Toward Sustainable Groundwater in Agriculture

An International Conference Linking Science and Policy

June, 15-17 2010 • Hyatt Regency San Francisco Airport • Burlingame, California

Organized by:

Sponsored by: Hagan Endowed Chair in Water Management and Policy, University of California, Davis

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Groundwater Resources Association of California • International Association of Hydrogeologists
John Muir Institute of the Environment, UC Davis • U.S. Geological Survey
International Water Management Institute
Groundwater is the lifeline for many rural and agricultural regions and their associated cultures and populations around the globe. Groundwater is a cornerstone of global food production and constitutes nearly half the world’s drinking water. The challenges of protecting this resource’s quality and ensuring sufficient quantities are the focus of this conference.

**Plenary Sessions:** The four plenary sessions will highlight the importance of information sharing, management, policy and legal control of groundwater in agricultural regions, and assessment of agricultural practices and associated effects on groundwater quantity and quality. Experts from California, the U.S. and around the world will speak about the important connection between groundwater supply and quality, rural livelihood, and agriculture/food production for local, regional, and global communities.

**Concurrent Tracks:** Four concurrent tracks offer a wide range of policy and technical presentations on such topics as irrigation and water use, salinity and nitrates, climate change, agricultural contamination and groundwater scarcity. More than 100 speakers – policymakers, researchers, water district managers, scientists, and others – will address these and other important issues.

**Exhibits:** Be sure and visit our exhibitors: Instrumentation Northwest, RSI Drilling, Solinst Canada Ltd., The Source Group, Groundwater Resources Association of California and the Water Education Foundation.

**Tuesday Reception and Poster Session:** More than 25 posters and our exhibitors will be showcased at a hosted reception from 5:30 p.m. until 7 p.m. This is the perfect place to network with colleagues and learn about cutting-edge research and policy issues related to groundwater and agriculture.

**Wednesday Poster Session:** The posters will continue to be on display for informal get-togethers.

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**Program Council**

**Executive Committee:**
- Thomas Harter, University of California, Davis
- Cathryn Lawrence, University of California, Davis
- Rita Schmidt Sudman, Water Education Foundation
- Sue McClurg, Water Education Foundation
- Alice Aureli, UNESCO, France
- Bret Bruce, U.S. Geological Survey, Colorado
- Adriana Bruggeman, ICARDA, Syria
- Jacob Burke, FAO, Italy
- Karen Burow, U.S. Geological Survey, California
- Dico Fraters, Dutch Environmental Protection Agency, The Netherlands
- Mark Giordano, International Water Management Institute, Sri Lanka
- Vicki Kretsinger Grabert, Luhdorff & Scalmanini Consulting Engineers, California
- Chris Green, U.S. Geological Survey, California
- Pep Mas Pla, Universida Girona, Spain
- Aditi Mukherji, International Water Management Institute, Sri Lanka
- Vera Nelson, Erler & Kalinowski, Inc., California
- Tim Parker, Groundwater Resources Association of California
- David Rudolph, University of Waterloo, Canada
- Bridget Scanlon, University of Texas at Austin
- John Selker, Oregon State University
- Michael Steiger, Erler & Kalinowski Inc., California
- Jeff Stoner, U.S. Geological Survey, Minnesota
- Marcel Tchaou, UNESCO, Zimbabwe
- Karen Villholth, Geological Survey of Denmark and Greenland, Denmark
- Mike Wireman, U.S. Environmental Protection Agency and International Association of Hydrogeologists
- MaryLynn Yates, University of California, Riverside
### Plenary Session 1

