USCID NEWSLETTER

Winter 2014 | USCID | Issue No. 116

The U.S. society for irrigation and drainage professionals

Canal Automation

Next Up: Phoenix

The **USCIO Fall Conference** will take place in sunny Arizona, December 2-5, 2014. The theme is *Planning, Operation and Automation of Irrigation Delivery Systems.* The Conference will provide an ideal forum for farmers and irrigation districts to learn about new advances in canal automation, as well as share their ideas and experiences with others.

The Conference will feature the work of the EWRI Task Committee on Recent Advances in Canal Automation, and participants will receive the just-published *Canal Automation Manual of Practice.*

An exhibition, field tours and social events will round out the program.

The Call for Papers is online at www.uscid.org. The deadline for abstracts is May 12.o

USCIO, GRA Meet in Sacramento

by Conference co-chairs Steve Macaulay, Macaulay Water Resources; and Bryan Thoreson, Davids Engineering, Inc.

USCID and the Groundwater Resources Association of California organize a very successful Conference on March 4-7. The co-located Conference addressed the theme ***Groundwater Issues and Water Management - Strategies Addressing the Challenges of Sustainability.*** The event included more than 75 presentations from USCID and ORA speakers covering a broad range of topics, from technical to legal and policy issues related to water management challenges in the West. While most presentations were related to groundwater in some respects, other

(continued on page 19)

Benefits of the South San Joaquin Irrigation District's Pilot Pressure Irrigation Project

by Jeff Shaw and Todd Kotey, Stantec Consulting, Rocklin, California

Editor's note: This paper was presented during the USCID Denver Conference, October 2013.

The South San Joaquin Irrigation District has historically delivered water to farmers through 400 miles of gravity-based canals and pipelines. Farmers drew from the network of laterals at scheduled times via flood irrigation or private pumps used for sprinkler or drip systems.

While the system works well for flood irrigation, the combination of flood and sprinkler usage on a single system becomes problematic. As a result, some customers did not buy water from the SSJID, opting instead to draw from their private, salinity stricken wells.

(continued on page 6)

President's Message

If you were unable to attend the recent ***Groundwater Issues and Water Management - Strategies Addressing the Challenges of Sustainability*** Conference in Sacramento, you missed an excellent and timely meeting. Conference attendees found the lively panel discussion interesting and informative and praised the opportunity to attend sessions of the co-located Conference of the California Groundwater Resources Association. You can read more about the successful Conference in the adjacent article.

You won't want to miss the ***Planning, Operation and Automation of Irrigation Delivery Systems*** Conference coming up later this year in Phoenix, at a perfect time of year to be in the Valley of the **Sun,** early December. The technical program will be scintillating, with the Conference focusing on canal automation. As described in the accompanying article, this Conference will be held in cooperation with the Task Committee on Recent Advances in Canal Automation, Environmental and Water Resources Institute, ASCE. Conference attendees will receive the new, hot-off-the-press *Canal Automation Manual of Practice.* The Call for Papers is on the USCID website. Successful conferences are made by members sharing their

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Inside ...

USCID

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The United States Committee on Irrigation and Drainage is a National Committee of the International Commission on Irrigation and Drainage.

USCID

Mission Statement

The Mission of the United States Committee on Irrigation and Drainage is to foster sustainable, socially acceptable and environmentally responsible irrigation, drainage and flood control systems and practices for providing food, clothing and shelter to the people of the United States and the World.

USCID Newsletter and Membership

The *USCID Newsletter* is published in Winter, Spring and Fall for USCID Members. News items and technical articles of interest to the irrigation community are invited. Membership information is available on the USCID website.

Standing Committees — Committee Chairs

Membership	Laura A. Schroeder
Technical Activities	Luis A. Garcia
Newsletter and Website	Charles M. Burt
Research and Special Studies	John A. Replogle
Long Range Planning and Conferences	Grant G. Davids

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Sustaining Member

- **Bureau of Reclamation**

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- **Advanced Drainage Systems**
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Institutional Members

- **American Academy of Water Resources Engineers**
- **Colorado Water Institute**
- **Irrigation Training & Research Center**
- **Pueblo of Sandia**

Membership Directory

The most recent Membership Directory is online in the Members Only section of the USCID website — www.uscid.org. In addition to contact information for each Member, the Directory includes member listings by state and organization, as well as information about USCID and ICID work body memberships.

ICID News and Activities

ICID·CIID

E-Books Now Available

The following ICID publications issued from 2000 to 2012 are now available for a nominal charge at www.debooks.in/catalog/show/icid/82/1/title_asc/0/all/list/.

- *Climate Change Adaptation for Irrigation and Drainage in Asia*, 2012.
- *Towards Sustainable Development of Tidal Areas – Principles and Experiences*, 2011.
- *Water Saving in Agriculture*, 2008.
- *Report of ICID Task Force for Least Developed Countries in Asia*, 2008.
- *Manual for Performance Evaluation of Sprinkler and Drip Irrigation Systems in Different Agro-Climatic Regions of the World*, 2008.
- *Micro Irrigation in Arid and Semi-Arid Regions – Guidelines for Planning and Design*, 2006.
- *Planning and Designing of Micro-Irrigation in Humid Regions*, 2005.
- *Application of Geosynthetics in Irrigation and Drainage Projects*, 2004.
- *The Indus Basin – History of Irrigation, Drainage and Flood Management*, 2004.
- *Danube Valley – History of Irrigation, Drainage and Flood Control*, 2004.
- *Historical Dams*, 2001.
- *Canal Operation Simulation Models*, 2000.
- *ICID Survey on Funding of Operation, Maintenance and Management of Irrigation Projects*, 2000.
- *Remote Sensing and Geographic Information Systems in Irrigation and Drainage – Methodological Guide and Applications*, 2000.¤

ICID Invites WatSave Nominations

ICID is inviting nominations for the 2014 WatSave Awards to recognize outstanding contributions to water savings/conservation in agriculture. ICID must receive nominations (via USCID) by May 30.

WatSave Technology Award

This award is presented to promote and encourage the best technological applications or projects which have been successful in saving water.

WatSave Innovative Water Management Award

This award is presented for promoting non-technological interventions and/or innovative land and water management/techniques for increasing the availability of water for different uses; promoting research that leads to substantial savings in water applications or uses; or promoting development of new policies/approaches for water saving, leading to cost effective and beneficial use of water.

WatSave Young Professionals Award

This award is presented for promoting water saving technologies, innovative water management practices, original research leading to substantial water saving/conservation, etc., by young professionals (younger than 40).

WatSave Farmer Award

The WatSave Farmer Award is given to a farmer(s) for proven water saving success story to promote successful water conservation.

The WatSave Awards will be presented during the 65th Meeting of the IEC in Gwangju Metropolitan City, Republic of Korea. Contact USCID (stephens@uscid.org) or visit www.icid.org/awards_ws.html for more information.¤

22nd ICID Congress

September 14-20, 2014 — Gwangju, Korea

Congress Theme: *Securing Water for Food and Rural Community under Climate Change*

Question 58: *How do irrigation and drainage play an important role in climate change adaptation?*

Question 59: *How do irrigation and drainage interventions secure food production and livelihood for rural community?*

Special Session: *New Partnership for Rural Development*

Symposium: *Non-Point Sources Pollution (NPS) and Best Management Practices (BMPs)*

Online Registration and Hotel Reservations now available:

www.icid2014.org

Pilot Pressure Project (continued)

The SSJID board commissioned Stantec Consulting as a partner in developing an irrigation program that could improve delivery efficiency and service. A portion of one of the district's nine divisions — 3,800 acres in Division 9 — was chosen as the site for building, testing and optimizing a pilot pressure irrigation project.

The newly completed pressurized irrigation system is among the most water-efficient in the agricultural industry. Designed to be an industry model for water efficiency and provide area growers with individualized, automated irrigation access through the use of online and mobile technology, the new system was designed and constructed over a three-year period. Design of the new system was developed and implemented as a cooperative effort between Stantec Consulting and the SSJID.

