inches, a savings of 25.5 percent . Harvest fruit size, fruit load, and packable cartons were not affected.

We are currently evaluating the use of continuously recorded trunk diameter measurements as an indicator of tree water status. The results to date are promising.

Implementation of RDI requires a user-friendly means of monitoring plant water stress, but proper timing of deficit irrigation saves water.

## Selenium Removal Process Successful

*Carla Scheidlinger*

Broadview Water District and Agrarian Research and Management Company, using funding from the Bureau of Reclamation, implemented a project that removed up to 90 percent of selenium from

agricultural drain water. Removal of selenium from agricultural drainage water greatly facilitates the opportunity to dispose of the water in an ecologically safe manner.

The project consists of a series of

shallow, meandering channels lined with a plastic through which drain water flowed. Plants such as saltgrass and rabbitsfoot grass were rooted in straw bales placed in the channels through which the drain water flowed. The entire project area was covered with bird netting to prohibit exposure to wildlife.



The selenium was removed from the water in two ways. One is by the chemical reduction of the selenium from the soluble to insoluble forms that are retained in the straw-rooting matrix. This reduction is accomplished by bacteria that grow in association with the straw, which provides a carbon source for active bacterial growth. The bacteria also removed almost 100 percent of the nitrates from the water, and induced a low oxygen environment.

The other means of removal is through volatilization, in which the soluble selenium is converted to a gaseous form that is discharged harmlessly to the atmosphere. This

project indicated that as much as 40 percent of the selenium may be volatilized, with the remainder immobilized as insoluble elemental selenium.

Data analysis showed that the amount of

selenium removed from the drain water is directly related to the amount of straw that the drain water passes through in its passage through the channels. A multiple linear regression predicts with confidence that about 2 tons of straw will treat an acre-foot of water for the consistent removal of 75 percent of the in-coming selenium. 💧

## DIRECTOR'S MESSAGE

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management programs may not be achieved through a comprehensive stakeholder involvement process. Stakeholder consensus has the benefit of minimizing the probability of disasters, but may also have the negative aspect of delaying, if not preventing, some extremely beneficial programs.

I have tried to visualize the present state of California in the absence of the State Water Project. If all of the population growth and economic development in southern California that has occurred by virtue of the State Water Project was transposed to northern California, where the water originates, my life in southern California might be considerably more serene.


On a personal note, I am extremely pleased to have Professor Andrew Chang as the Associate Director of the Center. He has an excellent research and teaching record on water related issues, and his experience will be valued. Of equal importance is his exceptional professional dedication and integrity.

I want to publicly acknowledge the major contribution and dedicated service of Cindy DeChaine, who recently resigned to assume another position. She played a vital role in helping establish the Center of Water Resources at Riverside following its transfer from Davis. I am pleased to welcome Pamela Dick as a member of the staff. We are fortunate to have a person with her experience and capabilities join us. 💧

# WRC Funded Research Projects

Each year, the Water Resources Center reviews research proposals to determine which to award. These projects provide critical information on issues related to some of

California's most difficult water issues. The new projects funded effective July 1, 2001 are listed below. Previously funded two-year projects have also been continued

through the 2001-2002 fiscal year. You can see a list of those projects in the Summer 2000 Currents. 

