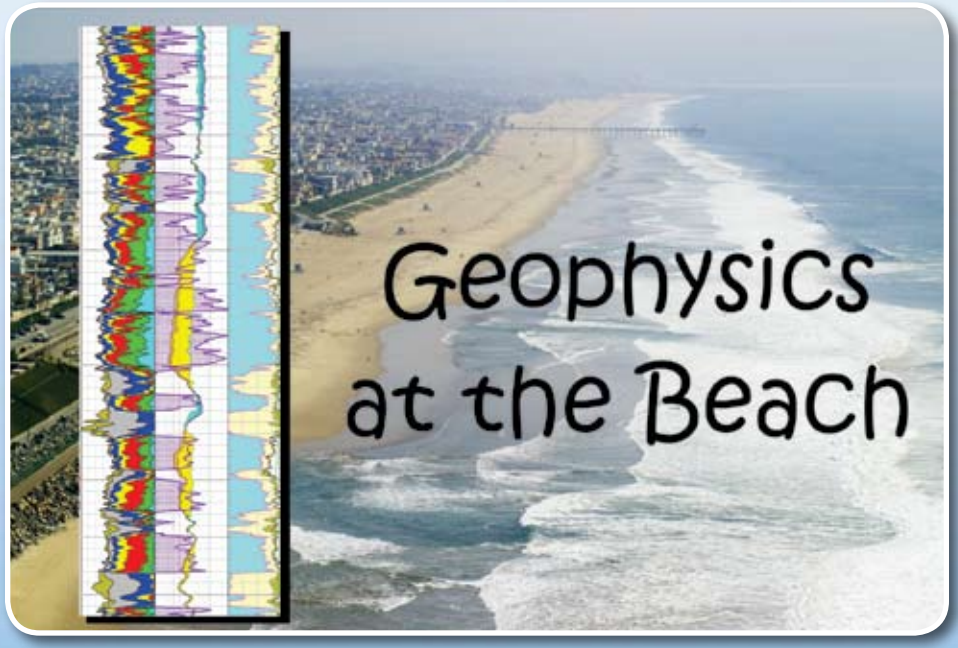
GROUNDWATER RESOURCES ASSOCIATION OF CALIFORNIA

HYDROVISIONS

VOLUME 19, NO. 3 FALL 2010

GRA Symposium – Geophysics at the Beach

By Ted Johnson, John Jansen, Tim Parker, and Ned Clayton



Groundwater is a critical resource that will increasingly be relied upon in the future to meet growing water demands in the face of changing climate, socio-economic pressures, and the decreasing availability and rising cost of surface water. More reliance on groundwater will drive the need for improved characterization of subsurface geohydrology and water quality, and improved tools for predicting the long-term viability of groundwater storage projects.

Geophysics is a discipline that utilizes a suite of high-resolution surface and downhole tools that play an important and increasing role in water resources investigations to obtain high-quality and cost-effective subsurface hydrogeologic information critical to making informed management decisions.

To provide a link between current and future groundwater problems and the latest in geophysical tools and technologies that can be applied to help solve these problems, GRA, in conjunction with the Environmental and Engineering Geophysical Society (EEGS), held a three-day symposium in Santa Ana and Newport Beach in May, 2010. A basic and advanced short course on borehole geophysics was held on May 24th; a symposium with 17 speakers and poster presentations was held on May 25th; and a field demonstration of geophysical equipment was held at the beach on May 26th.

About 60 people attended the three-day event; their varied backgrounds included technical professionals, public and regulatory agency staff, university staff, responsible parties, case managers, and others. Following is a summary of the information presented at the event.

May 24, 2010 – Basic and Advanced Borehole Geophysics Short Course

This one-day course provided the background information necessary for selecting appropriate geophysical logging technologies for various projects, and for interpreting and integrating geophysical logs into hydrogeologic investigations. Such investigations may include:

Continued on page 6…

The Groundwater Resources Association of California is dedicated to resource management that protects and improves groundwater through education and technical leadership.

The late Gene Luhdorff (left) standing in an irrigated field. See page 32.