The project consists of a 19-mile network of pipelines with flexible pressurization (currently set at 60 psi), a 56-acre-foot water storage basin, a 1,225-hp pumping station containing seven vertical turbine pumps capable of pumping a total of 23,500 gal/min (52.4 ft^3/s), and a total of 55 solar-powered Field Telemetry Units controlling 77 customer connections. The FTUs consist of a PV panel, a flow control valve and meter, and a radio based supervisory control that communicates with data acquisition system in the pump control room.

With the new system, irrigation water is distributed to the customers across 3,800 acres of California's Central Valley through an automated channel. Using an online system similar to an airline ticketing platform, growers in the District's Division 9 are able to log in and schedule water deliveries. Additional information on current and past weather forecasts, previous water usage, historical evapotranspiration rates and real-time moisture sensor readings are also available on the website. Each farmer selects from available delivery dates and receives alerts via email and text message before and after delivery to confirm volume and flow rate data. To promote efficient water usage, moisture sensors placed in the ground on each grower's property will help indicate optimal ordering times when orchards are at their greatest need. This paper will focus on the realized benefits of the Division 9 Pressure System Project.

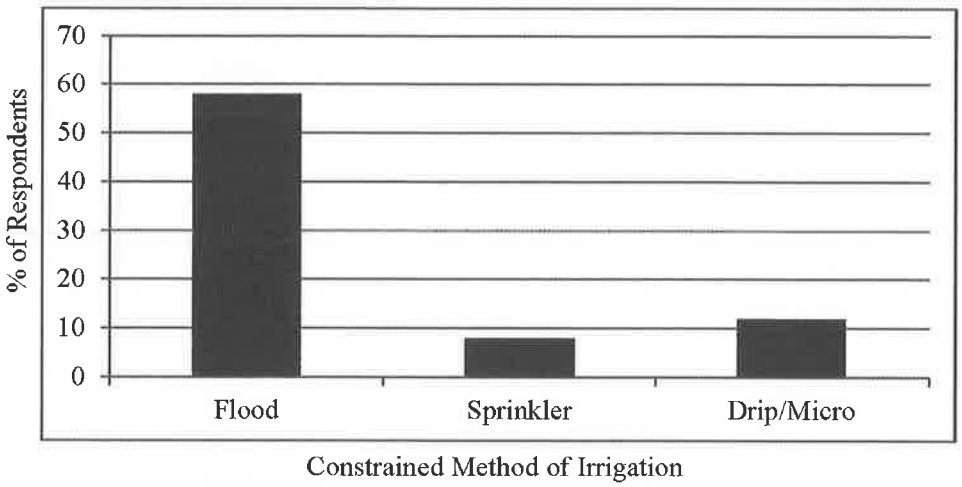


Figure 1. Percent of surveyed SSJID farmers for each irrigation application method who irrigate based on surface water availability.

Irrigation Service

An irrigation service study was conducted in 2012 by Davids Engineering in conjunction with the District's On-Farm Conservation Program to assess the current service quality the District is providing to its customers. Survey results related to irrigation water availability, flow rate and duration are detailed below. As a comparison, customers of the pressure system are now receiving irrigation water at the exact time, flow rate, pressure and duration they desire. In addition, the reduced number of customers using the gravity system has allowed the flood runs to be accomplished faster and more efficiently, with less stress on the previously overloaded gravity system and reduced long term maintenance costs.

Availability

Figure 1 shows the percent of surveyed SSJID farmers for each irrigation application method who irrigate based on surface water availability. With the Division 9 pressure system, zero farmers irrigate based on surface water availability; the farmers irrigate when their crops need it.

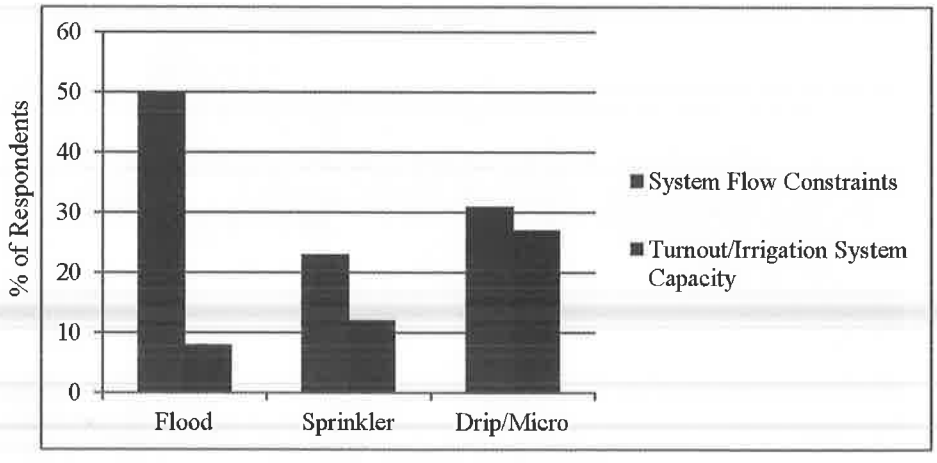


Figure 2. Percent of surveyed SSJID farmers for each irrigation application method who determine flow rate based on infrastructure limitations.

Flow Rate

Figure 2 shows the percent of surveyed SSJID farmers for each irrigation application method who determine flow rate based on District infrastructure system flow constraints and/or District infrastructure turnout system capacity. With the Division 9 pressure system, zero farmers determine flow rate based on District infrastructure system flow constraints and/or District turnout system capacity; the farmers irrigate at the exact flow rate they desire.

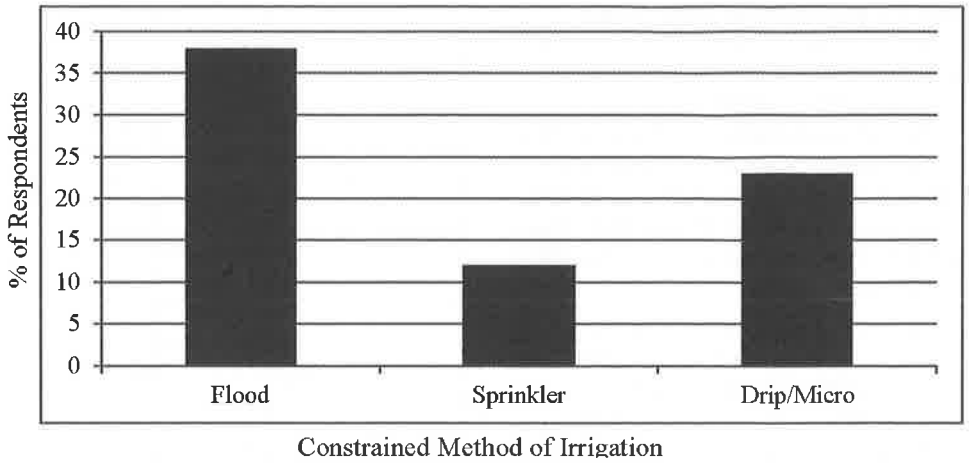


Figure 3. Percent of SSJID farmers for each irrigation application method who determine irrigation duration based on infrastructure constraints.

Water Conservation Act Compliance

A growing population and competing demands for limited water resources prompted California to pass the Water Conservation Act. In addition to a 20 percent reduction in per-capita urban consumption by 2020, the law requires agricultural suppliers to "implement efficient water management practices" and volumetric pricing. With a statewide assessment of water use under way, the SSJID Board of Directors realized the issue posed a potential threat and approved the Division 9 pressure system upgrade to demonstrate the District is proactively addressing California's conservation goals. The Division 9 system efficiently manages water delivered by reducing water needs by up to 30 percent (Dunbar, 2012) and accounts for water use through magnetic flow meters at each customer connection.

