

**Program —
Ninth International Conference on Irrigation and Drainage**

***Improving Irrigation Water Management —
Latest Methods in Evapotranspiration
and Supporting Technologies***



USCID

The U.S. society for irrigation and drainage professionals

Cooperating Organizations

American Society of Agricultural and Biological Engineers

Environmental and Water Resources Institute

American Society of Civil Engineers

October 11-14, 2016

**Hilton Hotel
Fort Collins, Colorado**

Program

Tuesday, October 11

7:00 a.m. - 5:30 p.m. **Registration**

8:00 a.m. - 11:30 a.m. **Field Tour**

This half-day field trip will visit the **Limited Irrigation Research Farm** near Greeley, Colorado. The LIRF is operated by the USDA-ARS Water Management & Systems Research Unit in Fort Collins. The overall goal of the group is to optimize management strategies to sustain irrigated agriculture with limited supplies, and more specific objectives include saving evapotranspiration through growth-stage based deficit irrigation, improving irrigation scheduling by using real-time crop coefficients from ground based remote sensing, and understanding physiological responses to crop water stress. The tour, facilitated by ARS scientist and Agricultural Engineer Kendall DeJonge, will include an overview of the research-based precision irrigation systems, CoAgMet weather station for ET monitoring, and corn and sunflower crops exposed to varying levels of water stress.

12:00 noon - 1:15 p.m. **Lunch with Speaker**

Moderator — **Brian T. Wahlin**, WEST Consultants, Inc., and President, USCID, Tempe, AZ

Speaker — **Neil Grigg**, Colorado State University, Fort Collins, CO

1:30 p.m. - 3:00 p.m. **Opening Plenary Session**

Moderator — **Delbert M. Smith**, Bureau of Reclamation, Denver, CO

Keynote Address

David Palumbo, Deputy Commissioner, Bureau of Reclamation, Washington, DC

ASCE Manual on Evapotranspiration

Richard G. Allen, University of Idaho, Kimberly, ID; and **Marvin E. Jensen**, Fort Collins, CO

Existing and Emerging Water Resource Administration Issues in Colorado

Dick Wolfe, State Engineer, Colorado Division of Water Resources, Denver, CO

3:00 p.m. - 3:30 p.m. **Break**

3:30 p.m. - 5:30 p.m. **Opening Plenary Session,
(continued)**

Using Remote Sensing of ET for Establishing Water Rights in Western China

Liping Jiang, Senior Water Resources Specialist, World Bank, Beijing, China

Can Urban Growth and Irrigated Agriculture Co-Exist in Northern Colorado?

Eric Wilkinson, General Manager, Northern Water, Berthoud, CO

Alternatives to Permanent Water Transfers in Colorado

Becky Mitchell, Colorado Water Conservation Board, Denver, CO

Colorado River System Conservation Pilot Program

Erin M. Wilson, Principal, Wilson Water Group, Lakewood, CO

5:30 p.m. - 6:00 p.m. **Meet the Exhibitors**

6:00 p.m. - 8:00 p.m. **Networking Reception,
Exhibition and Poster Session**

Identification of Agricultural Land Use in California through Remote Sensing

Nicholas Hembree, California Polytechnic State University, San Luis Obispo, CA

A Field Comparison of Soil Moisture Sensors

Jacob Stivers, Oklahoma State University, Stillwater, OK

Remote Sensing Assessments of Full and Partial Irrigation Regimes to Estimate Conserved Consumptive Use of Agricultural Water in Western Slope of Colorado

Amandeep Vashisht, **José L. Chávez** and **Perry Cabot**, Colorado State University, Fort Collins, CO

Comparison of Irrigation Scheduling Options for Southeast Missouri

Earl Vories, Agricultural Research Service, USDA, Portageville, MO; and **William (Gene) Stevens** and **Zach Straatmann**, University of Missouri, Portageville, MO

Wednesday, October 12

7:00 a.m. - 5:00 p.m. **Registration**

7:00 a.m. - 8:00 a.m. **Continental Breakfast in Exhibit Hall**

8:00 a.m. - 10:00 a.m. **Concurrent Technical Session — Evapotranspiration I**

Moderators — **Thomas W Ley**, Natural Resources Consulting Engineers, Inc., Fort Collins, CO; and **Saleh Taghvaeian**, Oklahoma State University, Stillwater, OK