Inside this Issue

Features

GRA Symposium – Geophysics at the Beach 1

Guest Editorial: Society-Science Synergism in Santa Clara Valley, by ***T.N. Narasimhan*** 4

Toward Sustainable Groundwater in Agriculture – An International Conference Linking Science and Policy 27

Obituaries: Eugene E. Luhdorff & Anne M.J. Schneider 32

Columns & Corners

President's Message 3

Upcoming Events 9

Technical Corner 12

California Legislative Corner 14

California Regulatory Corner 15

Federal Legislative/Regulatory Corner 16

Chemist's Corner 17

Student/Research Corner 18

Hydro-History Corner 22

Alliance Corner 23

Organizational Corner 25

Branch Highlights 36

HYDROVISIONS is the official publication of the Groundwater Resources Association of California (GRA). GRA's mailing address is 915 L Street, Suite 1000, Sacramento, CA 95814. Any questions or comments concerning this publication should be directed to the newsletter editor at editor@grac.org or faxed to (916) 442-0382.

EDITOR
Steven P. Phillips
sphillip@usgs.gov

EDITORIAL BOARD
Roy Herndon | Tom Mohr | Tim Parker
Kathy Snelson | David Von Aspern

Toward Sustainable Groundwater in Agriculture – An International Conference Linking Science and Policy

By Thomas Harter, University of California, Davis

On June 14 – 18, 2010 an international conference titled "Toward Sustainable Groundwater in Agriculture – An International Conference Linking Science and Policy" was held in Burlingame/San Francisco. The conference was organized by the University of California Davis and the Water Education Foundation (WEF) with help from GRA – including several enthusiastic GRA members on the conference council. The meeting brought together leading scientists, policy analysts, policy and decision makers, and agricultural and environmental stakeholder groups to define and highlight the science, challenges, and potential policy solutions in agricultural groundwater resources management and agricultural groundwater quality protection that will provide a sustainable future at regional, national, and global scales.

Groundwater is the lifeline for many rural and agricultural regions and their associated cultures around the globe, and a cornerstone of global food production. Groundwater constitutes nearly half the world's drinking water and much of the world's irrigation water supply. Population growth, overexploitation, salinization, nonpoint source pollution from agricultural activities (including animal farming, ranching, and forestry activities), impacts to surface water from groundwater depletion and degradation, and groundwater quality and quantity conflicts at the urban-rural interface have reached global dimensions and threaten the health and livelihood of this planet.

Yet, there are few—if any—conferences and workshops that attempt to bridge the multiple disciplinary and geographic divides between groundwater resources management and groundwater quality protection; between groundwater scientists working in agricultural regions, groundwater managers, and policy and decision makers governing agricultural groundwater basins; and between the people in California and in other parts of the world that struggle with assessing, managing, and regulating groundwater depletion and degradation. This conference attempted just that.

The three-day conference program was preceded by a full day of pre-conference workshops covering "Compliance Groundwater Monitoring in Agriculture: Monitoring Well Construction, Network Design, and Regulations for California Dairies," "Age-Dating, Geochemical Fingerprinting, and Emerging Contaminants in Animal Agriculture's Groundwater: California Dairy Case Studies," and "Learning how to Acquire Groundwater and Water Quality Data in California: GAMA, Geotracker, and IWRIS." A post-conference tour of lovely Sonoma Valley and its dairies and wineries featured a beautiful part of California, information about local groundwater issues related to agriculture, and time for networking. The tour was superbly facilitated by Rebecca Scott (WEF) and led by Tim Parker (Layne Christensen), Paul Martin (Western United Dairymen), and Marcus Trotta (Sonoma County Water Agency).

During the conference, each day began with a plenary session (summaries below) before dividing into four separate tracks. The conference wrapped up with a forward-looking plenary session offering lively discussion (see below). Altogether, 35 conference sessions, 135 speakers and 25 poster presenters were offered over the three days.

The over 250 attendees came from California (38 of them speakers), across the United States, and from around the globe—Asia, Africa, Europe, Latin America, and Australia. All had one thing in common—a shared interest in groundwater resources of agricultural regions and in agriculture's role in sustaining groundwater resources for future uses. A special journal issue on "Sustainable Groundwater in Agriculture," to be published in Water Resources Research, is in preparation.