Volumetric Billing

The farmers in the SSJID service area have historically been charged a flat rate of $24/acre for irrigation water. To come into compliance with the Water Conservation Act, the SSJID is required to bill water deliveries volumetrically. A typical 40-acre orchard has numerous valve structures used to flood irrigate the land. This poses a very difficult and expensive challenge for the District to comply with, due to the thousands of exit points off of the gravity system. With the Division 9 pressure system, each customer has one connection point, with a magnetic flow meter to measure and transmit water deliveries; historic data are automatically stored on the District's server for uploading into the District's billing software.

Reliability and Access to District's Water Supply

The District's fixed, 10-day delivery schedule does not provide an optimal water supply at the frequency needed to maximize yield of crops. The Division 9 pressure system's East Basin Pump Station doubles as a regulating reservoir, storing and pumping irrigation water to 77 customer connections on an on-demand basis.

Conversion from Flood to Sprinkler Irrigation

The introduction of the Division 9 pressure system induced a demand to convert from flood irrigation to sprinkler/drip application methods. Of the 77 customer connections in the system, 18 have installed sprinkler or drip systems immediately after the pressure system was available to serve their land. The increased use of sprinkler/drip increases the irrigation efficiency of the farming operation and contributes to the goal of maximizing beneficial use of the District's water rights.

Renewable Energy

The abundant sunlight in the Central Valley of California is one of the reasons why agriculture is so successful. The Division 9 pressure system taps this readily available solar energy to meet the power demands of all of the customer connections. The solar system powers the solenoids of the flow control valve, magnetic flow meter, moisture sensors, process logic controller, and radio communications to operate the turnouts and provide real time information on flow rate, crop moisture conditions, turnout pressure, control and battery component status, and delivery details (start time, end time, total hours irrigated, average flow rate, total water delivered).

Water Conservation

The Division 9 pressure system includes a number of conservation features that contribute to the District's water savings. These measures include drip and sprinkler conversions, a tail water recovery system, intelligent irrigation scheduling and soil moisture monitoring.

From a conservation perspective, delivering the right amount of water (and nothing more) to the District's irrigation customers through 400 miles of gravity based pipelines spanning approximately 72,000 acres is very problematic and often times causes spills to the drain. During drought years, when water conservation is paramount, infrastructure that allows precise and accurate water deliveries that match a farmer's actual water needs is a crucial asset to ensure that the water needs of all of the District's customers can be met. Frank Avila, SSJID's telemetry and SCADA manager, reports that the new pressure system reduced spills to the drains in Division 9 by 5,000 acre-feet in the 2012 irrigation year.

The ten year average water supply (2002-2011) to the Division 9 pressure system customer base has been 7,528 acre-feet. The summation of water deliveries (calculated via magnetic flow meters at each customer connection) through the pressure system for the first year amounted to 4,695 acre-feet. Thus, a 2,833 acre-foot conservation has been achieved.

On a water delivered per acre basis, the savings are magnified because 50 percent of the customers of the pressure system were using their own wells prior to the pressure irrigation system being constructed. With the introduction of the Division 9 pressure system, the District was able to re-enroll these farmers and get them to reduce ground water pumping and use higher quality surface water. Prior to the pressure system, 19,924 acre-feet of water was delivered to Division 9 to support 3,151 acres, or 6.32 feet of water per acre. Water deliveries for the pressure system customer connection for the 2012 irrigation year amounted to 4,695 acre-feet to support 2,389 acres, or 1.96 feet of water per acre. In addition to the Division 9 water conservation, Davids Engineering found that SSJID's On-Farm Conservation Program is also producing water savings using many of the same measures featured in the Division 9 project.

Farmer Operating Costs

A case study was conducted at the end of the 2012 irrigation season on three customer pressure system turnouts that previously elected to not take District water and use their own wells to pump water from the groundwater aquifer. When the current diesel fuel costs and their historical records of run time hours are compared to the $30/acre-foot the District charges for delivered pressurized water, the farmers at these three locations are experiencing between 34-67 percent reductions in costs for pressurized irrigation water. These numbers do not factor in costs the farmers historically incurred to maintain their personal pumps and the increased labor costs of a manual irrigation operation compared to the fully automatic pressurized water the District now supplies.

Conservation Measure	Fields Evaluated	% of Fields Evaluated for each Conservation Measure	Acres	% of Acres Evaluated for each Conservation Measure	True Point Deliveries, ac-ft (March - October)		Preliminary Conservation Estimate	
					2010	2011	ac-ft	inches
Drip Conversion	8	53%	379	54%	1093	719	374	11.8
Sprinkler Conversion	4	80%	220	90%	472	373	99	5.4
Tail water Recovery	0	NA	0	NA	NA	NA	NA	NA
Grower Proposed	1	11%	25	10%	100	101	-1	-0.6
Irrigation Scheduling	7	30%	278	30%	996	721	275	11.9
Soil Moisture Monitoring	47	61%	1,497	58%	5,242	4,695	547	4.4
Totals	67	51%	2,399	45%	7,902	6,608	1,294	6.5

Table 1. Water conservation results from SSJID's On-Farm Conservation Program (Davids, 2012).

	Farmer Savings
Orchard 1	34%
Orchard 2	67%
Orchard 2	52%

Table 2. Farmer savings from pressurized system compared to energy costs to pump from private well.

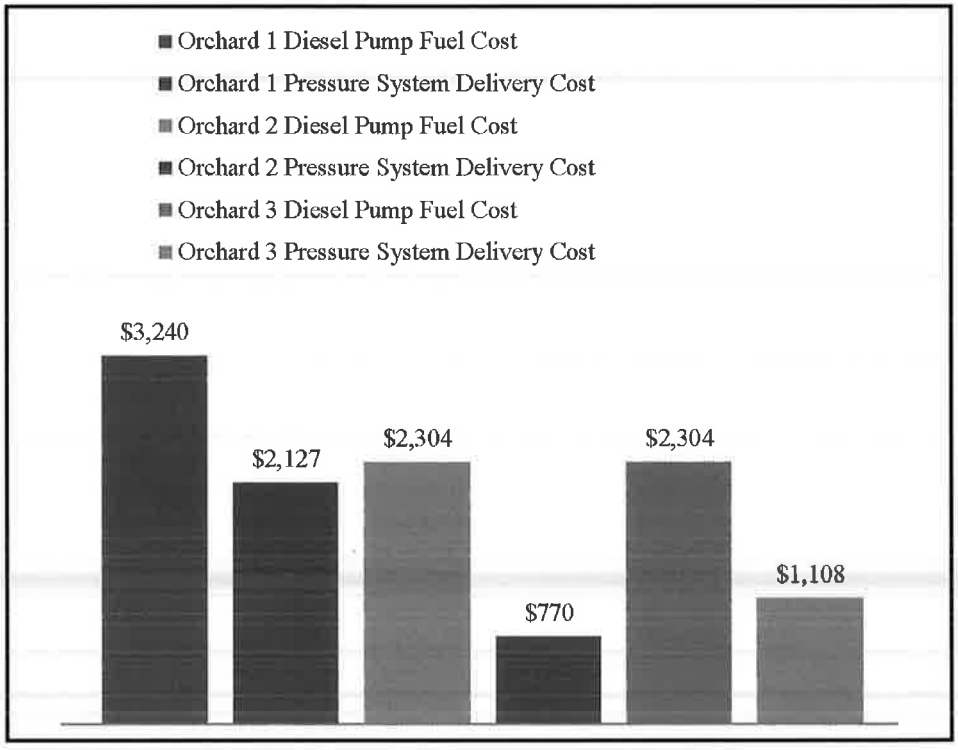


Figure 4. Comparison of farmer fuel cost to pump water from private well to meet irrigation demands vs. SSJID supplied pressurized water for a peak summer month.

Groundwater Pumping and Air Quality

The irrigation service component of this project was conceived because growers in this immediate area were coming into our office and complaining that the groundwater was getting too salty to apply to permanent crops and the cost of running pumps was chewing up profits," SSJID General Manager Jeff Shields said (Campbell, 2012). The Division 9 pressure system has reduced the acreage pumping from the ground water aquifer by 50 percent, according to the Division 9 Manager Michael Donahue. Groundwater pumping in the Division 9 area was primarily conducted using diesel driven pumps. The reduction in diesel emissions has improved the air quality, and the high quality surface water has improved crop (primarily almond and walnut orchards) health.

