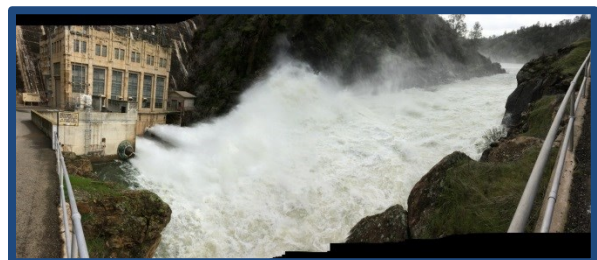
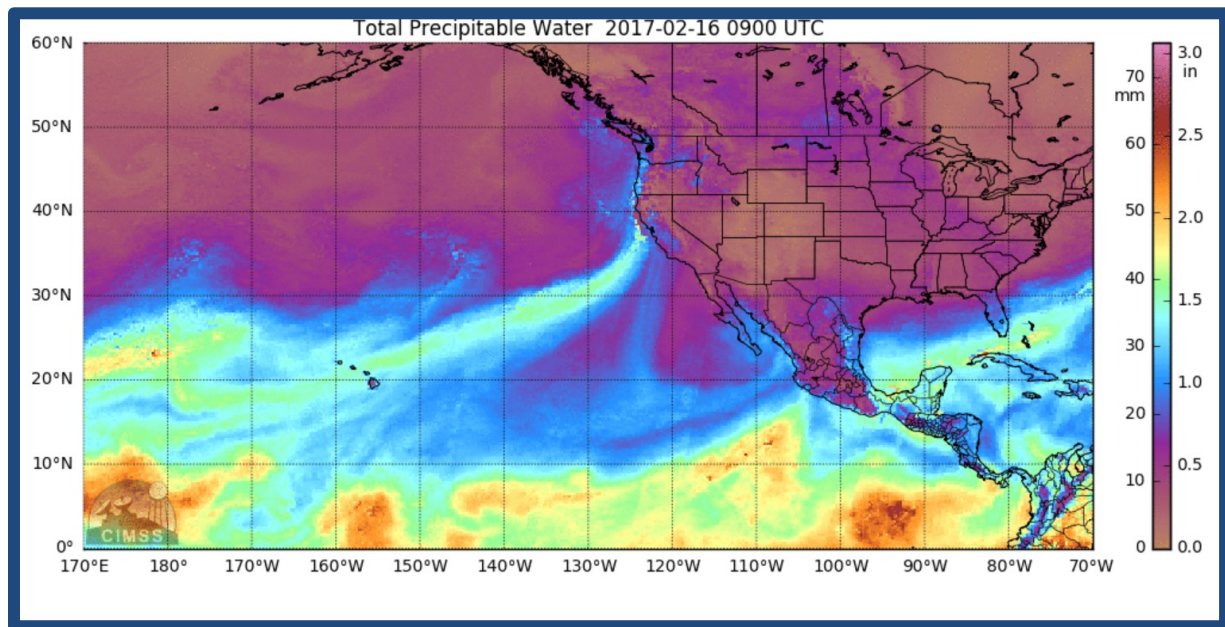




## California Water and Environmental Modeling Forum

### 2017 ANNUAL MEETING PROGRAM

#### The Atmospheric River Strikes Back



## **ORGANIZATIONAL MEMBERS**

California Department of Water Resources

California State Water Resources Control Board

CH2M

Contra Costa Water District

Delta Stewardship Council

East Bay Municipal Utility District

ICF International

Metropolitan Water District of Southern California

U.S. Bureau of Reclamation

## **SPECIAL THANKS**

To Solano Irrigation District for providing a conference room for Steering Committee meetings.