As co-chair of the conference, I am deeply grateful to the conference program council for their enthusiasm, creativity, and tireless efforts in planning and putting together an impressive speaker list; to my executive conference committee, Rita Schmidt-Sudman and Sue McClurg from WEF and Cathryn Lawrence from UC Davis; to the wonderful folks at the Water Education Foundation (Jean Nordmann, Diana Farmer, Rebecca Scott, Robin Douglas, Susan Lauer, Beth Stern), and my students Katie Lockhardt, Reid Bryson, Tyler Hatch, Tomer Schetrit, and Vivian Jensen, for the hard work on organizing this conference; to the session chairs; to the speakers for their high quality presentations; to the conference sponsors for their financial support (U C Davis College of Agricultural and Environmental Sciences, Erler and Kalinowski Inc, Kings River Conservation District, and GEI Consultants, and—indirectly through travel support—UNESCO and FAO); and to the Groundwater Resources Association for their help in bringing exhibitors and visitors to the conference.

Continued on the following page…

Toward Sustainable Groundwater in Agriculture – An International Conference Linking Science and Policy – *Continued*

A summary of the talks would fill half of this issue of *HydroVisions*. But not to despair – a complete volume of abstracts is available at the post-conference website, as well as a copy of the final program. Videos and presentations will be posted later this summer for your perusal; the website will be publicly available, so please pass the link to those who may be interested. Also available is a blog by Michael Campana, one of our final panelists, about Day 1, Day 2, and Day 3 of the conference (thank you, Michael!). You can also find my personal—and much drier—"classroom notes" from the conference, covering about a quarter of the presentations. Mind that these are unedited and I am not guaranteeing completeness or accuracy! Vivian Jensen, one of the attending students, generously provided her notes as well. Below is a summary of the plenary and breakout sessions.

The discussion panel for the lively final plenary session was led by Margaret Catley-Carlson (right) with panel members (left to right): Jacob Burke, Jean Fried, Mark Giordano, and Michael Campana. (Photo courtesy of Rita Schmidt Sudman)

Plenary Session Summaries

Rita Schmidt-Sudman, Executive Director of the Water Education Foundation, led the opening plenary session on Day 1 titled "Global Groundwater in Agricultural/Rural Regions - Livelihoods and Use of Groundwater in Agriculture." **Dr. Thomas Harter**, U C Davis, presented "For Want of Food: Groundwater in Agriculture." With his talk, Harter provided one of many possible frameworks for this conference: the link between groundwater resources and global food security. At the same time, he provided a comprehensive context for the large diversity of topics to be covered. Worldwide food, feed, and fiber production needs will increase by 70% over the next 40 years, not including additional demands for biofuels. Nearly half of the world's crops are grown on irrigated lands, and many of the most groundwater-dependent agricultural regions have experienced significant overdraft. Additional challenges to managing groundwater use come from increasing demands for biofuel crops, a changing climate, subsidence, salinization and nitrate leaching from animal manure, and farm chemicals. The expansion of food production to feed the world's population in 2050 will be limited by land and water resources; groundwater will play an increasingly critical role in the stability of rural livelihoods and food economies against climate variability.

Paula Landis, Chief of the Division of Integrated Regional Water Management, California Dept. of Water Resources, highlighted "The Groundwater-Agriculture Nexus in California." Her talk focused on groundwater management and legislation in California, where control of groundwater is left to local agencies and individual groundwater users. She pointed out the lack of a comprehensive, statewide monitoring network to evaluate both groundwater quantity and quality, which impairs the efficient management of groundwater. Local monitoring and management efforts—if any at all—through local agencies or joint powers agreements, and in some case through court adjudications, vary widely, often dependent on water availability and demand. She asserted that the state's primary role will be in providing incentives and technical assistance to promote regional coordination, including the development of integrated regional water management plans, and effective groundwater management. She also saw the state playing a significant role in facilitating the sharing of data for effective and efficient groundwater management. To that end, Paula is leading the statewide groundwater monitoring initiative legislated through the 2009 Senate Bill x7-6. Her crew is currently in the process of establishing—with input from a wide range of stakeholders—statewide groundwater monitoring guidelines for local agencies. She emphasized that these guidelines will protect landowners from trespass by state or local entities, and that this program is not changing the water rights landscape, nor does it include monitoring of groundwater quality. She also pointed out that no funding is currently available either to DWR or to local agencies for running this program.