Fertilizer Application

Farmers participating in the pressure system to a large extent are using direct injection of fertilizer at their filter stations and delivering chemicals directly to the root zone area; reducing the deposition of fertilizer in the local surface and ground water.

Irrigation Scheduling and Account Management

To provide a manageable pressure system for both the SSJID and the customers, a user-friendly software interface to replace the practice of phoning in delivery orders was crucial. Since creating an interactive tool required a two-way conversation, sizeable portions of early community meetings were devoted to gathering insight into the features, capabilities, and information farmers felt would be helpful for scheduling deliveries online. Through a web-based interface entitled "The Division 9 Irrigation Information Center," each farmer has been assigned a unique platform to service all of their irrigation related needs. Tools at the farmers fingertips to plan their irrigations includes national weather service alerts for the area (including frost and wind alerts), weather forecasts, Doppler radar imaging, customizable and exportable/printable charts on past weather (rainfall, wind, temperature, humidity, evapotranspiration rates), water deliveries (time start, time end, total hours irrigated, average flow rate and total water delivered) and moisture sensor information. After the farmer has analyzed all of the information, an irrigation can be completed with only three selections. Via an airline ticketing type calendar, a farmer selects a date, followed by the number of hours of irrigation desired. The website immediately queries system capacity for the requested date, times and flow rate, and displays available times for the requested day (order time options are normally available on the hour every hour). If there are times unavailable for the requested day, the system gives all time options 48 hours before and after the requested day for the farmer to select. After the farmer selects the optimal time, text and email alerts notify the farmer (24 hours and 1 hour prior to irrigation, and an irrigation delivery summary after the order has completed). Full account management is available through the website to keep the customers apprised of their records on file at the District.

Next Generation of Farmers

While it's a stark departure from the way that agriculture has been approached in the area for decades, younger generations that are set to take over operations at some point are more likely to pick up and embrace the new technology. It is something that SSJID Engineering Department Manager Sam Bologna said he has already seen playing itself out. "We had a father out here with his son that will more than likely take over the operation and he's already up to speed on the system — we expected that would be the case with the younger generations that are savvier with technology," he said (Campbell, 2012).

Yields

Although it will take many years of data to figure the increase in yield due to the Division 9 pressure system project, evidence from other case studies leads the District to believe that farmers will see an increase in yield of up to 30 percent according to the Jeff Shields, General Manager of SSJID.

Pests and Disease

With increased control of irrigation timing, duration and application rate, there has been a marked decrease in pests and disease associated with water delivery.

Pumping Efficiency

A major benefit from the Division 9 pressure system project has been the consolidation of pumping operations. Historically, farmers used private motors and pumps that were diesel driven and provided much less water per unit of energy input. With the construction of the Division 9 East Basin Pump Station, seven 480V variable frequency drive vertical turbine pumps deliver water in a much more efficient manner. The pump station has two 50 hp pumps for low flow operation, one 125 hp pump, and four 250 hp pumps with a combined pumping capacity of 23,500 gpm.

Conclusion

The clear winner for this design innovation is the community of farmers that make up Division 9 of SSJID. For the first time, these farmers get water exactly when they need it at the pressure and flow rate they desire. Since the valves are automatic and the web based interface allow management through an Internet connection (smart phone and iPad compatible), farmers can concentrate on other aspects of their farming operation. Since gravity water was often not available when farmers needed it, groundwater pumping had become commonplace. Due to the new surface water based pressure system, there has been a considerable reduction in the pumping of salinity stricken groundwater, and the trees in Division 9 are already benefitting. With less groundwater pumping, air quality throughout Division 9 has improved due to the reduced use of diesel powered well pumps. With a pressure system available, farmers can reduce flood irrigation and utilize drip, micro, and solid state sprinklers to irrigate their land which improves crop yield, conserves water by up to 30 percent, and reduces erosion and deposition of fertilizer into local surface and groundwater. Finally, the system

complies with new State regulations on volume based billing.

Acknowledgements

South San Joaquin Irrigation District: Sam Bologna, Frank Avila, Lloyd Wayman, Jerry Donahue, Michael Donahue, Bere Lindley, Jeff Shields, Dawn Driesen, Julie Vrieling, Michael O'Leary, John Holbrook, Ralph Roos, Dale Kuil, Robert Holmes, Dave Kamper and Forrest Killingsworth

The farmers of Division 9

Natural Resources Conservation Service

Bureau of Reclamation

References

Campbell, Jason, iWATER COMES TO SSJID, Manteca Bulletin, June 2, 2012.

Davids Engineering, Inc., Technical Memorandum to South San Joaquin Irrigation District: Initial Evaluation of On-Farm Conservation Program, December 2, 2012.

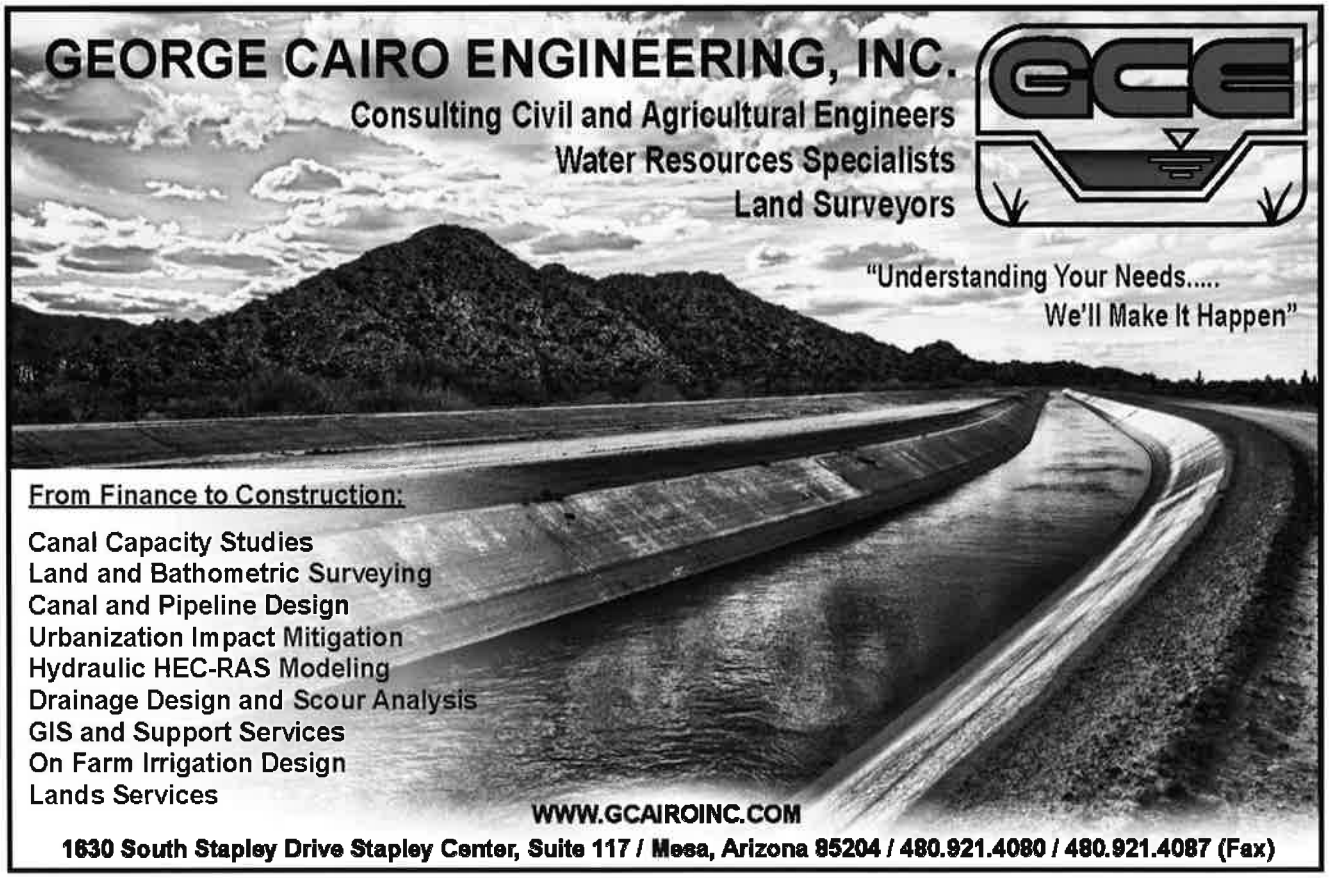
Dunbar, Mike, SSJID irrigation goes high tech, Modesto Bee, June 10, 2012.¤

News of Members

Charles Caruso, as a member of the Tetra Tech, Inc. team, recently completed a comprehensive evaluation of the operations of the Hammond Conservancy District, Bloomfield, New Mexico.