**Global Groundwater in Agricultural/Rural Regions: Livelihoods and Use of Groundwater in Agriculture**

**Tuesday, June 15, 2010**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Title</th>
<th>Chair(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:15</td>
<td>Welcome</td>
<td>Welcome and Opening Remarks</td>
<td>Rita Schmidt Sudman, Executive Director, Water Education Foundation Thomas Harter, Robert M. Hagan Chair, University of California, Davis</td>
</tr>
<tr>
<td>8:30</td>
<td>A</td>
<td>For Want of Food: Groundwater in Agriculture</td>
<td>Thomas Harter, Robert M. Hagan Chair, University of California, Davis</td>
</tr>
<tr>
<td>9:00</td>
<td>A</td>
<td>The Groundwater-Agriculture Nexus in California</td>
<td>Paula Landis, Chief, San Joaquin Valley District, California Department of Water Resources</td>
</tr>
<tr>
<td>9:30</td>
<td>A</td>
<td>Groundwater Irrigation and Small-holder Agriculture: India's Experience and its Implications for sub-Saharan Africa</td>
<td>Tushaar Shah, Senior Fellow, International Water Management Institute</td>
</tr>
<tr>
<td>10:00</td>
<td>Break</td>
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<tr>
<td>10:20</td>
<td>B</td>
<td>Evaluation of Numeric and Integrated Models for Applications in Texas</td>
<td>Susan V. Roberts, River Systems Institute, Texas State University-San Marcos</td>
</tr>
<tr>
<td>10:45</td>
<td>B</td>
<td>Offsetting Allochthonous Salinity Increases Threatening Irrigated Agriculture with Managed Recharge</td>
<td>Jennie Munster, Balance Hydrologics, Inc.</td>
</tr>
<tr>
<td>11:10</td>
<td>D</td>
<td>Can Electricity Pricing be a Tool for Efficient, Equitable and Sustainable Use of Groundwater in Indian Agriculture?</td>
<td>Dinesh Kumar, Institute for Resource Analysis and Policy</td>
</tr>
<tr>
<td>10:45</td>
<td>C</td>
<td>Simulating Hydrologic and Biologic Response to Land Use and Climate Change</td>
<td>Randall Hunt, U.S. Geological Survey</td>
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### Session A.2 Groundwater and Livelihood
**Chair:** Laurel A. Firestone, Community Water Center

- **Looming Impact of Groundwater Quality Degradation on Our Rural Municipal Water Supply and Ag Lands: Not a Technical Issue but a Political and Financial Issue**
  - **José Antonio Ramirez,** City of Firebaugh

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### Session B.2 Agricultural Groundwater Management
**Chair:** Vicki Kretsinger Grabert, Luhdorff & Scalmani

- **Water, People, and the Future: Water Availability for Agriculture in the United States**
  - **Sharon B. Megdal,** University of Arizona

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### Session C.2 Groundwater, Salinization, and Salinity
**Chair:** Vera Nelson, Erler & Kalinowski, Inc.

- **Land Clearing, Rainfed Cropping and Increased Groundwater Resources in Semiarid SW Niger, Africa**
  - **Guillaume E. Favreau,** IRD

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### Session D.2 Groundwater Quality at the Ag-Urban Interface and Agricultural Legacy Contamination
**Chair:** Mike Wireman, U.S. Environmental Protection Agency

- **Evidence for Denitrification Processes in Nitrate Polluted Groundwater (Catalonia, NE Spain) Using a Multi-Isotopic Approach**
  - **Pep Mas Pla,** Universidad Girona, Spain

---

### Lunch and Keynote Speaker • Unquenchable: America’s Water Crisis and What to Do About It
**Robert Glennon,** University of Arizona, and Author

---

### Session A.2 Groundwater and Livelihood
**Chair:** Laurel A. Firestone, Community Water Center

- **Sustainable Groundwater Management: The Role and Performance of Institutions in India**
  - **Vasant P. Gandhi,** Indian Institute of Management

---

### Session B.2 Agricultural Groundwater Management
**Chair:** Vicki Kretsinger Grabert, Luhdorff & Scalmani

- **Evaluating Agricultural Water Use with Crop Life Cycle Assessments**
  - **Richard Joost,** United Soybean Board

---

### Session C.2 Groundwater, Salinization, and Salinity
**Chair:** Vera Nelson, Erler & Kalinowski, Inc.

- **A Mass Balance Approach to Evaluating Salinity Sources in the Turlock Sub-Basin, California**
  - **Michael Steiger,** Erler & Kalinowski, Inc.