Using Surface Energy Balance Model (ReSET) to Estimate Seasonal Crop Water Use for Large Agricultural Areas — Case Study for the Kingdom of Saudi Arabia

Aymn Elhaddad, Colorado State University, Fort Collins, CO; and **Luis A. Garcia**, University of Vermont, Burlington, VT

Comparison of Daily Evapotranspiration Estimates for Sprinkler-Irrigated Sugar Beets from a Cloud-Based Irrigation Scheduling Tool and Remote Sensing

Allan A. Andales and **Aymn Elhaddad**, Colorado State University, Fort Collins, CO; **Andrew C. Bartlett**, Northeastern Junior College, Sterling, CO; and **Mingze Yao**, Colorado State University, Fort Collins, CO

Sensitivity of Reference ET to Weather Station Sensor Accuracy

Kendall DeJonge, Agricultural Research Service, USDA, Fort Collins, CO

Seasonal ETc Estimation: Random and Systemic Error

Garrett Banks, **Kendall DeJonge** and **Tom Trout**, Agricultural Research Service, USDA, Fort Collins, CO

8:00 a.m. - 10:00 a.m. **Concurrent Technical Session — Irrigation Management I**

Moderators — **Eduardo Bautista**, Agricultural Research Service, USDA, Maricopa, AZ; and **Tom Gill**, Bureau of Reclamation, Denver, CO

Irrigation Scheduling of Apple Orchards Based on Soil-Moisture in Prespa Region of the Republic of Macedonia for Reducing Irrigation Water Use

Ordan Chukaliev and **Vjekoslav Tanaskovik**, Saints Cyril-Methodius University, The Republic of Macedonia; and **Mohan Reddy Junna**, Colorado State University, Fort Collins, CO

Integration of Remotely Sensed Drought and Evapotranspiration Products for Improved Irrigation Water Management

Kul Khand and **Saleh Taghvaeian**, Oklahoma State University, Stillwater, OK

Performance Evaluation of Irrigation Systems in Western Oklahoma

Blessing Masasi, **Saleh Taghvaeian** and **Scott Frazier**, Oklahoma State University, Stillwater, OK

Drip/Micro Performance in California — an Update

Charles M. Burt, Irrigation Training and Research Center, San Luis Obispo, CA

10:00 a.m. - 10:30 a.m. **Break in Exhibit Hall**

10:30 a.m. - 12:00 noon **Concurrent Technical Session — Evapotranspiration I (continued)**

Moderators — **Thomas W. Ley** and **Saleh Taghvaeian**

Use of Unmanned Aircraft System in Environmental and Hydrological Research and Management

Jeff Sloan, **Todd Burton**, **Mark Bauer** and **Joe Adams**, U.S. Geological Survey, Denver, CO

Issues Encountered Operating an UAS for Crop ET Estimations

José L. Chávez and **Joseph Yu Zhang**, Colorado State University, Fort Collins, CO; **Huihui Zhang**, Agricultural Research Service, USDA, Fort Collins, CO; and **Wayne Woldt**, University of Nebraska-Lincoln, Lincoln, NE

A Heat-Pulse Method for Measuring Sap Flow in Corn and Sunflower using 3D-printed Gauges and Low-Cost Electronics

Grace Lloyd Miner and **Jay M. Ham**, Colorado State University, Fort Collins, CO; and **Gerard J. Kluitenberg**, Kansas State University, Manhattan, KS

10:30 a.m. - 12:00 noon **Concurrent Technical Session — Irrigation Management I (continued)**

Moderators — **Eduardo Bautista** and **Tom Gill**

Variable-Rate Irrigation Technology for Overhead Sprinkler Systems in the Central Arizona Valley

K. R. Thorp and **K. F. Bronson**, Agricultural Research Service, USDA, Maricopa, AZ

Irrigation with Swine Effluent: Effects on Soil and Subsurface Drip Irrigation System

Patrick Fox, **Saleh Taghvaeian** and **Hailin Zhang**, Oklahoma State University, Stillwater, OK

Predicting Irrigation Efficiency in the Rio Grande Project

Gerardo “Jerry” Melendez, Bureau of Reclamation, El Paso, TX; and **Shane Walker**, **John Walton** and **Stanley Mubako**, University of Texas at El Paso, El Paso, TX

12:00 noon - 1:15 p.m. **Lunch with Speaker**

Moderator — **Brian T. Wahlin**, WEST Consultants, Inc., and President, USCID, Tempe, AZ