Yujin Wen, formerly a student at Utah State University, is now a student at Texas A&M University, residing in Cary, North Carolina.¤

USCID Newsletter Advertisers, Winter 2014



USCID Water Management Meeting

Om Prakash, WEST Consultants, Inc; and Jeff Davids, Davids Engineering, Inc. and H2oTech.

Jim Oster, consultant, and Paul Sagues, XIO, Inc.

Darrel Evensen, Rubicon Water.

Vic DeGrande, Ameron International.

Todd Hillaire, California Department of Water Resources.

Fred Holloway, Stevens Water Monitoring Systems.

Lunch speaker Pablo Arroyave, Deputy Regional Director Mid-Pacific Region, Bureau of Reclamation.

Maaike Hough and Lisa Howard, George Cairo Engineering.

Shane Scott, Hydro Component Systems.

Sacramento, California — March 4-7, 2014

Bert and Kelly Clemmens on the Friday field tour.

Conference Co-Chair Bryan Thoreson, Davids Engineering.

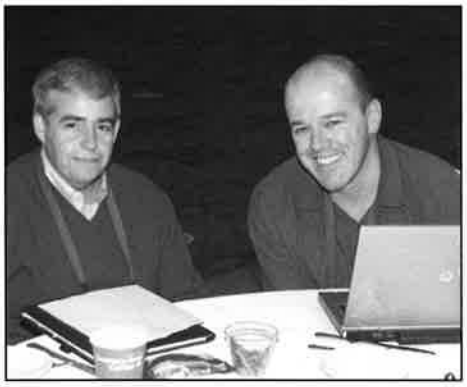
Brian Sheets, Schroeder Law Offices, PC.

Former USCID President Joe Burns, and Sam Bologna, South San Joaquin Irrigation District.

Michael Jerzykowski and Nadya Alexander, Sierra Controls; and Aron Balok, Pecos Valley Artesian Conservancy District.

Steve Knell, Oakdale Irrigation District.

Tony Sanella, Sage Designs, Inc.; and Emily Cady, Cal Poly.



Alejandro Paolini, Henry Miller Reclamation District; and Peter-Jules van Overloop, Delft University of Technology.

Kurt Chirbas, Soils and Seeds Solutions.

IQ™

Pronunciation: /ˌī-ˈky{uuml}/
Function: n
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California's Drought — Today and Tomorrow

by David C. Curtis, Ph.D., WEST Consultants, Inc., Folsom, California; Alan Haynes, National Weather Service, Nevada River Forecast Center, Sacramento, California; and Maury Roos, California Department of Water Resources, Sacramento, California

California is in the midst of its third dry year in a row. Drought conditions are having significant impacts on the state and contracted water deliveries for some customers may be cut to zero — an unprecedented event. Governor Jerry Brown has called on Californians to cut water use by 20 percent to preserve as much water as possible for the dry summer months ahead. Figure 1 shows the critically low levels in one of the state's major reservoirs, Folsom Lake, which in late January was just 17 percent of capacity.

The dry lake bed is a major problem for today. However, new data suggests that bigger problems may loom over the horizon and are coming faster than we realize.

Figure 1. Folsom Lake as seen from Beales Point on January 31, 2014. Lake elevation: 359 feet, storage ~170,000 acre-feet or 17 percent of capacity.

California's Climate

Most of California is in a Mediterranean climate zone with strong seasonality in precipitation. The winters are wet and summers dry and mostly cloudless except for fog along the coast. About 50 percent of California's precipitation comes during the three mid-winter months, December through February, and about 75 percent occurs from November through March.

Precipitation from year to year is quite variable, illustrating the need for substantial reservoir storage to carry water from wet years into dry ones. The California reservoir system does pretty well for single dry years, but multiple dry years in succession can lead to water shortages.

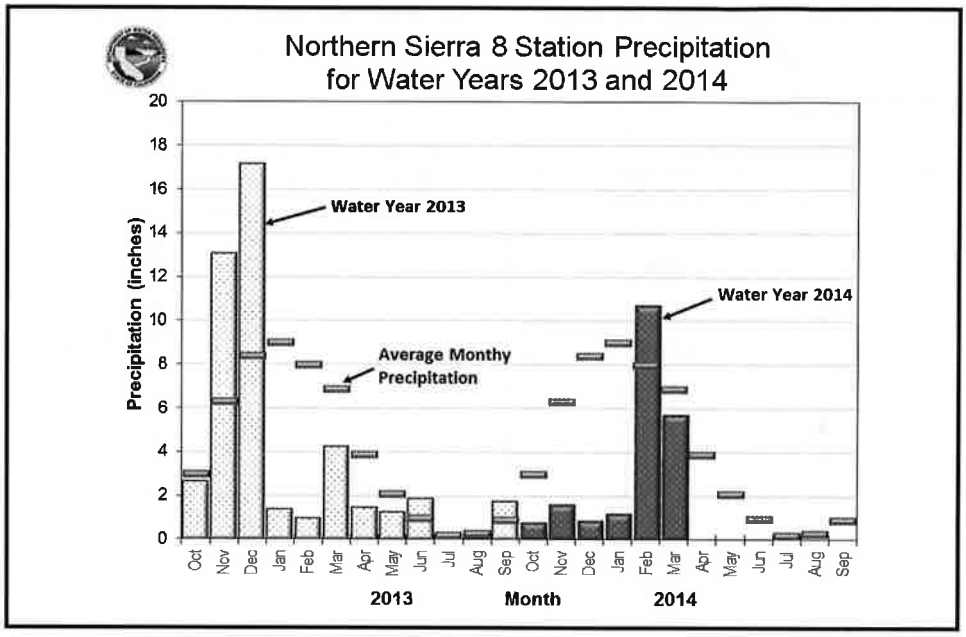


Figure 2. Northern Sierra 8-Station Precipitation Index.

It's Dry, Again

In terms of precipitation, calendar year 2013 (January through December) was the driest year of record at many locations in California, exceeding previous records by a wide margin. Previous dry calendar years such as 1923 and 1976 both led to critically dry water years in 1924 and 1977.

Figure 2 shows the monthly precipitation for the northern Sierra Nevada Mountains from October 2012 through March 22, 2014, compared to the average. The northern Sierras are the major source of California's water supply. This is a region which averages 50 inches of precipitation annually, much in the form of winter snow.

After two very wet months in November and December 2012, a strong high pressure system parked off the California coast, effectively blocking storms from the west and shutting off the supply of much needed moisture. From the end of December 2012 through the end of January 2014, only June and September 2013 had above average rainfall. These showers were helpful for fire control, but contributed little to water supply.

By the end of December 2013, statewide reservoir storage had fallen to 70 percent of the average for that date and just 41 percent of capacity, thereby reaching hydrologic drought level. Soon after, with bleak moisture forecasts for January 2014, Governor Jerry Brown declared an official drought.

January 2014 continued nearly rainless until a small storm during the last week of the month. The Central Valley was especially dry. Sacramento had 52 consecutive days with no measurable rain by January 28, exceeding the previous winter dry spell record of 46 days set in 1884 and the 44 day period in 1976. Normally, Sacramento would receive about one third of its annual total during this 52 day period.