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### Session D.2 Groundwater Quality at the Ag-Urban Interface and Agricultural Legacy Contamination
**Chair:** Mike Wireman, U.S. Environmental Protection Agency

- **Case Study of Groundwater Remediation of Non-point Source Nitrate**
  - **Ian Bowen,** University of Kansas

---

### Session A.2 Groundwater and Livelihood
**Chair:** Laurel A. Firestone, Community Water Center

- **The California Almond Sustainability Program: An Ag Community’s Proactive Approach to Sustainable Water Management**
  - **Daniel Sonke,** SureHarvest, Inc.

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### Session B.2 Agricultural Groundwater Management
**Chair:** Vicki Kretsinger Grabert, Luhdorff & Scalmani

- **Legal Regimes for Groundwater Regulation: Managing an Increasingly Crucial Resource**
  - **Stefanie Hedlund,** Best Best & Krieger

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### Session C.2 Groundwater, Salinization, and Salinity
**Chair:** Vera Nelson, Erler & Kalinowski, Inc.

- **Agricultural Irrigation Management in Semi-Arid Areas**
  - **Larry L. Russell,** Marin Municipal Water District

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### Session D.2 Groundwater Quality at the Ag-Urban Interface and Agricultural Legacy Contamination
**Chair:** Mike Wireman, U.S. Environmental Protection Agency

- **Evidence for Denitrification Processes in Nitrate Polluted Groundwater (Catalonia, NE Spain) Using a Multi-Isotopic Approach**
  - **Pep Mas Pla,** Universidad Girona, Spain

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### Session A.2 Groundwater and Livelihood
**Chair:** Laurel A. Firestone, Community Water Center

- **Constraints to Smallholder Livelihoods in Irrigated Agriculture in Groundwater-Dependent Parts of Asia**
  - **Karen G. Villholth,** Geological Survey of Denmark and Greenland

---

### Session B.2 Agricultural Groundwater Management
**Chair:** Vicki Kretsinger Grabert, Luhdorff & Scalmani

- **Gendered Access to Shallow Wells and Riverine Alluvial Dugouts in the Upper East Region of Ghana**
  - **Eric Antwi Ofosu,** UNESCO-IHE

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### Session C.2 Groundwater, Salinization, and Salinity
**Chair:** Vera Nelson, Erler & Kalinowski, Inc.

- **Implications of Past Agricultural Practices on Mobilization and Transport of Selenium and Nutrients from Groundwater to Surface Waters**
  - **Peter Mangarella,** GeoSyntec Consultants

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### Session D.2 Groundwater Quality at the Ag-Urban Interface and Agricultural Legacy Contamination
**Chair:** Mike Wireman, U.S. Environmental Protection Agency

- **Evaluation of Legacy Contamination at the Urban/Agricultural Interface Using Publically-Available Data**
  - **Eric Suchomel,** GeoSyntec Consultants