Dr. Tushaar Shah from the International Water Management Institute in Anand, Gujarat State in India, closed the first plenary session with an international perspective on Asian and African groundwater management in agriculture: "Groundwater Irrigation and Small-holder Agriculture: India's Experience and its Implications for sub-Saharan Africa." Dr. Shah discussed the possible implications of the Asian experience for Sub-Saharan Africa. Both regions feature low-yielding aquifers at a sub-continental scale. In India, these predominantly hard rock aquifers have recently become a resource to stabilize the livelihood of small-holder farms, although the resource is now becoming over-exploited by the high density of

Continued on the following page…

Toward Sustainable Groundwater in Agriculture – An International Conference Linking Science and Policy – *Continued*

these farms and associated wells. Dr. Shah suggested that a similar availability of well and pump maintenance resources would provide agriculture in Sub-Saharan Africa with a stable source of irrigation water and, thus, a much more stable livelihood. As population density and agricultural land fraction is much lower than in India, he suggested that this may not be a threat to groundwater sustainability in Africa.

For lunch, keynote speaker **Dr. Robert Glennon,** Morris K. Udall Professor of Law and Public Policy in the Rogers College of Law at the University of Arizona, entertained the audience with a tour of water and groundwater issues around the United States, as recently published in his book, *Unquenchable. America's Water Crisis and What to Do About It*. He began his talk with a quote from Edward Abbey: "There is no lack of water in the Mojave Desert unless you try to establish a city where no city should be." He followed with a photo tour of the amazing water features in desert-bound Las Vegas. Prof. Glennon did a thought-provoking and witty re-examination of how we use, value and often perceive water through the lens of history, showing that perhaps little has changed in a hundred years. His examples of water follies, ill will, and idiosyncrasies, but also innovation and creativity, came from throughout the country. Ideas for "fixing" the water problem—yet to be done—ranged from the century-old "don't put sewage in drinking water" (Teddy Roosevelt, 1910) to the newly innovative (e.g., changes in farming practices to cut down on unnecessary virtual water exports from water limited regions). Professor Glennon's blueprint for reform includes the familiar (conservation, abandoning of the old way of building more dams, and drilling more wells) to the innovative (using market incentives and price signals, recognizing the links between water and energy and the economy, incentives for water harvesting and reuse, alternative waste disposal, separation of storm water from sewer water, and others).

On Day 2, the plenary session on "Managing Groundwater Use and Groundwater Quality" was chaired by **Dr. Jacob Burke**, Food and Agriculture Organization in Rome, Italy. Dr. Burke opened with a few brief, but thought-provoking remarks to guide the morning. **Bill Alley**, Chief of the USGS Office of Groundwater, reviewed "Challenges in Groundwater Supply and Quality in the U.S." He began by pointing out that 90% of groundwater used in the U.S. comes from 20 aquifers, the largest being the High Plains and Central Valley aquifers. Total withdrawals there and in much of the west have been stable, while withdrawals in the eastern 31 states have recently been increasing. He reviewed national groundwater overdraft and geographic changes in its distribution; recent additions include the Dakotas, southwest of the Great Lakes, the southern Mississippi Valley and the Atlantic coastal plane, among others. Dr. Alley spoke of the need—at a national level—for providing more groundwater monitoring, driven by modeling efforts to identify the most effective monitoring approach (see http://acwi.gov/sogw/pubs). He identified better assessment of groundwater-surface water interaction as another key groundwater issue in agricultural regions across the U.S. The USGS is involved in the development of new modeling and measurement techniques (e.g., fiber-optic temperature sensing) to guide these efforts. On the groundwater quality side, he reviewed the efforts of the National Water Quality Assessment (NAWQA) Studies, which, when conceived in the early 1980s, almost missed the boat; initial discussions about the design of NAWQA considered excluding groundwater altogether. Many case studies have since been used to identify key groundwater quality issues and their geographic distribution. Other critical issues that the USGS is concerned with in the context of groundwater in agricultural regions include salinization, and the link between groundwater and energy.