Near Empty Reservoirs

Through a dry January, California reservoir levels continued to fall and further threatened water supplies. By the end of January 2014, California reservoirs had fallen so low that portions of lake bottoms not seen in decades were exposed. A series of storms finally arrived in February and March. Welcome relief but the

combined precipitation totals were only a little above average — far short of the amounts needed to break the drought. As Figure 3 shows, the key California reservoirs are all well below average for late March; not a good sign for water deliveries this summer.

The Forecast

Water managers throughout the state are closely following the California Nevada River Forecast Center's (CNRFC)

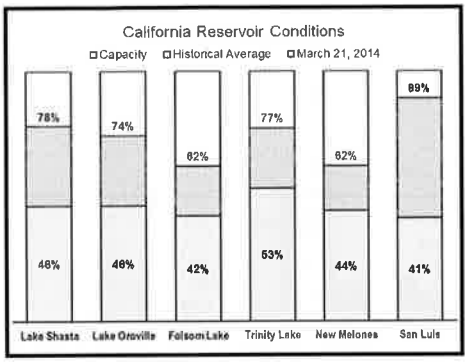


Figure 3. California Reservoir Conditions, March 21, 2014.

projections of water supply and low river flow thresholds. These projections are helping water managers decide how to prioritize water use in view of an increasingly bleak outlook.

The Sierra Nevada snowpack typically accumulates in the winter months and serves to recharge reservoirs that supply water to much of the state. On January 30, snow surveyors found the statewide snowpack water content at 12 percent of average for this time of year or just seven percent of the April 1 average. December, January and February are normally California's wettest months, but little precipitation fell in December and January this season.

The CNRFC produces hydrologic forecasts for many watersheds in California and Nevada on a daily basis. CNRFC forecasters combine observed precipitation, estimated snowmelt, and the latest weather forecast information to forecast streamflow. Single-valued forecasts are produced out to five days and probabilistic forecasts extend out to one year.

Probabilistic forecasts provide a range of values, with each value assigned a confidence level. (e.g. a monthly inflow forecast of 220,000 acre-feet might have less than a 10 percent chance of being equaled or exceeded while a lower forecast of 90,000 acre-feet might have a 50 percent chance of being equaled or exceeded.) Probabilistic forecasts of reservoir inflows and seasonal runoff volumes provide important insights to decision-makers managing critical water resources.

Figure 4 shows the probabilistic forecasts made of February 1 for monthly inflows to Folsom Lake. At that time it was still possible to get significant precipitation in February and March and build the Sierra snowpack. But the deficit was so great that there was high confidence that even an extraordinarily wet late winter/spring wouldn't bring the seasonal runoff volumes back to average. According to an analysis done by Paul Iniguez of the National Weather Service in late January, there was only a one in 500 chance (0.5 percent) of receiving enough precipitation statewide for the remainder of the water year to bring the total to average.

Figure 5 shows the probabilistic forecast from the CNRFC made on March 22 after the February and March storms. Despite the much needed precipitation, the Sierra snowpack was still stuck at or below historic record lows. The expected peak inflow to Folsom is now anticipated to occur in April instead of June. Without a significant snowpack, projected inflows for June and July are dramatically lower than the February 1 outlook.

How bad is the drought compared to past droughts? Well, it depends on how you measure it. Statewide reservoir storage as of March 1 (16.2 million acre-feet) ranks third driest, being above the levels in 1991 (12.0 MAF) and 1977 (9.8 MAF). Three-year seasonal runoff volumes for the combined Sacramento and San Joaquin watersheds, using the observations from the 2012 and 2013 water years, the 2014 water year-to-date, and projections for the remainder of the 2014 water year, indicate that this will likely fall within

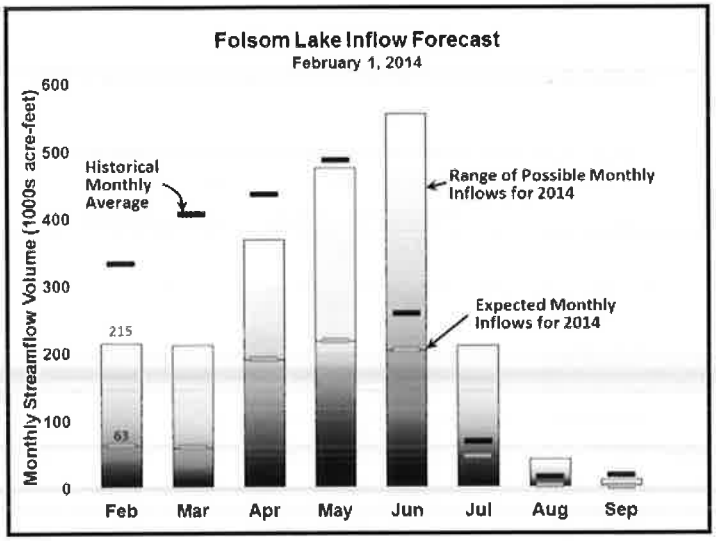


Figure 4. Folsom Lake Probabilistic Inflow Forecast, February 1, 2014 (NWS California Nevada River Forecast Center).

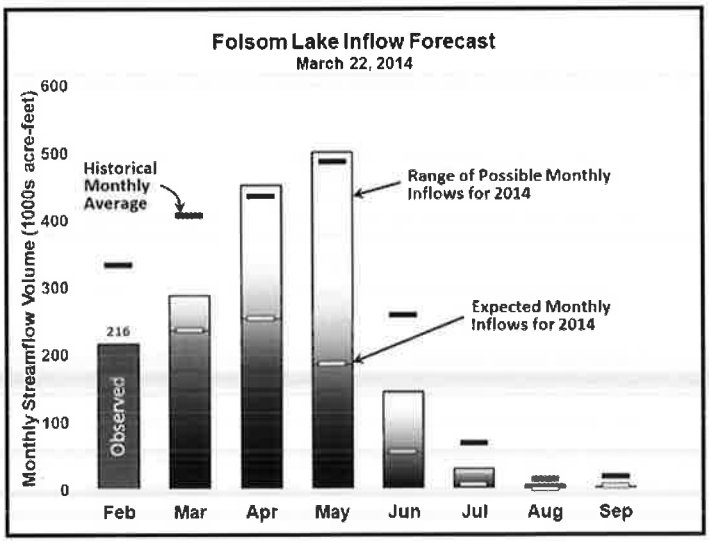


Figure 5. Folsom Lake Probabilistic Inflow Forecast, March 22, 2014.

the top ten driest three-year periods in the observed record. The February and March storms were enough to avoid setting a new record, this time.

Looking Back — A Long Way Back

To get a better handle on the vagaries of California's climate, the California Department of Water Resources commissioned a study producing a new data set containing more than 1,100 years of Sacramento River annual flow volumes reconstructed from a detailed analysis of tree rings by the University of Arizona. The dramatic swings between extreme high and low streamflow volumes are evident in Figure 6. It appears that California doesn't have a "normal," just an average between extremes. California has the most volatile climate in the nation.

The 30-year trailing average streamflow volume is also plotted in Figure 6 to show how persistently the California climate stays in a wet or dry condition. Every point on the curve shows the average streamflow for the previous 30-years. (Note: the National Weather Service defines "climate" of our every-day life as the average condition over 30-years.) A peak on the 30-year average curve means that the climate was very wet for the previous 30 years. Conversely, a trough or minimum on the 30-year curve indicates a 30-year dry period.

Significantly changing a 30-year average isn't easy. It's a bit like getting a lumbering supertanker to change direction. Yet, in California, the change from wet to dry and back again is often quite fast. Throughout the 1,100 year record of reconstructed streamflows, the shift from peak (extreme wet) to trough (extreme dry) occurred in just a few decades.