# SUMMARY OF SESSIONS

**Monday, March 20**

Time	Session	Moderator	Room
8:00 - 8:30	Registration		Sierra Hallway
8:30 - 10:15	1. Sustainable Groundwater Management Act	Steffen Mehl & Steven Springhorn	Sierra 1
	2. Applications of Evapotranspiration in Water Resource Management	Michael Tansey	Folsom/Natoma
10:15 - 10:30	Break		
10:30 - 12:15	3. DSM2	Min Yu	Sierra 1
	4. MODFLOW-OWHM, Topics and Applications of this Integrated Hydrologic Modeling Software	Scott Boyce	Folsom/Natoma
12:15 – 1:00	Lunch - Included in registration fee		Restaurant
1:00 - 2:00	5. CWEMF Awards Ceremony	Benjamin Bray	Sierra 1
2:00 - 3:15	6. Pop-up Talks	Stacy Tanaka & Nigel Quinn	Sierra 1
3:15 - 3:30	Break		
3:30 - 5:15	7. Integrated Water Resources Modeling	Ali Taghavi	Sierra 1
	8. Remote Sensing and GIS	Nigel Quinn	Folsom/Natoma
5:30 - 8:00	9. Business Meeting and Social	Josué Medellín-Azuara	Cliff House of Folsom

## Tuesday, March 21

Time	Session	Moderator	Room
7:30 - 8:00	Registration		Sierra Hallway
8:00 - 9:45	10. California Water Plan Update 2018: Envisioning and Tracking California Water Sustainability	Abdul Khan	Sierra 1
9:45 - 10:00	Break		Sierra 2
10:00 - 11:45	11. Climate Change	Jamie Anderson & Tapash Das	Sierra 1
	12. Simulating Irrigated Agriculture: Modeling Techniques and Case Studies in Demand Estimation	Mesut Cayar	Folsom/Natoma
11:45 - 12:30	Lunch - Included in registration fee		Restaurant
12:30 - 1:15	13. Keynote Speaker – Phil Isenberg	Josué Medellín-Azuara	Sierra 1
1:15 – 3:00	14. Central Valley Flood Protection Plan (CVFPP) Update 2017 Session 1	Samson Haile-Selassie	Sierra 1
	15. Environmental Flows Modeling	Mike Deas	Folsom/Natoma
3:00 - 3:15	Break		
3:15 - 5:00	16. Central Valley Flood Protection Plan Update 2017 Session 2	Samson Haile-Selassie	Sierra 1
	17. A Kaleidoscope of Modeling	Josué Medellín-Azuara	Folsom/Natoma
	18. Student/Young Professional Mentoring Session	Holly Canada	Restaurant
5:00 - 7:00	19. Poster Session and Social	Stacy Tanaka	Sierra 2

\*Posters will be set up by 10:00 am and available for viewing all day. Presenters will be available from 5:00 to 7:00 pm.

## Wednesday, March 22

Time	Session	Moderator	Room
7:30 - 8:00	Registration		Sierra Hallway
8:00 - 9:45	20. Multi-D Modeling	Eli Ateljevich and Aaron Bever	Sierra 1
	21. The Surface-Groundwater Continuum: A Modeling Challenge	Hubert Morel Seytoux	Folsom/Natoma
9:45 - 10:00	Break		
10:00 - 11:45	22. CalSim and CalLite Model Applications	Karandev Singh	Sierra 1
	23. Modelers' Plethora: Retooling, Innovating, and Advancing Models and Methods	Ben Bray	Folsom/Natoma
11:45 - 1:15	Lunch at area restaurants		
1:15 - 3:00	24. Modeling Major Floods to Monthly Water Supply	Shyamal Chowdhury	Sierra 1
	25. Applications of 2-Dimensional HEC-RAS to Ecosystem Enhancement in the Central Valley	Paul Frank	Folsom/Natoma
3:00 - 3:15	Break		
3:15 - 5:00	26. A New MILP Solver for CalSim/CalLite	Junaid As-Salek	Sierra 1
	27. Modeling Floods and Human Behavior	Holly Canada	Folsom/Natoma

## 2017 ANNUAL MEETING SPONSORS

### POSTER SESSION



### EVENING SOCIALS



## 2017 ANNUAL MEETING SPONSORS

### LUNCHES



### REFRESHMENTS





# California Water and Environmental Modeling Forum

Promoting Excellence and Consensus in Water and Environmental Modeling

P.O. Box 22529, Sacramento, CA 95822 • 916-833-6557 • [cwemf@cwemf.org](mailto:cwemf@cwemf.org) • [www.cwemf.org](http://www.cwemf.org)