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### Break
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<tr>
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<tr>
<td>3:30</td>
<td>Monterey County Agricultural Water Sustainability in the Salad Bowl of the World: Generations of Innovation and Conservation</td>
<td>The Impact of Dairy Farms on the Groundwater Quality of Israel's Coastal Aquifer</td>
<td>Assessment of Pesticide Leaching to Groundwater in Germany: Comparison of Indicator and Metamodel Approaches</td>
<td>Trends and Alternatives to Ag to Urban Water Transfers in Colorado</td>
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<td></td>
<td>Kathleen Thomasberg, Monterey County Water Resources Agency</td>
<td>Shahar Baram, Ben Gurion University</td>
<td>Frank Wendland, Research Center Juelich</td>
<td>Reagan M. Waskom, Colorado State University</td>
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<td>Project GROWNET</td>
<td>Jennifer A. Burney, Program on Food Security and the Environment, Stanford University</td>
<td>Registration</td>
<td>Jacqueline M. Brook, University of Waterloo</td>
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<td>Shrikant D. Limaye, Ground Water Institute, India</td>
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<td>Jos Boesten, Alterra</td>
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<tr>
<td>4:20</td>
<td>Till the Wells Run Dry? Dealing with Groundwater Depletion in Victoria, Australia, and California, U.S.A.</td>
<td>Farmers' Willingness to Adopt BMPs to Control Nonpoint Source Pollution in the Lower Bhavani River Basin, India</td>
<td>Groundwater Vulnerability Assessments for the San Joaquin Valley</td>
<td>Groundwater Banking and Management in Mixed Agricultural and Urban Regions</td>
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<td></td>
<td>Rebecca L. Nelson, Stanford University</td>
<td>Sacchidananda Mukherjee, National Institute of Public Finance and Policy</td>
<td>Keith Loague, Stanford University</td>
<td>Jim Beck, Kern County Water Agency</td>
</tr>
<tr>
<td>4:45</td>
<td>Water Supply Enhancement Project for the Poso Creek Integrated Regional Water Management Plan, Tulare Lake Basin</td>
<td>Opportunities and Constraints to Community Regulation of Groundwater: Lessons from a Grassroots Project in</td>
<td>Regression Model for Predicting the Concentration of Atrazine Residues in Shallow Agricultural Groundwater across</td>
<td>Social Sustainability of a Groundwater Allocation Plan toward the Resolution of an Allocation Dispute between</td>
</tr>
<tr>
<td></td>
<td>Sam Schaefer, GEI Consultants, Inc.</td>
<td>Andhra Pradesh, India</td>
<td>the Conterminous United States</td>
<td>Agricultural and Forest Water Users</td>
</tr>
<tr>
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<td>Rama Mohan Venkata Ramachandru, Centre for World Solidarity</td>
<td>Paul E. Stackelberg, U.S. Geological Survey</td>
<td>Virginie Gillet, Centre for Comparative Water Policies and Laws, University of South Australia</td>
</tr>
<tr>
<td>5:10</td>
<td>END SESSIONS</td>
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<tr>
<td>5:30-7:00</td>
<td>Hosted Reception and Poster Session</td>
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</table>
**Program**

**Wednesday, June 16, 2010**

**Plenary Session 2**

*Managing Groundwater Use and Groundwater Quality*

*Moderator: Jacob Burke, Senior Water Policy Officer, Land and Water Division, Food and Agriculture Organization of the United Nations (FAO)*

**8:30**

Challenges in Groundwater Supply and Quality in the U.S.

*Bill Alley, Chief of Groundwater, U.S. Geological Survey*

**9:00**

The Global Boom in Groundwater Irrigation: Experience of Reconciling Resource Use and Sustainability

*Stephen Foster, Groundwater Management Team Director, World Bank*

**9:30**

Satellite and Ground-based Approaches for Monitoring Impacts of Agriculture on Groundwater Resources

*Bridget Scanlon, Senior Research Scientist, University of Texas, Austin*

**10:00**

**Track A**

Session A.4

Economic Drivers of Groundwater Management

*Chair: Sharon Megdal, University of Arizona*

**Track B**

Session B.4

Sustainability Economics of Agricultural Groundwater Usage and Management

*Keith C. Knapp, University of California, Riverside*

**Track C**

Session C.4

Groundwater Chemical Status in Denmark Based on Environmental Objectives for Ecosystems and European Water Directives and Guidelines

*Klaus Hinsby, Geological Survey of Denmark and Greenland*

**Track D**

Session D.4

Denitrification at a Dairy Site Supported by Gas-Liquid Phase Modeling of Tritium/Helium-3 Groundwater Age