A closer look in Figure 7 shows 30-year averages for both precipitation in Sacramento and annual volumes for the Sacramento River since the 1880s. The precipitation peaks are more than 40 percent higher than the minimums. Streamflow volume peaks are 30 percent higher than the minimums for the same period. The peak to trough transition occurred in just four decades. These transitions are, in effect, major shifts in our climate. This rapid shift from wet to dry regimes and back again occurs repeatedly throughout the 1,100 year record of reconstructed streamflows.

Warming Atmosphere

The signal for a warming atmosphere emerging from a wide array of Global Climate Models (GCMs) is strong. Warmer temperatures will have a major impact in California as more precipitation falls as rain rather than snow and mountain snowpacks will melt earlier in the year.

The signal for changes in annual precipitation driven by rising greenhouse gases is less clear. Some models show a slight downward trend in California. Others show the opposite. The GCM consensus projects changes in California's average annual precipitation of +/- 5 percent through the next hundred years.

A warmer atmosphere may make California's precipitation regime more volatile than it is today. Even with about the same average annual precipitation, precipitation may arrive in fewer but more intense storms.

Implications

The summer of 2014 will be painful for many Californians, especially those in the agricultural sector, as we adapt to the evolving drought. However, the implications of rapid climate transitions in the future are truly sobering.

At the time of the last 30-year "trough" in the 1930s and 1940s, just six to seven million people lived in California. Today, more than 38 million people call California home. Population growth alone explains much of our current water stress. By the time the next trough arrives, and it will, the state will likely need water for 50-60 million thirsty residents and to satisfy the attendant demands of its agriculture, commercial and industrial users.

Matching water supply with demand has always been a major challenge. However, the speed of California's climate transitions takes the challenge to a whole new level. A major climate transition in four decades is on nearly

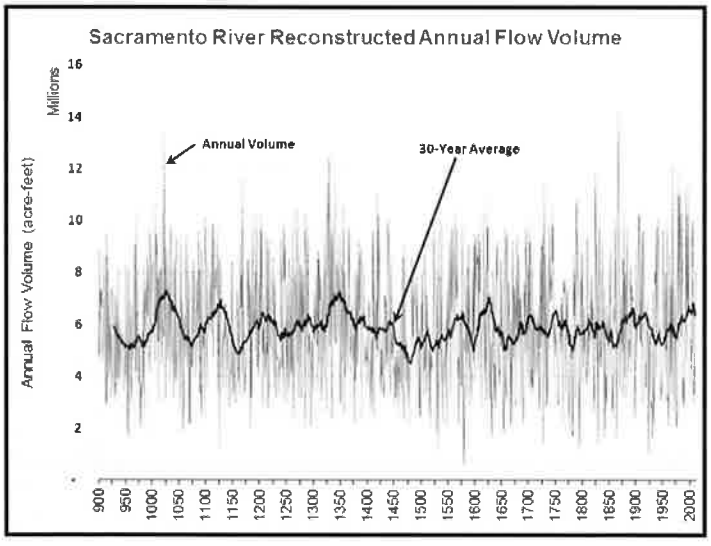


Figure 6. Reconstructed Annual Flow Volumes for the Sacramento River.

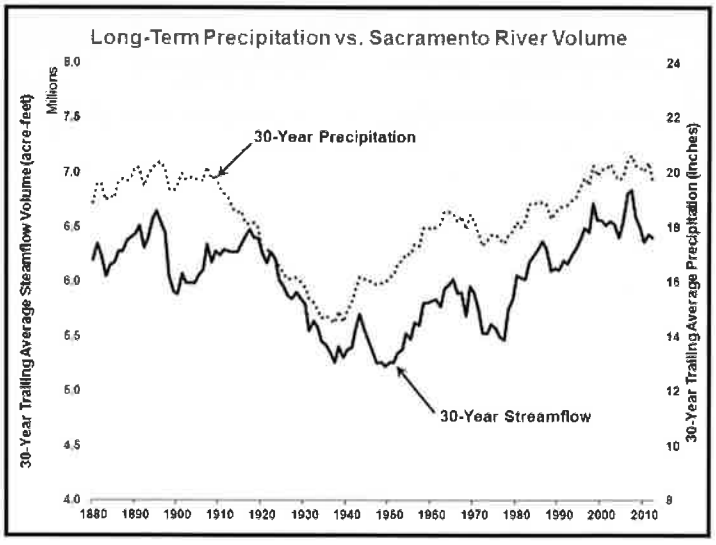


Figure 7. Long-Term Precipitation vs. Sacramento River Volume.

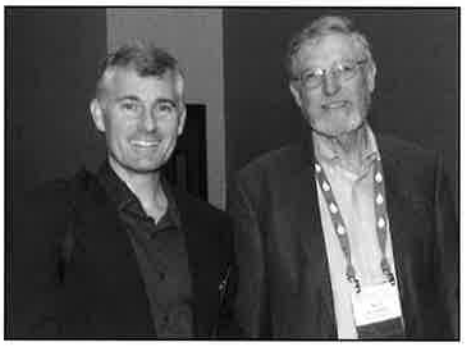
the same scale as current water planning horizons and perhaps faster than our ability to plan, design and build major water infrastructure projects.

Recent hydro-meteorologic observations suggest that the California water climate is near historic maxima. If our rapid climate transitions continue, California could tumble into the next trough faster than we can create the necessary solutions — whether the solutions are based on policy or concrete.

The current drought may just be a wake-up call. At some point, California's current climate trend of increasing water will reverse as it has for millennia. Perhaps, it's already started. If so, we can't start preparing soon enough.¤

Sacramento (continued)

presentations dealt with crop water requirements, irrigation management, drainage reuse, remote sensing and conjunctive water management. Nearly 200 participants registered for the Conference through the two organizations, in addition to many exhibitors and sponsors. The Conference was held at the new McClellan Conference Center at the former McClellan Air Force Base.



GRA co-chair Chris Petersen (left) and USCID co-chair Steve Macaulay.

The co-located Conference was a first for both USCID and GRA, with a joint field trip Tuesday morning, a plenary session on Tuesday followed by separate USCID and GRA tracks on Wednesday. The USCID conference continued with presentations on Thursday and a field tour on Friday. People signing up through either organization were free to go to any of the presentations, and we received many compliments on this approach as well as the overall quality of the Conference and tours.

The Tuesday morning field tour involved a short bus ride to the offices of the Sacramento Regional Water Authority, a water user organization consisting primarily of urban water purveyors in the region. Our first presentation was on the American River Water Forum Agreement, and how groundwater management fits into protecting the instream resources of the Lower American River and long-term water supply reliability for the region. The second presentation was on the Sacramento Groundwater Authority, a locally-managed and very successful water banking program. The third presentation described the City of Roseville's new and successful aquifer storage and recovery program (ASR). Our final presentation described the ongoing extensive modifications to Folsom Dam, followed by a quick tour to the construction site to view the major new spillway and control gates. This $1 billion infrastructure project will bring additional flood control to the Sacramento region, while providing greater water supply reliability to the Bureau of Reclamation's agricultural and urban customers.

The Conference program began with lunch speaker David Guy, President of the Northern California Water Association. David addressed the latest thinking and accompanying controversies regarding groundwater management in California, brought to a sharp focus by the ongoing severe drought. David contrasted academic vs. practical approaches: "It may sound good at UCLA, but it will never work in Woodland." He asked Conference participants to spend time thinking about the concept of "sustainability" and its application to water supplies, which he believes will be an important challenge for the future.

Following lunch, the program started with an excellent panel chaired by USCID Board member **Thad Bettner**. Panelists were Reclamation District 108 General Manager Lewis Bair; Metropolitan Water District of Southern California Assistant General Manager Roger Patterson; State Water Resources Control Board Member Dee Dee D'Adamo, and attorney Richard Roos-Collins with the Water and Power Law Group. The panel addressed a wide range of water management issues in the context of the ongoing California drought, including the longstanding facilities and fisheries issues in the Sacramento-San Joaquin Delta and the emerging concern throughout the state on groundwater management and local vs. state management. The USCID panel was followed by three presentations by GRA authors, ranging from emerging groundwater sustainability and water quality issues in California's Central Valley, to the special case of groundwater management in the upper Klamath River watershed and its relationship to ongoing resource conflicts with irrigation and wildlife.