Folsom, California, March 20<sup>th</sup>, 2017

Dear CWEMF Community:

We welcome you back to Folsom for our 2017 Annual Meeting, The Atmospheric River Strikes Back! The wettest year on record so far for the Northern Sierra and the San Joaquin River basin, has reemerged the need for directing our attention to California's amazing flood control infrastructure and models; yet presents opportunities to prepare for future droughts by managing groundwater and reinvigorating our environmental systems often impacted in dry years. California remains a fascinating place to work on water and environmental problems using models.

We start Monday with groundwater management under SGMA and applications for consumptive use. Then grab lunch to connect with others and congratulate this year's winners during CWEMF's awards ceremony. We follow with our popular pop up talks. Hydrodynamics and remote sensing/GIS close the first day. Join us for our business meeting at the Cliff House of Folsom to review this past year of accomplishments.

On Tuesday, learn about California's 2018 Water Plan Update in a plenary session. We continue with climate change and agricultural modeling before lunch. After lunch our keynote speaker, Phil Isenberg former chair of the Delta Stewardship Council, will provide us insights on modeling and policy. Two flood sessions and top notch modeling applications continue over the afternoon. If you are a student or young professional, we encourage you to join our mentoring session. The poster session and social close our second day.

On Wednesday, sessions on multi-dimensional modeling and the surface groundwater interface will open the day. Advancing models and methods and applications with CalSIM run on concurrent sessions. Environmental flows, flood, and applications of CalSIM with a new MILP solver will make for an exciting afternoon.

This year we also celebrate Elaine Archibald's retirement after a long and successful consulting career that included serving as our executive director since 2010. Her long list of clients in the water community has undoubtedly benefited from her expertise in water quality and watershed management. Our organization has also benefited from her management experience, efficiency, attention to detail, flexibility, and also from her interpersonal skills and patience in execution of her duties as our executive director. We wish her the very best in her endeavors going forward where we imagine time allocated for travel, beaches, children, and grandchildren as well as a few great glasses of some reddish-colored adult beverages along the way. We thank Elaine for her service to our Modeling Forum, we wish her the very best in all she does, and wholeheartedly thank her for her contribution to CWEMF's legacy!



Please take the time to thank our sponsors and volunteers, they are the special ingredient which makes this endeavor a successful event. Also, please use our follow up survey to let us know what we are doing right and what can be improved in future CWEMF annual meetings. For the second consecutive year, we offer the opportunity to publish your paper as part of CWEMF's Annual Meeting proceedings. Visit our website to see last year's proceedings.

Lastly, I want to thank the rest of CWEMF's Steering Committee and our Executive Director, for being such a supportive group during my past two years as a convener. I feel blessed for learning and working with an amazing group of colleagues with high regards for CWEMF's mission. I am thankful to the CWEMF community at large and I hope to continue to volunteer in other capacities. This has been a very rewarding experience and I encourage you to join the Steering Committee in its activities.

Sincerely,

A handwritten signature in black ink, reading "Josué Medellín-Azuara". The signature is fluid and cursive, with the first name "Josué" being more prominent and the last name "Medellín-Azuara" following in a similar style.

Josué Medellín-Azuara  
CWEMF Convener

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# **AGENDA**

**Monday, March 20**

**8:00 – 8:30 a.m. – Registration in Sierra Hallway**

Refreshments sponsored by cbec ecoengineering

**8:30 – 10:15 a.m.**

## **Session 1. Sustainable Groundwater Management Act**

***Moderators: Steffen Mehl (CSU Chico) and Steven Springhorn (DWR)***

***Location: Sierra 1***

1. DWR Best Management Practices and Tools for Sustainable Groundwater Management – Lisa Porter (CH2M) and Steven Springhorn (DWR)
2. Incorporating Model Uncertainty Analysis into SGMA Decision Making – Jon Traum (USGS)
3. Decisions, Decisions: Decision Support Modeling in Groundwater Sustainability Planning – Aaron Mead (Exponent)
4. DWR Water Available for Replenishment Estimates – Romain Maendly and Devinder Dhillon (DWR)