*Steve Carle, Lawrence Livermore National Laboratory*

**10:20**

Managing the Operational Cost of Groundwater Production to Sustain Profits

*Robert Turnbull, Roscoe Moss Company*

**10:45**
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</table>
| 11:10 | Groundwater or Livelihood? The Case of Al-Ajaz Community in Northern Syria  
Adriana Bruggeman, The Cyprus Institute |                                | Trends in Nitrate Concentrations in Agricultural Areas of the United States: Implications for Aquifers and Streams  
Chris Green, U.S. Geological Survey |                                |
| 11:35 | Groundwater Sustainability – Merely an Illusion?  
David Eaton, University of Texas, Austin | Cropping System Model for Integrated Evaluation of Agricultural Activities  
Marco Acutis, University of Milano |                                |                                |
| NOON  |                                | LUNCH                                        |                                |                                |
| 1:25  | Using a Multi-Actor Framework for Simulating the Interaction between Various Actors, Water Supply and Groundwater in Response to Global Change  
Roland Barthel, Institute of Hydraulic Engineering, University of Stuttgart, Germany | Groundwater Governance in Spain: Aligning Science with Policy  
Elena Lopez-Gunn, Marcelino Botin Foundation-Water Observatory | Bioavailability of Dissolved Organic Carbon and Ambient Redox Processes in Groundwater Associated with Agricultural Land Use  
Frank Chapelle, U.S. Geological Survey | Forecasting the Effects of EU Policy Measures on the Nitrate Pollution of Groundwater Based on a Coupled Agroeconomic Hydro(geo)logic Model  
Frank Wendland, Research Centre Juelich |
| 1:50  | Groundwater and Climate Change: Forcing, Feedbacks, and Integrated Hydrologic Response  
Reed Maxwell, Colorado School of Mines | The Use of Reserve Determination in Assessing Groundwater Quantity  
Adaora Unoma Okonkwo, South Africa, Department of Water Affairs | Can Groundwater Protection and Agricultural Production Co-exist over Vulnerable Aquifers?  
Cathy Ryan, University of Calgary | An Overview of Studies of Agricultural Contaminant Trends in Groundwater in the United States  
Bruce D. Lindsey, U.S. Geological Survey |
| 2:15  | Rural Water Supply Drought Vulnerability Assessment in the Desert Southwest  
Kristine A. Uhlman, Water Resources Research Center, University of Arizona | Managing the Groundwater-Agriculture Nexus in the Largest U.S. Irrigation District  
Tom Glover, Westlands Water District | Modeling Agricultural Impacts on Groundwater at Contrasting Spatial Scales  
Hans Peter Broers, TNO Geological Survey of the Netherlands |
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</table>
| 2:40  | Climate Change, Agriculture and Sustainable Groundwater Management: Developing a Strategic Groundwater Reserve to Buffer Extreme Droughts  
Ruth Langridge, University of California, Santa Cruz | In-stream Bioreactor for Agricultural Nitrate Treatment  
William D. Robertson, University of Waterloo | Modeling Seasonal Risk of Deep Drainage for Different Regions of Ontario: Implications for Source Protection Guideline Development  
Gary Parkin, University of Guelph |
| 3:05  | **BREAK**                                                              |                                                                         |                                                                         |                                                                         |
| 3:05  | **Session A.6**  
Green Water Management and Climate Change  