Speaker — **Signe Snortland**, Area Manager, Bureau of Reclamation, Loveland, CO

1:30 p.m. - 3:00 p.m. Concurrent Technical Session — Evapotranspiration II

Moderators — **Kendall DeJonge**, Agricultural Research Service, USDA, Fort Collins, CO; and **José L. Chávez**, Colorado State University, Fort Collins, CO

Verification of Reduced Consumptive Use from Deficit Irrigated Pastures in the Upper Colorado River Basin Using Landsat Data

L. Niel Allen and **Alfonso Torres-Rua**, Utah State University, Logan, UT

Variable Rate Irrigation Management Using a Remote Sensing Water Balance Model

J. Burdette Barker, **Derek M. Heeren**, and **Christopher M. U. Neale**, University of Nebraska-Lincoln, Lincoln, NE

Alfalfa Evapotranspiration Estimation: One Step Model

Abhinaya Subedi, **José L. Chávez** and **Allan A. Andales**, Colorado State University, Fort Collins, CO

1:30 p.m. - 3:00 p.m. Concurrent Technical Session — Irrigation Management II

Moderators — **Charles M. Burt**, Irrigation Training and Research Center, San Luis Obispo, CA, and **Samuel W. Schaefer**, GEI Consultants, Inc., Santa Barbara, CA

Hydraulic Analysis of Surface Irrigation Systems with WinSRFR 5

Eduardo Bautista and **James L. Schlegel**, Agricultural Research Service, USDA, Maricopa, AZ

Irrigation Management Using Wi-Fi Based Smart Controllers

Mark A. Crookston, Northern Water, Berthoud, CO

Maximizing Yield per Unit of Water Consumption

Daniel Howes, California Polytechnic State University, San Luis Obispo, CA; and **Charles M. Burt**, Irrigation Training and Research Center, San Luis Obispo, CA

3:00 p.m. - 3:30 p.m. Break in Exhibit Hall

3:30 p.m. - 5:30 p.m. Concurrent Technical Session — Evapotranspiration II (continued)

Moderators — **Kendall DeJonge** and **José L. Chávez**

Deficit Irrigation: Solution to Sustain Irrigated Agriculture?

Manijeh Mahmoudzadeh Varzi and **Ramchand Oad**, Colorado State University, Fort Collins, CO

Crop Water Use by Corn in the Central High Plains under Full and Deficit Irrigation

Tom Trout and **Kendall DeJonge**, Agricultural Research Service, USDA, Fort Collins, CO

Evapotranspiration Measurement and Modeling in Mid-South Irrigated Rice

Bryant Fong and **Michele L. Reba**, Agricultural Research Service, USDA, Jonesboro, AR

Remote Sensing of ET Based on Aerodynamic Temperature

José L. Chávez, Colorado State University, Fort Collins, CO; **Christopher Neale**, University of Nebraska-Lincoln, Lincoln, NE; **Terry Howell**, Agricultural Research Service, USDA, Bushland, TX; **Marcos Carrasco-Benavides**, Universidad Católica del Maule, Curicó, Chile; and **Allan Andales** and **Mahmoud Soliman**, Colorado State University, Fort Collins, CO

3:30 p.m. - 5:30 p.m. Concurrent Technical Session — Irrigation Management II (continued)

Moderators — **Charles M. Burt** and **Samuel W. Schaefer**

Real-Time Monitoring of Soil Moisture Sensors: A Tool to Maximize Water Use Efficiency

Diganta D. Adhikari and **Tom Penning**, Irrrometer Company, Inc., Riverside CA

Soil Salinity Dynamics under Irrigated Cotton in Southwest Oklahoma

Samia Amiri and **Saleh Taghvaeian**, Oklahoma State University, Stillwater, OK

Deficit Irrigation Strategies for Strawberry in California: Yield Performances and Water Savings

Jean Caron, **Lélia Anderson** and **Guillaume Sauvageau**, Université Laval, Québec, Canada; and **Oleg Daugovesh**, University of California Cooperative Extension, Ventura, CA

Integration of Soil Moisture and Geophysical Datasets for Improved Water Resource Management in Irrigated Systems

Catherine Finkenbinder, **Trenton E. Franz**, **Derek M. Heeren**, **Justin Gibson** and **Matt Russell**, University of Nebraska-Lincoln, Lincoln, NE