Conference participants may recall Dan Wendell's comment regarding groundwater pumping and its impact on stream systems. "You have to pay back the cone of depression." Tuesday evening ended with our usual reception and the introduction of the many USCID and GRA exhibitors. The reception was lively, with active discussions continuing well into the evening among participants and exhibitors.

The Wednesday morning parallel USCID and GRA tracks were followed by a joint luncheon, with attorney Valerie Kincaid making a presentation on the potential role of state regulation in managing local groundwater basins.

Following a full afternoon of parallel sessions, our dinner speaker was University of California, Davis engineering professor Jay Lund, who also serves as the Director of the UC Davis Center for Watershed Sciences. A well-known researcher on California water management challenges, he gave an engaging presentation on the important role of groundwater and overall water management. As is often said, "you had to be there" to see Jay's entertaining and enlightening presentation.

Jay Lund, University of California, Davis.

By Thursday our GRA colleagues had ended their Conference, and the USCID sessions continued. Our lunch speaker that day was Bureau of Reclamation, Mid-Pacific Region Deputy Regional Director Pablo Arroyave. He described the Bureau's ongoing challenges in dealing with the current severe drought,

including discussions with state and local agencies on how best to manage water systems in real time.

On Friday, Conference participants visited two nearby irrigation districts. South San Joaquin Irrigation District and Oakdale Irrigation District both recognize the need for service improvements to keep growers from switching to groundwater. Each district, based on its own unique cropping, soils, topography, existing water distribution system and other factors, has completed a pilot project to improve service. Participants saw SSJID's Division 9 Irrigation Enhancement Project near Ripon and OID's Northside Reservoir and automated lateral demonstration project. The SSJID Division 9 project delivers pressurized water to growers in a 3,800-acre area west of Ripon (see article that begins on page 1). SSJID General Manager Jeff Shields and Chief Engineer Sam Bologna described the project objectives, design and operation. Participants saw a turnout and the 56 acre-foot east storage basin and pumping plant supplying the project. Following lunch at Woodward Reservoir, the tour visited OID's Northside Reservoir and automated lateral demonstration project. OID General Manager **Steve Knell** and Water Operations Manager Eric Thorburn described the project objectives, design and operation. Participants saw check gates and turnouts along the Cometa Lateral and the Northside Reservoir.

The collaboration of USCID and GRA resulted from more than a year of dialogue and planning among USCID co-chairs **Bryan Thoreson** and **Steve Macaulay** and GRA co-chair Chris Petersen. These organizers were supported by hard-working planning committees and organization staff. USCID's Larry Stephens and his staff took the lead in making hotel, food and conference venue arrangements. While the financial numbers are not yet in, every indication points to a very successful Conference. In the words of long-time USCID member **Jim Oster**, "This Conference is the best I've attended. The panel, luncheon speakers and papers have been excellent."¤

Sacramento Conference

Exhibitors

- Ameron International
- Axter Coletanche
- CONTECH Engineered Solutions
- Concepts in Controls, Inc.
- Electronic Data Solutions
- GE Druck
- George Cairo Engineering, Inc.
- Hydro Component Systems, LLC
- Inflatable Packers International LLC
- Irrigation Training & Research Center
- Kisters North America, Inc.
- Rubicon Water
- Sage Designs, Inc.
- Sierra Controls, LLC
- Soils and Seeds Solutions LLC
- Stevens Water Monitoring Systems, Inc.
- WEST Consultants, Inc.
- YOOIL Engineering Co., Ltd.

Sponsors

- Ameron International
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- Macaulay Water Resources
- YOOIL Engineering Co., Ltd.

President's Message (continued)

experiences, so please submit a paper describing your experiences with canal automation or irrigation, drainage or flood control. The deadline for submitting abstracts is May 12.

Also taking place during the December Conference will be the annual USCID awards dinner. Look for an e-mail announcement in the near future requesting nominations for the *USCID Merriam Improved Irrigation Award* and the *USCID Service to the Profession Award*. Please send your nominations to Larry Stephens, USCID Executive Vice-President.

USCID also has many opportunities for students to get involved. Six fellowships for full registration to the Phoenix Conference will be available for students who submit a poster abstract. Low cost registration is also available for students who want to attend, but are unable to prepare a poster. Another excellent opportunity for students is the **USCID/Summers Engineering Scholarship**. Applications for the Scholarship (which includes a $1,000 grant plus travel, hotel and registration expenses for the Phoenix Conference) will be solicited and accepted this summer.

Another upcoming event this fall is the **22nd International Congress on Irrigation and Drainage**, September 14-21, in Gwangju Metropolitan City, Republic of Korea. The Congress theme is *Securing Water for Food and Rural Community under Climate Change.* USCID members are encouraged to attend.

In closing, I want to thank all the conference planning committee members for their great work organizing the conferences and all the speakers for sharing their experiences. I invite you to get involved with USCID — present a paper at a conference, join a conference planning committee, and share your ideas and experiences with others.

Bryan Thoreson
President, USCID¤

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USCID Notes

by Larry D. Stephens,
Executive Vice President

USCID recently completed another outstanding Conference. As noted in the page one article, the Sacramento Conference during March focused on groundwater issues and was held in cooperation with the Groundwater Resources Association of California. This was definitely the right theme at the right time, as California is experiencing record drought which has resulted in dramatic increases in the use of groundwater. Don't miss the page one article by **Jeff Shaw**, describing the pilot project on the South San Joaquin Irrigation District, and the page 15 article by David Curtis providing details about the California drought. Thanks to **Steve Macaulay** and **Bryan Thoreson** for their work to ensure the success of the Sacramento Conference!!

The next USCID Conference will be held in Phoenix during the first week of December 2014. **Brian Wahlin**, WEST Consultants, will chair the Planning Committee for the Conference which will address the theme *Planning, Operation and Automation of Irrigation Delivery Systems*. Since irrigated agriculture faces continuing competition for water, improving the efficiency of water delivery systems through automation is certainly important and makes the Phoenix Conference a "don't miss" event. In addition to canal automation and implementation of automation, the Conference will include other topics of interest to irrigation engineering professionals, including canal modernization, infrastructure modernization and SCADA systems. The Call for Papers for the Conference is available on the USCID website. The deadline for submitting an abstract is May 12 — plan now to submit an abstract and join us in Phoenix.

A reminder — USCID is the U.S. member of the International Commission on Irrigation and Drainage. ICID is the leading non-governmental organization involved with irrigated agriculture. Each year, ICID member countries meet to address current issues. Every third year, the annual gathering of the ICID family includes a Congress which features technical presentations by irrigation professionals from many countries. This is a Congress year so plan to attend. Additional information about ICID, the technical committees, and the 22nd Congress is available on the ICID website — www.icid.org. In addition to Korea, the venues for future ICID meetings include Montpellier, France, and Thailand. This would be an excellent time to become involved with an ICID technical committee and to share your expertise with irrigation professionals from around the world!

Important support for USCID comes from organizations who advertise in this Newsletter and who exhibit at and sponsor events for our Conferences. Please acknowledge this support the next time you have an opportunity. Thanks!

Finally, and last but certainly NOT least, thanks to **Luis Garcia**, **Laura Schroeder** and **John Sweigard** for serving on the USCID Board of Directors. Your support and leadership will be missed!¤

USCID Meetings

December 2-5, 2014, Phoenix, Arizona. *Planning, Operation and Automation of Irrigation Delivery Systems.*

ICID Meetings

June 23-26, 2014, 12th International Drainage Workshop, St. Petersburg, Russia.

September 14-20, 2014, 65th IEC Meeting and 22nd Congress, Gwangju, Korea.

October 11-16, 2015, 66th IEC Meeting, Montpellier, France.

2016, 67th IEC Meeting and 9th Asian Regional Conference, Thailand.