Chair: Reed Maxwell, Colorado School of Mines | **Session B.6**  
Agricultural Groundwater Management  
Chair: Adriana Bruggeman, The Cyprus Institute | **Session C.6**  
Nutrients: Groundwater Impacts, Monitoring, BMPs, and Regulation  
Chair: Scott Bradford, U.S. Department of Agriculture | **Session D.6**  
Aquifer Recharge in Agricultural Regions  
Chair: Frank Wendland, Research Centre Juelich |
| 3:30  | Green Water Management to Sustain Agricultural Production in a Changing Climate  
David Purkey, Stockholm Environment Institute | Framework for the San Joaquin Valley Integrated Regional Water Management Plan  
Sargent Green, California Water Institute | Denitrification and Nitrate Transport in Groundwater Underlying Large Dairy Operations in California's Central Valley  
Brad Eser, Lawrence Livermore National Laboratory | Groundwater Recharge in Eastern San Joaquin County Resulting from the Farmington Program  
John Green, Stockton East Water District |
| 3:55  | The Impact of Climate Change on Groundwater Recharge in Karkheh River Basin (Iran)  
Ahmad Abrishamchi, Department of Civil Engineering, Sharif University of Technology | Collaborative, Stakeholder-Driven, Water-Energy-Agriculture-Ecosystems Modeling and Planning for Long-Term Resource Sustainability  
Howard Passell, Sandia National Laboratories | Quantifying the Performance of Regional Scale Reductions in Nutrient Applications for Source Water Protection through Vadose Zone Monitoring  
David L. Rudolph, Department of Earth and Environmental Sciences, University of Waterloo, | Managed Aquifer Recharge as Tool for Sustainable Management of Groundwater Quantity and Quality in Agricultural Basins  
Calla M. Schmidt, University of California, Santa Cruz |
| 4:20  | Interannual to Multi-decadal Climate Variability Effects on Sustainable Groundwater for Agriculture  
Jason Gurdek, Geosciences Department, San Francisco State University | Impact of State Regulation on Groundwater Exploitation in the “Hotspot” Region of Punjab, India  
Bharat Raj Sharma, International Water Management Institute | Relationship between Nitrogen Surpluses and Nitrate Leaching on Sandy Soils  
Dico Fraters, National Institute for Public Health and the Environment | Climate Change and Subsurface Storage; or: Groundwater Age Mixing and What it Means to Water Quality  
Graham Fogg, University of California, Davis |
| 4:45  | Impacts of Groundwater Pumping and Irrigation on Regional Hydrology and Climate  
Ian M. Ferguson, Colorado School of Mines | Environmental and Socio-economic Implications of Overexploitation of Groundwater Resources in Hassa Oasis in Eastern Saudi Arabia  
Nasser A. Alsaaran, King Saud University | Assessing Potential Nutrient Losses in Tile Drained, Macroporous Soils over an Annual Cycle through Conservative Tracer Tracking  
Steven K. Frey, University of Waterloo | Groundwater Management Program for Yuba County Water Agency: A Conjunctive Use Pilot Project  
Christian E. Petersen, MWH |
| 5:10  | **END SESSIONS**                                                        |                                                                         |                                                                         |                                                                         |
| 5:30-7:00 | **Poster Session**                                                      |                                                                         |                                                                         |                                                                         |
## Program