6:30 p.m. - 7:00 p.m. Reception

7:00 p.m. - 9:00 p.m. Awards Dinner with Speaker

Moderator — **Brian T. Wahlin**

Conjunctive Use in Ancient Peru

Kenneth R. Wright, Wright Water Engineers, Denver, CO

Thursday, October 13

7:00 a.m. - 5:00 p.m. **Registration**

7:00 a.m. - 8:30 a.m. **Continental Breakfast Exhibit Hall**

8:00 a.m. - 10:00 a.m. **Technical Session — Irrigation Management III**

Moderators — **Gerald A. Gibbens**, Northern Water, Berthoud, CO; and **Byron Clark**, Davids Engineering, Inc., Davis, CA

Conjunctive Use of Surface and Groundwater at Mirage Flats Irrigation District

Tom Gill, Bureau of Reclamation, Denver, CO; and **Brett Skinner**, Mirage Flats Irrigation District, Hay Springs, NE

Conjunctive Use of Groundwater and Surface Water for Sustaining Irrigated Agriculture in a Humid Region

Gary Feng, Agricultural Research Service, USDA, Mississippi State, MS; **Liwang Ma**, Agricultural Research Service, USDA, Fort Collins, CO; **Ying Ouyang**, Forest Service, USDA, Mississippi State, MS; and **Johnie Jenkins**, Agricultural Research Service, USDA, Mississippi State, MS

Web-Based Decision Support for Sustainable Salinity Management in the San Joaquin River Basin

Nigel W.T. Quinn, Lawrence Berkeley National Laboratory, Berkeley, CA; **Jun Wang**, Bureau of Reclamation, Sacramento, CA; **Joel Herr**, Systech Water Resources Inc., Walnut Creek, CA; **Amye Osti**, 34 North Inc., Truckee, CA; and **Michael Mosley** and **Jobaid Kabir**, Bureau of Reclamation, Sacramento, CA

Optimization of Hydro Power System at TransAlta

Massimiliano Parisi, KISTERS North America, Citrus Heights, CA; and **German Mojica**, TransAlta, Calgary, Alberta, Canada

8:30 a.m. - 10:00 a.m. **Evapotranspiration Workshop — Session 1, Introduction**

Workshop Goal: Accurate, efficient, and standardized methods to estimate historic (25 – 50 year), recent (previous year), and current (previous month) consumptive use for the purpose of documenting historic CU and CU savings for water transfers and augmentation requirements.

ET Workshop Goals

Tom Trout, Agricultural Research Service, USDA, Fort Collins, CO

Colorado Division of Water Resources Needs for Consumptive Use Estimation

Jeff Deatherage, Colorado Division of Water Resources, Denver, CO

What the CWCB Needs and Can Help Fund.

Steve Miller, Colorado Water Conservation Board, Denver, CO

Recommended B-C TR-21 Procedures: Crop Coefficients, Elevation Adjustment, Calibration, and Estimating Irrigation Efficiency

Dean Santistevan, Colorado Division of Water Resources, Greeley, CO

Update on Arkansas Valley Lysimeter Operations

Allan Andales, Colorado State University, Fort Collins, CO

The Water Irrigation Scheduler for Efficiency (WISE)

Allan Andales, Colorado State University, Fort Collins, CO

10:00 a.m. - 10:30 a.m. **Break in Exhibit Hall**

10:30 a.m. - 12:00 noon **Technical Session — Irrigation Management III (continued)**

Moderators — **Gerald A. Gibbens** and **Byron Clark**

“Reservoir Operations” (A case study of Chowtiary Reservoir)

Mansoor Ahmed Memon and **Shoaib Ahmed Sugrio**, Irrigation Department, Sindh, Pakistan

Reservoir Operation at Terbela Dam Project During Floods

Sajid Ali Bhutto, Irrigation Department, Government of Sindh, Sindh, Pakistan

Irrigation Design for Riparian Establishment on the San Joaquin River Restoration Project

Rebecca Kallio, Bureau of Reclamation, Denver, CO

10:30 a.m. - 12:00 noon **Evapotranspiration Workshop — Session 2, Weather Data**

Weather Data for ET Calculations: CoAgMet

Nolan Doeskin, State Climatologist, Fort Collins, CO

Weather Data for ET Calculations — Northern Water

Mark Crookston, Northern Water, Berthoud, CO

QA/QC and Calibration of Standardized, Long-Term, and Basin-Wide Reference ET Datasets