## **Session 2. Applications of Evapotranspiration in Water Resource Management**

***Moderator: Michael Tansey (Reclamation)***

***Location: Folsom/Natoma***

1. A Comparative Study on Consumptive Use in the Sacramento-San Joaquin Delta – Josué Medellín-Azuara (UC Davis)
2. Google Earth Engine Metric (GEM) Application for Remote Sensing of Evapotranspiration – Nadya Alexander-Sanchez (UC Davis)
3. Application of Evapotranspiration Forecasting to Water Management in the Klamath Basin – Michael Tansey (Reclamation), David Yates (NCAR), and Zackary Leady (Reclamation)

**10:30 a.m. – 12:15 p.m.**

**Session 3. DSM2**

***Moderator: Min Yu (DWR)***

***Location: Sierra 1***

1. DSM2 Nutrients Modeling Sensitivity Analysis – Ming-Yen Tu (DWR)
2. Extending DSM2 V8.1.2 Historical Simulation to 1962 – Steve Micko (CH2M)
3. Juvenile Salmon Swimming Behavioral Parameter Estimation and Routing Sub-model Development in an Enhanced Particle Tracking Model – Xiaochun Wang (DWR)

**Session 4. MODFLOW-OWHM, Topics, and Applications of this Integrated Hydrologic Modeling Software**

***Moderator: Scott Boyce (USGS)***

***Location: Folsom/Natoma***

1. Using the New FREEWAT Platform for Water Management: Development and Preliminary Applications – Laura Foglia (UC Davis)
2. Implementing Available Data Streams for Better Conjunctive Use Modelling using MODFLOW-OWHM – Wesley Henson (USGS)
3. Simulating Water Availability and Sustainability in California's Central Valley – Claudia Faunt (USGS)
4. Salinas Valley Integrated Modeling of Agricultural Conjunctive-Use – Randall Hanson (USGS)

**12:15 – 1:00 p.m.**

**Lunch**

Pick up a box lunch and then join us for the CWEMF Awards Ceremony in Sierra 1.

**Lunch sponsored by Larry Walker Associates**

**1:00 – 2:00 p.m.**

**Session 5. CWEMF Awards Ceremony**

***Moderator: Benjamin Bray (CWEMF/EBMUD)***

***Location: Sierra 1***

Presentation of the Hugo B. Fischer, Career Achievement, and Distinguished Life Membership awards.

**2:00 – 3:15 p.m.**

**Session 6. Pop-up Talks**

***Moderators: Stacy Tanaka (Watercourse Engineering) and Nigel Quinn (Berkeley National Laboratory/Reclamation)***

***Location: Sierra 1***

Five minute overviews summarizing modeling work using a maximum of five PowerPoint slides per speaker.

**3:30 – 5:15 p.m.**

**Session 7. Integrated Water Resources Modeling**

***Moderator: Ali Taghavi (RMC)***

***Location: Sierra 1***

1. Projecting Forward: A Framework for Groundwater Model Development under the Sustainable Groundwater Management Act – Tara Moran (Stanford)
2. Problem with the Use of an Empirical “Leakance Coefficient” to Evaluate Seepage – Hubert Morel-Seytoux (Hydroprose)
3. MercedWRM: Integrated Groundwater Model Development and Calibration – Dominick Amador (RMC)
4. Application of Integrated Surface-Subsurface Models for Managed Aquifer Recharge – Mehdi Ghasemizade (UC Davis)

**3:30 – 5:15 p.m.**

**Session 8. Remote Sensing and GIS**

***Moderator: Nigel Quinn (Berkeley National Laboratory/Reclamation)***

***Location: Folsom/Natoma***

1. The Evolution of GIS Assisted Water Modeling – Tom Heinzer (Reclamation)
2. Comparison of Methods for Estimating Water-Budget Components in the Central Valley, CA – Stephen Maples (UC Davis)
3. California Actual Evapotranspiration (CalETa) Mapping Program – George Paul (Formation Environmental LLC)