Dr. Stephen Foster, former President of the International Association of Hydrogeologists and also former Director of the British Geological Survey, spoke on behalf of the World Bank on "The Global Boom in Groundwater Irrigation: Experience of Reconciling Resource Use and Sustainability." The World Bank's Groundwater Management Advisory Team (GW-MATE) has focused mostly on physical water scarcity; the diffuse pollution issues (nitrate, salts, etc.) are not currently addressed in developing countries. GW-MATE provides advice mostly to public administrations, but also to local, on-the-ground efforts in groundwater management. It is a small, international advisory team with access to very large programs within the World Bank, and therefore can affect groundwater management at national scales in developing countries. The Team embraces a top-down (central public administration) combined with a bottom-up (local) approach to groundwater management. Criteria for public administrations to intervene may include social inequity, negative effects on downstream users, viable exit strategy, and the risk for non-reversible damage such as subsidence or salinization. To be pragmatic, GW-MATE encompasses both hydrogeologic and socioeconomic elements. In Dr. Foster's experience, a certain "harmony" has to be found between the top-down and bottom-up approaches [reminiscent of the California experience]. Successfully addressing excessive groundwater use in agricultural regions involves hard work, an understanding of resource dynamics and use, user participation, a legal mandate or political backing for local government to be a groundwater guardian, and the "push" of a local groundwater champion. Dr. Foster also

Continued on the following page…

Toward Sustainable Groundwater in Agriculture – An International Conference Linking Science and Policy – *Continued*

pointed out that higher irrigation efficiency does not always "save" water; rather, higher water productivity, integration of regulatory action, economic intervention, and technical innovation are needed for these programs to be successful in developing countries.

Bridget Scanlon, Univ. of Texas, Austin, provided a colorful overview of "Satellite and Ground-based Approaches for Monitoring Impacts of Agriculture on Groundwater Resources." Dr. Scanlon introduced the audience to the basic tools available for estimating water balance components of groundwater basins using remote sensing tools; she then focused in on the role of the two "GRACE" satellites, launched in 2002, in specifically estimating net changes in groundwater storage for large groundwater basins. Significant processing is involved in interpreting GRACE data, which are gravimetrically based and collected around the globe at weekly to monthly time intervals. Reasonable groundwater storage changes can be computed for basins on the order of 150,000 square miles or larger, though the technique also has been applied to smaller basins. Dr. Scanlon reviewed applications in the Ganges and Niger Basins, High Plains Aquifer, and California's Central Valley.

On the third day, **Vicki Kretsinger Grabert** of Luhdorff & Scalmani and **Chris Scott**, Professor at University of Arizona, presided over the plenary session covering "Law and Legal Policy in Groundwater Governance (Use and Quality)." **Dr. Jennifer McKay**, University of South Australia, opened the morning with a talk on "Sustainable Development Law Via Regional Plans for Groundwater in Australia." Dr. McKay reviewed groundwater management in Australia and led the audience through what she referred to as five epochs of water policies and water law. Groundwater users in Australia hold (defeatable) licenses to groundwater use, which the government may (and has) revoke during drought conditions. Initially resistant to groundwater metering, the Australian farming community has surprisingly embraced metering as a way to manage their groundwater, although much of the initial metering system was found to underestimate deliveries by 30%. In 1992, the federal environmental sustainable development law (ESD) took hold in Australia, which is based on four elements: sustainable use, intergenerational equity, intragenerational equity, and integration of environmental concerns into the decision making process. States use several policy instruments to apply the ESD to groundwater resources: buy-back of water and land, water allocation plans, infrastructure improvements to increase irrigation efficiency, and pay incentives for retirement of agricultural lands. Water markets have not worked in Australia as consumptive use increased above sustainable yields. Jennifer also concluded that community involvement and fair process is critical to successful water management.