Kelley Thompson, Colorado Division of Water Resources, Denver, CO

12:00 noon - 1:15 p.m. **Lunch with Speaker**

Moderator — **Brian T. Wahlin**

EEFlux: Google Earth Engine ET — ET Maps for the Public — Current Status

Richard G. Allen, University of Idaho, Kimberly, ID

1:30 p.m. - 3:00 p.m. **Technical Session — Irrigation Management IV**

Moderators — **Blair L. Stringam**, New Mexico State University, Las Cruces, NM; and **Tony Wahl**, Bureau of Reclamation, Denver, CO

Reforming Irrigation Management in the Former Soviet Union: the Case of Georgia

Mark Svendsen, Water Resource Consultant, Philomath, OR

Applying DWR's IDC Method for Estimating Ag Water Demand in Northern Cities Management Area

Samuel W. Schaefer, GEI Consultants, Inc., Santa Barbara, CA; and **Ashlee Casey**, GEI Consultants, Inc., Rancho Cordova, CA

Rain Comes from Clouds, Why Not Your Data? Integrating ET, Weather, Soil Moisture, and Water Flows with User Interface

Greg Allen, REDtrac LLC, Bakersfield, CA

1:30 p.m. - 3:00 p.m. **Evapotranspiration Workshop — Session 3, Crop Coefficients and Deficit Irrigation**

Deficit Irrigation Options in Colorado and Need for ET Monitoring

Jon Altenhofen, Northern Water, Berthoud, CO; **José L. Chávez**, Colorado State University, Fort Collins, CO; and **Kendall DeJonge**, Agricultural Research Service, USDA, Fort Collins, CO

Adapting Crop Coefficients for Local Conditions

Richard G. Allen, University of Idaho, Kimberly, ID

Potential ET Estimates from Reflectance-Based Crop Coefficients and Reference ET: TOPS-SIMS

Tom Trout, Agricultural Research Service, USDA, Fort Collins, CO

3:00 p.m. - 3:30 p.m. **Break in Exhibit Hall**

3:30 p.m. - 5:00 p.m. **Technical Session — Irrigation Management IV (continued)**

Developing Kimberlina Avenue Recharge Basin in the Shafter-Wasco Irrigation District

Samuel W. Schaefer, GEI Consultants, Inc., Santa Barbara, CA; **Dana Munn**, Shafter-Wasco Irrigation District, Bakersfield, CA; and **Matt Wicks**, GEI Consultants, Inc., Bakersfield, CA

Sustaining Irrigated Agriculture in the Lower Gunnison River Basin Using Efficiency and Economics

Perry Cabot, Colorado State University, Grand Junction, CO; and **David Kanzer**, Colorado River Water Conservation District, Glenwood Springs, CO

Developing Incentive Programs for On Farm System Improvements

Owen E. Kubit, Provost & Pritchard Consulting Group, Clovis, CA

3:30 p.m. - 5:00 p.m. **Evapotranspiration Workshop — Session 4, Remote Sensing of ET**

Large-Scale Evaporative Demand: Opportunities In Re-Analysis, Forecasting, and Projections

Mike Hobbins, NOAA, Boulder, CO

Field-Scale Actual ET Estimates Using the Operational Simplified Surface Energy Balance (SSEBop) Approach with Landsat Imagery

Gabriel Senay, U.S. Geological Survey, Fort Collins, CO

Mapping ET at Fine Spatial and Temporal Resolution by Fusing Multiple Satellite Resources

Martha Anderson, Agricultural Research Service, USDA, Beltsville, MD

Panel Discussion of Remote Sensing Methods

Session Presenters

Summary and Closing Comments

Tom Trout, Agricultural Research Service, USDA, Fort Collins, CO

Friday, October 14

8:00 a.m. - 4:30 p.m. **Field Tour with lunch**

Northern Water will host the Friday tour, where participants will visit Northern Water's headquarter facilities and interpretive gardens, east slope facilities of the Colorado Big-Thompson Project, the Robert V. Trout Hydropower Plant at Carter Lake, the proposed Glade Reservoir and Chimney Hollow reservoir sites, and the Colorado State University Hydraulics Lab. Lunch will be held on the shores of Horsetooth Reservoir, and include a visit to the new Horsetooth Area Information Center. The afternoon stops include a tour of the Historic Bellvue Hydraulics Laboratory.

Early fall is the best time to be out in Northern Colorado, with crisp cool mornings and warm sunny days. Make sure to bring a light jacket!

(October 2, 2016)