**Thursday, June 17, 2010**

**Plenary Session 3**

**Law and Legal Policy in Groundwater Governance (Use and Quality)**

*Moderators: Vicki Kretsinger Grabert, Luhdorff & Scalmani, and Chris Scott, Professor, University of Arizona*

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<td>8:30</td>
<td>Plenary</td>
<td>Sustainable Development Law via Regional Plans for Groundwater in Australia, USA, and EU – Early Court Decisions and Future Implications</td>
<td>Jennifer McKay, Director for the Centre for Comparative Water Policies and Laws at the University of South Australia, Adelaide</td>
</tr>
<tr>
<td>9:00</td>
<td>Plenary</td>
<td>A Summary of Laws and Regulations Related to Agricultural Chemicals and Groundwater</td>
<td>Mike Wireman, Hydrogeologist, U.S. Environmental Protection Agency and Former U.S. Chair, International Association of Hydrogeologists</td>
</tr>
<tr>
<td>9:30</td>
<td>Plenary</td>
<td>Legal Tools for Managing Groundwater Resources – Options, Best Practices, and Issues</td>
<td>Stefano Burchi, Chairman, Executive Council, International Association for Water Law</td>
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<td>10:00</td>
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<tr>
<td>10:20</td>
<td>Track A</td>
<td>Just Water? Environmental Justice and Drinking Water Quality in California’s Central Valley</td>
<td>Carolina Balazs, University of California, Berkeley</td>
</tr>
<tr>
<td>10:45</td>
<td>Track A</td>
<td>Ag Perspectives on Groundwater</td>
<td>Jack Rice, California Farm Bureau</td>
</tr>
<tr>
<td>10:20</td>
<td>Track B</td>
<td>Municipal/Agricultural Conservation Tools Applied in Central Texas, U.S.</td>
<td>Meredith A. Blount, River Systems Institute, Texas State University-San Marcos</td>
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<td>10:45</td>
<td>Track B</td>
<td>Groundwater Overdraft in Mexico: Climate, Energy, and Population Drivers</td>
<td>Christopher A. Scott, University of Arizona</td>
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<td>10:20</td>
<td>Track C</td>
<td>Central Valley Groundwater Requirements for Dairy Farms</td>
<td>Paul Martin, Western United Dairymen Association</td>
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<td>10:45</td>
<td>Track C</td>
<td>Microbial Contamination of Groundwater under Agricultural Fields, Sources and Pathways</td>
<td>Michael J. Goss, University of Guelph, Kemptville Campus</td>
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<td>10:20</td>
<td>Track D</td>
<td>Nationwide Ambient Groundwater Monitoring Approaches in Europe for Monitoring the Effectiveness of the Nitrates Directive Action Programs</td>
<td>Dico Fraters, National Institute for Public Health and the Environment, the Netherlands</td>
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<td>10:45</td>
<td>Track D</td>
<td>Groundwater Monitoring and Compliance Checking According to WFD and GD</td>
<td>Esther Wattel-Koekkoek, National Institute for Public Health and the Environment, the Netherlands</td>
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<td>11:10</td>
<td>Socio-Economic Impact of Groundwater Pollution Due to Disposal of Textile Effluent – A Case Study from India Saravanan Ramasamy, Anna University</td>
<td>Policy and Economic Drivers in California that Affect Groundwater Management and Sustainability in Agricultural Regions Matt Zidar, GEI Consultants, Inc.</td>
<td>Cycling of Organoarsenicals Released from Poultry Litter: Results from a Field Experiment in an Agricultural Watershed Oluyinka Oyewumi, Virginia Tech and State University</td>
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<td>2:15 Can We Determine</td>
<td>Strategies for Efficient</td>
<td>Relationship between Farm Management, Nitrogen Surplus, Nitrate</td>
<td>Modeling Crop Water Demand and Root Zone Flow Processes at Regional</td>
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<td>Background Nitrate</td>
<td>Irrigation</td>
<td>Concentrations and Economic Performance of Dutch Dairy Farms on Sandy</td>
<td>Scales in the Context of Integrated Hydrology</td>
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<td>Concentration in Groundwater</td>
<td>John Selker, Oregon State University</td>
<td>Soils</td>
<td>Emin C. Dogrul, California Department of Water Resources</td>
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<td>Kelly L. Warner, U.S.</td>
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<td>Geological Survey</td>
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<td>2:40 CV-SALTS Initiative:</td>
<td>Groundwater in China: Development, Regulation and</td>
<td>An Investigation of Polices for Controlling Groundwater Pollution from</td>
<td>Assessing and Forecasting Nitrate Fluxes in Agricultural Aquifers</td>
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<td>Central Valley Regional Water</td>
<td>Farmers’ Responses</td>
<td>Confined Animal Feeding Operations</td>
<td>Chris Green, U.S. Geological Survey</td>
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<td>Quality Control Board</td>
<td>Qiuqiong Huang, Department of Applied Economics,</td>
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<td>Efforts to Tackle Salinity</td>
<td>University of Minnesota</td>
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<td>and Nitrate throughout</td>
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<td>the Central Valley and Who</td>
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<td>Pamela Creedon, Central</td>
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<td>Valley Regional Water</td>
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<td>3:05 BREAK</td>
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3:20 Plenary Session 4

**Toward Sustainable Groundwater In Agriculture: Challenges, Observations, and Key Outcomes**

**Moderator:** Margaret Catley-Carlson, Chair, Canadian Water Network

**Panel:**
- Mark Giordano, Principal Researcher, International Water Management Institute
- Michael Campana, Professor of Geosciences, Oregon State University
- Jacob Burke, Senior Water Policy Officer, Land and Water Division, Food and Agriculture Organization of the United Nations (FAO)
- Jean Fried, Project Scientist, University of California, Irvine, and Consultant, UNESCO