Mike Wiremann of U.S. Environmental Protection Agency presented "A Summary of Laws and Regulations Related to Agricultural Chemicals and Groundwater." He defined groundwater sustainability as having sufficient quantity and suitable quality for designated beneficial uses. Groundwater quality in agricultural regions is affected by federal regulations on the registration and use of pesticides (FIFRA), pesticide tolerance on food and feed (FFDCA), public flow of information (PRIA), food production standards (FQPA), and endangered species (ESA). Fertilizer use is not regulated, but the largest animal farming operations will be required to prepare nutrient management plans. State regulations generally focus on best management practices, and are not always efficient in their implementation. Mike raised the question of whether nonpoint source loading must be limited through federal regulation, proposed numeric rather than narrative nutrient standards, and suggested that groundwater quality monitoring in agricultural regions must be implemented. He suggested that differential management concepts responding to hydrogeologic and soil conditions, especially through the land-use planning process, will be critical for success. EPA has initiated a nutrient initiative and is working with the states and agricultural stakeholders to further address nutrient management.

Dr. Stefano Burchi gave the final plenary session talk. He is with the International Association for Water Law and has written a book on groundwater in international laws around the world. His very enlightening talk, "The Maturing Law of Groundwater – A Comparative Perspective," touched on a variety of topics. He explored conjunctive use in China and India, where it is a matter of policy; in Jamaica and the United States, where it is a matter of domestic legislation; and in Spain, where interbasin water transfers are used to relieve groundwater stress. He considered land-use regulation and planning, mostly from the perspective of diffuse sources of groundwater pollution. The European Union has the Nitrate Directive, which instituted a number of controls on agricultural practices, mandated legislation of nitrate sensitive areas, and codified regional best management practices. Europe and North America have various regulations and policy guidelines for potable-well source areas. Land-use planning is not regulated anywhere with respect to groundwater, although in California, integrated water resources management plans offer the possibility of incorporating a strong land-use planning component. The role of groundwater in ecosystems is considered, where priority ranking is given to the ecosystem-support role of groundwater through resource allocation or via environmental impact

Continued on the following page…

Toward Sustainable Groundwater in Agriculture – An International Conference Linking Science and Policy – *Continued*

reviews. South Africa reserves both surface water and groundwater for environmental conservation; in Australian New Wales, groundwater licenses are adjusted to maintain aquifer sustainability. Dr. Burchi observed that water legislation around the world remains surface-water centric, while groundwater is perceived globally as an intrinsically private source. Legal options disconnect groundwater and surface water not only in California, but in most countries, making it difficult for government to regulate groundwater, particularly policing of well production and monitoring of groundwater. He recommended a mix of regulatory and non-regulatory approaches to protect groundwater, including giving groundwater a legal status as a publicly/state-held resource, providing more opportunities for managing water within existing land-use regulations, and—as other speakers had mentioned—providing for economic incentives and structures to provide funding for groundwater management and quality protection measures.

The conference closed with an exciting panel discussion on "Toward Sustainable Groundwater in Agriculture: Challenges, Observations, and Key Outcomes." The discussion was facilitated by witty and sharp Margaret Catley-Carlson, Canadian Water Network and former chair of the Global Water Partnership, who quick-fired questions at her panel and the audience. The panel included **Mark Giordano**, International Water Management Institute and co-author of the recent book *The Agricultural Groundwater Revolution*; **Michael Campana**, aka "aquadoc," Oregon State University; prolific water-scene blogger **Jacob Burke**, Food and Agriculture Organization (FAO); and **Jean Fried**, UNESCO and University of California Irvine, who had organized a recent conference on water scarcity and groundwater management. The panel was excited about the conference theme and topical range, although some suggested coverage on linkages between agriculture and other groundwater users could have been more extensive. Margaret's questions included:

- Are we satisfied with the ability of measuring the impacts of agricultural practices?
- Does illiteracy have anything to do with how we can manage groundwater?
- Where does know-how need to be further developed?
- At what level should farms be regulated?
- How do we successfully manage groundwater?
- Do the international/national water players really make a local impact?
- How do we connect age-old cultures with novel engineering solutions?
- How do we best share ideas and move them forward, and where do we go from here?

Panelists and the audience responded in quick succession with succinct ideas and suggestions.

All of this can be seen on video, later this summer, at the conference website.

Acknowledgments: Thank you to Karen Burow, Vicki Kretsinger, and Steven Phillips for the critical reviews, suggestions, and editing of this article!