<b>CATEGORY I</b>		
<i>Hydrology, Climatology and Hydraulics</i>		
<u>TITLE</u>	<u>PRINCIPAL INVESTIGATOR</u>	<u>CAMPUS</u>
Application of a New Model for Groundwater Age Distributions: Modeling and Isotopic Analysis of Artificial Recharge in the Rialto-Colton Basin, California	<i>Timothy R. Ginn</i>	<i>UC Davis</i>
The Effect of Soil Water Content on Organic Chemical Sorption During Transport through Unsaturated Soil	<i>William A. Jury</i>	<i>UC Riverside</i>
Emplacement and Release of Brines from the Subsurface	<i>James R. Hunt</i>	<i>UC Berkeley</i>
<b>CATEGORY II</b>		
<i>Aquatic Ecosystems</i>		
<u>TITLE</u>	<u>PRINCIPAL INVESTIGATOR</u>	<u>CAMPUS</u>
Fate of Viruses, Endocrine Disrupters, and Nitrogen in Non-Conventional Onsite Wastewater Treatment Processes: A Technical and Economic Analysis	<i>Jeannie L. Darby</i>	<i>UC Davis</i>
Restoring Alpine Lake Ecosystems Through Control of Trout Spawning	<i>Peter B. Moyle</i>	<i>UC Davis</i>
<b>CATEGORY III</b>		
<i>Water Quality</i>		
<u>TITLE</u>	<u>PRINCIPAL INVESTIGATOR</u>	<u>CAMPUS</u>
Abiotic Nitrogen Removal Mechanisms in Rapid Infiltration Wastewater Treatment Systems	<i>Mark R. Matsumoto</i>	<i>UC Riverside</i>
Development of a Liquid Membrane Technique to Measure the Temporal Variation in "Bioavailable" Copper and Nickel in the South San Francisco Bay	<i>Kenneth Bruland</i>	<i>UC Santa Cruz</i>
Perchlorate Removal in Groundwater Using Immobilized Cell-Free, Purified and Recombinant Perchlorate Reductases from the Perchlorate Respiring Bacterium, Perc1ace	<i>William T. Frankenberger</i>	<i>UC Riverside</i>
<b>CATEGORY V</b>		
<i>Water Law, Institutions and Policy</i>		
<u>TITLE</u>	<u>PRINCIPAL INVESTIGATOR</u>	<u>CAMPUS</u>
Economic Incentive and Policies to Improve Water Quality in a Binational Watershed	<i>Linda Fernandez</i>	<i>UC Riverside</i>
Voluntary Compliance Versus Mandatory Sanctions: A Natural Experiment in Water Quality Regulation	<i>Paul Sabatier</i>	<i>UC Davis</i>

## GROUNDWATER ISSUES

*Continued from front page*

remediation; and GIS for hydrologic applications.

"The speakers outlined in great detail the issues surrounding management of groundwater quality and quantity in California in the 21st century," said Carl Hauge, Chief Hydrogeologist for DWR.

Keynote speaker Celeste Cantu', Executive Director of the State Water Resources Control Board (State Board), kicked off the two-day conference. In her speech, she highlighted the important role for education as officials work to teach people about the wise use of water, and how to protect its quality. Cantu', who was appointed in April, also spoke of the need to form partnerships with other agencies and organizations in order to stretch available resources and address groundwater issues.

Education was also the theme of Susan Seacrest, president of The Groundwater Foundation, a national organization based in Nebraska. Seacrest, who spoke at lunch the first day, related her personal experiences of how she first got involved in groundwater issues in Nebraska, which led the formation of The Groundwater Foundation. Grassroots work is a major focus of her organization's mission and she issued an enthusiastic invitation for California communities to join her

Groundwater Guardian program, which recognizes communities that work to resolve groundwater issues.

Panelist presentations the first day focused on a wide range of water quality issues such as pharmaceuticals in groundwater. On the



*Susan Seacrest, President of the Groundwater Foundation and Rita Schmidt Sudman of the Water Education Foundation.*

water quantity side, conjunctive use was the focus of the policy track while the technical track examined the cleanup and use of impaired waters.

On the second day of the conference, policy panel discussions shifted to questions of groundwater management and monitoring, and coordinating surface water and groundwater issues. Technical track speakers, meanwhile, took on such water quality challenges as MTBE and perchlorate in the morning and the role of GIS technology in the afternoon.

Groundwater management was the focus of Steve Macaulay's luncheon address. "Groundwater management," said Macaulay, chief deputy director of DWR, "is like a

Monet. It looks good from a distance, but there's an awful lot of details that can be overlooked." DWR's role in groundwater management, he said, is to form partnerships with local entities, not implement a statewide program. Such

local plans are especially important, Macaulay noted, in light of newly enacted legislation to better coordinate growth and water supplies.

At the luncheon, GRA honored Hauge with its 2001 Lifetime Achievement Award. GRA also recognized the American River Basin Cooperating Agencies and Sacramento Groundwater Authority Partnership with its annual Kevin J.

Neese Award. GRA celebrated its 10<sup>th</sup> anniversary at the Biennial Groundwater Conference.

Hauge, Sudman and GRA Director Vicki Kretsinger served as co-chairs of the conference organizing committee. Conference cooperating organizations were International Association of Hydrogeologists, Association of California Water Agencies, California Groundwater Association, National Ground Water Association and the Natural Resources Section of the California State Bar.