5:30 ADJOURN

6:00 Journal Special Issue Author Meeting
Zeinab Shaaban Abou-Elnaga, Mansoura University, Challenges of Water sector: Groundwater and Agriculture in Egypt

Alishir Afrous, University of Azadegan, Nitrate Leaching in Various Irrigation Methods and Simulating Nitrate Movement and Transport with LEACHN Model

Jocelyn Boudreau for Jean Caron, Université Laval, Qc, Canada, Saving Water and Energy Using Spatially Distributed Real Time Water Potential Sensors in Cranberry

Hans Peter Broers, TNO Geological Survey of the Netherlands, Implementing the EU Water Framework and Groundwater Directives in the Netherlands: Monitoring and Compliance Regime for Groundwater

Michael V. Callaghan, University of Calgary, Investigation of Groundwater Flow Paths During Leaching of Salt-affected Soils

Pennan Chinnasamy, University of Missouri, Measuring and Monitoring HydroBiogeochemical Flux in a Forested Riparian Floodplain/wetland

Guillaume Favreau for Ibrahim Maïmouna, Université Montpellier, Impact of Irrigation on Soil and Groundwater Salinity in the Komadugu Yobe Valley, Lake Chad Basin.

Tigistu Haile for Wakgari Furi Konchi, University of Poitiers, Aquifer Geometry and the Impact of Irrigation Water on Groundwater Level Changes in Main Ethiopian Rift

Thomas Harter for Ryan Hines, University of California, Davis, Understanding the Effects of Agriculture-Driven Multiscale Groundwater-Surface Water Interactions on Scott River Baseflow and Stream Temperature in Support of Beneficial Salmon Habitat

Heidar Ali Kashkuli, Islamic Azad University, Groundwater Investigation and Modeling of Buchir-Homeyran Plain, Hormozgan Province, Iran

Daniel B. Marcum, University of California Cooperative Extension, Groundwater Monitoring in Big Valley in the Northeastern California Counties of Lassen and Modoc


Gene-Hua Crystal Ng, MIT, Probabilistic Predictions of Groundwater Recharge Under Climate Change Scenarios in a Dryland Cotton Region of the Southern High Plains

Adaora Unoma Okonkwo, South Africa, Department of Water Affairs, Assessment of the Influence of Geology on Groundwater Quality: A Case Study of Kutama and Sinthumule Areas in Limpopo Province

Pep Mas Pla for A. Folch, Universitat Autònoma de Edifici, Groundwater in Situ Biodenitrification Pilot Test in Fractured Media

Pep Mas Pla for Anna Menció, Universitat de Girona, Spring Water Nitrate Content as Indicator of Hydrological Response to Agricultural Fertilization (Osona region, NE Spain).

Rey A. Rodriguez, H2O R2 Consulting Engineers, Inc., Restoring and Maintaining a Lakes Oxygen Supply Using the RezOX gPRO H2O Oxygenator

Bridget R. Scanlon, University of Texas at Austin, Comparison of Irrigated Agriculture in the U.S. High Plains and North China Plain

Bridget R. Scanlon, University of Texas at Austin, Impacts of Rain-fed and Irrigated Agriculture on Soil Water and Groundwater Salinity

Heejun Suk, Korea Institute of Geoscience and Mineral Resources, Model Development for Analysis of Nitrate Leaching and its Field Application in a Rural Area

Kristine A. Uhlman, University of Arizona, Predicting and Mapping Ground Water Vulnerability to Nitrate in Arizona


Esther J.W. Wattel-Koekkoek, RIVM, Monitoring the Effects of Emission Reduction Policy: Groundwater Quality in Forests and Heathland in the Netherlands

Yohannes Woldeyohannes, La Trobe University, Characterizing Groundwater Dynamics in Western Victoria Using Menyanthes Software