**5:30 – 8:00 p.m.**

**Session 9. Business Meeting and Social**

***Moderator: Josué Medellín-Azuara (CWEMF/UC Davis)***

***Location: Cliff House of Folsom***

**Social sponsored by MBK Engineers and Resource Management Associates**

**PLEASE RETURN YOUR NAME BADGE TO THE REGISTRATION TABLE IF YOU WILL NOT BE COMING BACK TO THE ANNUAL MEETING.**

## **Tuesday, March 21**

**7:30 – 8:00 a.m. – Registration in Sierra Hallway**

Refreshments sponsored by Pacific Agroecology LLC

**8:00 – 9:45 a.m.**

### **Session 10. California Water Plan Update 2018: Envisioning and Tracking California Water Sustainability**

*Moderator: Abdul Khan (DWR)*

*Location: Sierra 1*

1. California Water Plan Update 2018 Overview – Paul Massera (DWR)
2. Water Budget Framework and Dashboard – Todd Hillaire (DWR)
3. California Water Plan Update 2018: Enhancing the Effectiveness of State Government Policy and Investment – Megan Fidell (DWR)

**10:00 – 11:45 a.m.**

### **Session 11. Climate Change**

*Moderator: Jamie Anderson (DWR) and Tapash Das (CH2M)*

*Location: Sierra 1*

1. Developing Data Sets and Models for California's Water Storage Investment Program – Rob Leaf (CH2M)
2. From the Bottom Up: New Insights into State Water Project Vulnerabilities to Climate Change – Andrew Schwarz (DWR)
3. Climate Vulnerability and Adaptation Planning in Sonoma County – Armin Munévar (CH2M)
4. Our Coast, Our Future – Communicating Sea Level Rise Estimates across California (Michael Fitzgibbon (Blue Point)

## **Session 12. Simulating Irrigated Agriculture: Modeling Techniques and Case Studies in Demand Estimation**

***Moderator: Mesut Cayar (RMC)***

***Location: Folsom/Natoma***

1. Integration of Remote Sensing and Root Zone Water Balance Modeling to Estimate Daily Water Budgets for Individual Agricultural Fields – Byron Clark (Davids Engineering)
2. Developing Data Consistency with Models and Local Knowledge in the Tulare Lake Hydrologic Region for Estimation of Agricultural Demand – Frank Qian (RMC)
3. Cal-SIMETAW: A Model for Agricultural Water Demand Planning in California – Morteza Orang (DWR)
4. Field Application of IWFM Demand Calculator to Estimate Irrigation Water Requirement – Pavithra Prakash(UC Davis)

**11:45 a.m. – 12:30 p.m.**

### **Lunch**

Pick up a box lunch and then join us for the keynote speech by Phil Isenberg.

**12:30 – 1:15 p.m.**

## **Session 13. Keynote Speaker**

***Moderator: Josué Medellín-Azuara (CWEMF/UC Davis)***

***Location: Sierra 1***

**Phil Isenberg, Former Member of the California State Assembly and Former Chair of the Delta Stewardship Council**



**1:15 – 3:00 p.m.**

## **Session 14. Central Valley Flood Protection Plan (CVFPP) Update 2017 Session 1**

***Moderator: Samson Haile-Selassie (DWR)***

***Location: Sierra 1***

1. An Overview of Modeling Approaches and Review Tools for the 2017 CVFPP Update – Yiguo Liang (DWR) and Paul Robinson (CH2M)
2. Changing Flood Risks in the Central Valley under Climate Change – Armin Munévar (CH2M)
3. Development of Stage and Flow Frequency Curves for the 2017 Central Valley Flood Protection Plan Update – David Arrate (DWR)
4. Assessing Flood Risk over Time using Information from the 2017 Central Valley Flood Protection Plan Update – Devinder Dhillon (DWR) and Nathan Pingel (David Ford Consulting Engineers)
5. Evaluation of Subsidence Impacts on Flood Risks in the San Joaquin Basin – Mary Horvath (CH2M)