The speaker abstracts for the 23<sup>rd</sup> Biennial Groundwater Conference can be viewed and downloaded at the UC Center for Water Resources web site, [www.waterresources.ucr.edu](http://www.waterresources.ucr.edu). 💧



# National Research Council Reviews TMDL Approach

## *Editor's Note*

*The Total Maximum Daily Load (TMDL) program is an approach to reduce water pollution from nonpoint sources. In California, the TMDL program is administered by the Regional Water Quality Control Boards. In October 2000, Congress suspended EPA's implementation of the TMDL rules until further information could be gathered on several aspects of the program. In particular, Congress requested that the National Research Council examine the scientific basis of the TMDL program. Dr. Kenneth H Reckhow, Director, Water Resources Research Institute, North Carolina State University, and chair of the committee to assess the scientific basis of the TMDL approach to water pollution reduction, testified before the U.S. House Subcommittee on Water Resources and Environment, Committee on Transportation and Infrastructure on June 28, 2001. Because of the importance of the TMDL program in California (as well as all other states), excerpts from Dr. Reckow's testimony are reported here.*

Our central message can be summarized in a short sentence – we have the scientific capability to identify the polluted waters and develop plans for their cleanup. Underlying this general message are specific key points:

1. Current scientific knowledge and techniques are sufficient to proceed with the TMDL program.
2. Using current science, we recommend several changes in how EPA and the states conduct the TMDL program that can be immediately implemented, leading to improvements in the TMDL program. Many of these recommendations simply involve changes in the techniques used in the TMDL process, not development of new techniques.
3. In the long run, science advances through a process of research and improved understanding. We can improve the science used to support the TMDL program over time, and we recommend research activities to do that.

Let me now elaborate on my second point, which was that there are several changes that EPA and the states could immediately implement to improve the science underlying the TMDL program. I provide two brief examples:

1. As part of the TMDL, EPA requires a “margin of safety” factor that is protective of water quality. This factor is intended to reflect the uncertainty in the TMDL forecast; however, EPA allows the margin of safety to be arbitrarily chosen, resulting in a variable level of

protection. We can do better; techniques exist now to base the margin of safety on an explicit calculation of uncertainty.

2. A TMDL is required for water bodies listed by the states as in violation of a water quality standard. Unfortunately, many states have not required well-designed monitoring programs with statistical hypothesis testing to diagnose standard violations. We know how to do this now, but states are just not using the best science in many situations. Using the medical analogy, this issue is equivalent to using outdated techniques for diagnosing a disease.

The second example addresses a vital feature of the TMDL program – the listing, or diagnosis, of water bodies in violation of a water quality standard. Clearly, what we want to do is correctly identify all water bodies in need of a TMDL, and we believe that the statistical hypothesis testing procedure will add the necessary scientific rigor to the identification task. At this point, the States already have identified, and listed (on the 303d list), water bodies they believe to be in violation of water quality standards and hence in need of a TMDL. However, due to limitations in state water quality monitoring and assessment programs, many of these lists appear to be in error. That is, we believe that some water bodies have been identified as “in violation” when in fact standards are being met, while other water bodies that truly are in violation of a standard have not yet been identified. To

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correct this problem, we propose that EPA approve a two-list process in which States would create a “preliminary list” of water bodies suspected of being in violation of a water quality standard. They would then have a limited period of time to undertake the necessary monitoring and statistical hypothesis testing to refine the preliminary listing decision. Those water bodies thus determined to be in violation would then go on an “action list” (the 303d list) and require a TMDL to meet the standard and achieve the designated use.

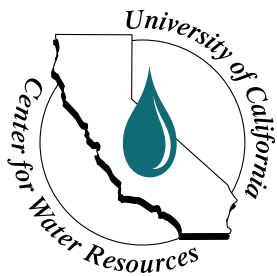
In conclusion, it is important to recognize the tremendous variability among the estimated 40,000 projected TMDLs. Some are accompanied by a great deal of data and existing knowledge; for others, very little may be presently known. Some have self-evident solutions, while for others the problem is exceedingly complex and solutions are unclear. We believe that the NRC report outlines a strategy for using the best science to move ahead with the TMDL program. 💧

# Annual U.C. Salinity-Drainage Meeting

*Mark your calendar!  
The Annual U.C.  
Salinity-Drainage  
Meeting will be held  
March 26-27, 2002  
in Sacramento.*

The meeting will feature the latest research findings on issues such as water treatment, wildlife impacts, integrated farm management, selenium ecotoxicology, the economics of integrated drainwater management, and others.

The research findings will be complemented by presentations on policy issues by experts in the field. A series of presentations are tentatively planned to address the opportunities and constraints toward finding an "in-valley" solution that will achieve a sustainable high agricultural production and preserve and protect wildlife. Visit our website [www.waterresources.ucr.edu](http://www.waterresources.ucr.edu) after February 15, 2002 for complete details of this meeting.



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