## **Session 15. Environmental Flows Modeling**

***Moderator: Mike Deas (Watercourse Engineering)***

***Location: Folsom/Natoma***

1. The Structure of Compromise and Conflict in Setting Environmental Flows – Jay Lund (UC Davis)
2. A Coordinated Approach for Developing Statewide Environmental Flow Regulations in California – Julie Zimmerman (The Nature Conservancy)
3. Optimal Reservoir Releases for Downstream Environmental Purposes – Lauren Adams (UC Davis)
4. Achilles' Heel of Integrated Hydrologic Models: the Stream-Aquifer Flow Exchange – Hubert Morel-Seytoux (Hydroprose)

**3:15 – 5:00 p.m.**

## **Session 16. Central Valley Flood Protection Plan (CVFPP Update 2017 Session 2**

***Moderator: Samson Haile-Selassie (DWR)***

***Location: Sierra 1***

1. Assessing Ecological Benefits of River and Floodplain Restoration using Targeted Processes, Habitats, Species, and Stressors – Craig Williams (DWR)
2. CVFPP Lower San Joaquin Basin 2D Modeling – Clark Churchill (DWR)
3. Integrated HEC-RAS 2D Hydraulic Models for the Sacramento River Basin Floodplains and Bypass Systems for Improved Flood Risk and Ecosystem Management Analyses – Chakri Malakpet (DWR)
4. Wave Runup and Wind Setup Analysis for the Lower Elkhorn Setback Levees – Mahesh Gautam (DWR)
5. Development of Stage-Frequency Curves in the Sacramento-San Joaquin Bay Delta for Current Climate, Sea Level Rise, and Climate Change Conditions – Romain Maendly (DWR)

## **Session 17. A Kaleidoscope of Modeling**

***Moderator: Josué Medellín-Azuara (CWEMF/UC Davis)***

***Location: Folsom/Natoma***

1. Comparison of Drought Severity, Intensity, and Duration in Sacramento, San Joaquin, and Tulare River Basins – Ramesh Gautam, Mitch Russo, and Michael Anderson (DWR)
2. Drought Water Right Curtailment – Jeff Laird (UC Davis)
3. Enhancing Los Vaqueros Expansion Project Operations with Optimization-based Smart Searches – Thomas FitzHugh (MWH Global)

## **Session 18. Student/Young Professional Mentoring Session**

***Moderator: Holly Canada (David Ford Consulting Engineers)***

***Location: Lake Natoma Inn Restaurant***

The Student/Young Professional Mentoring Session is designed to bring students and young professionals together with experienced modelers. We welcome any interested student, young professional or experienced professional to join us. We plan to split up into smaller groups to facilitate informal, yet useful, conversations.

**5:00 – 7:00 p.m.**

## **Session 19. Poster Session and Social**

***Moderator: Stacy Tanaka (Watercourse Engineering)***

***Location: Sierra 2***

**Poster session sponsored by Watercourse Engineering.**

**Social sponsored by ICF, RMC, and Tetra Tech**

### **Poster Session Titles**

1. Development of Integrated HEC-RAS 2D Hydraulic Models for the Sacramento River Basin Floodplains and Bypass Systems – Chakri Malakpet and Steve Micko (CH2M)
2. Successfully Integrating of Central Valley Hydrology Study (CVHS) to DWR Systemwide Studies – Nathan Pingel (David Ford Consulting Engineers), Devinder Dhillon and Mahesh Gautam (DWR), and Chakri Malakpet (CH2M)
3. Assessing Flood Risk over Time using Information from the 2017 Central Valley Flood Protection Plan Update – Devinder Dhillon (DWR) and Nathan Pingel (David Ford Consulting Engineers)
4. An Outcome-Driven Approach to Flood Management in California's Central Valley – Paul Robinson and Robyn Grimm (CH2M)
5. Changing Flood Risks in the Central Valley under Climate Change – Armin Munévar (CH2M)
6. Development of Stage-Frequency Curves in the Sacramento - San Joaquin Bay Delta for Current Climate, Sea Level Rise and Climate Change Conditions – Romain Maendly (DWR)
7. Evolution of the Technical Tools Utilized in Development of the 2017 CVFPP Update – Paul Robinson (CH2M)
8. Evaluation of Subsidence Impacts on Flood Risks in the San Joaquin Basin – Mary Horvath (CH2M)
9. California's Fourth Climate Change Assessment: An Overview of Research to Inform Climate-Resilient Policy and Action in California – Jamie Anderson (DWR)
10. Development of a Database for Tracking High Speed Rail Submittals to the Bureau of Reclamation – James Lu (Reclamation)
11. CWMS Flood Forecasting Model for the Neches River, Texas – Om Prakash (West Consultants)
12. Estimating Field Scale Crop Evapotranspiration using Landsat and MODIS Satellite Observations – Andy Wong (UC Davis)

13. Effects of Climate Uncertainty on the Development and Evaluation of Adaptation Strategies – Michael Tansey (Reclamation)
14. A Comparative Study on Consumptive Use in the Sacramento-San Joaquin Delta – Josué Medellín-Azuara
15. Scientific Progress Goes “Boink”: EBMUD’s Three-Year Drought Operations in Comic Prose – Kevin Fung (EBMUD)
16. Ensemble Flow Forecasts for Risk-based Reservoir Operations of Lake Mendocino in Mendocino County, California – Chris Delaney (Sonoma County Water Agency)
17. Analysis of Flood Bypasses around the World – Alessia Siclari (UC Davis)
18. HEC-RAS 2D and Flow 3D – Jeanette Newmiller (UC Davis)
19. Relationship between Hydroclimatic Extremes and the Madden-Julian Oscillation in California from an Operational Perspective – Kevin He (DWR)
20. The Chehalis Flood Alert System: Delivering Information to the Public – Eric Mork (WEST Consultants)
21. Water Storage Investment Program Climate Change and Sea Level Rise – Craig Colledge (CH2M)

**PLEASE RETURN YOUR NAME BADGE TO THE REGISTRATION TABLE IF YOU WILL NOT BE COMING BACK TOMORROW.**

## Wednesday, March 22

**7:30 – 8:00 a.m. – Registration in Sierra Hallway**

Refreshments sponsored by LimnoTech

**8:00 – 9:45 a.m.**

### **Session 20. Multi-D Modeling**

*Moderator: Eli Ateljevich (DWR) and Aaron Bever (Anchor QEA)*

*Location: Sierra 1*

1. Tides, Salinity, and Transport in the Pre-development San Francisco Estuary – Steve Andrews (RMA)
2. Evaluation of the Effects of Long-Term Trends in Sediment Supply and Wind Speed on Turbidity in Suisun Bay and the Delta – Aaron Bever (Anchor QEA)
3. The Influence of Estuarine Circulation on Recruitment from the Ocean to Low Salinity Habitat – Edward Gross (RMA)
4. Effect of Geometry Configuration and Vegetation Removal on Transport and Tidal Energy near Franks Tract – Kijin Nam (DWR)

### **Session 21. The Surface-Groundwater Continuum: A Modeling Challenge**

*Moderator: Hubert Morel-Seytoux (Hydroprose)*

*Location: Folsom/Natoma*

1. A Hydrologic and Geomorphic Classification of Rivers in California – Samuel Sandoval Solis (UC Davis)
2. Impact of Agricultural Groundwater Recharge on Soil Water Balance and Crop Productivity of Alfalfa and Almonds – Helen Dahlke (UC Davis)
3. MODFLOW-OWHM Version 2: Discussion of New Features, Updates, and Improvements – Scott Boyce (USGS)
4. The Untold Story of Taggart Aston's Fight for Hetch Hetchy – Max Fefer (UC Davis)

**10:00 – 11:45 a.m.**

## **Session 22. CalSim and CalLite Model Applications**

***Moderator: Karandev Singh (DWR)***

***Location: Sierra 1***

1. Scenarios by the Hundreds: Using CalLite's Fast Run Capability to Probe Uncertainty – Andrew Schwarz (DWR)
2. Quantification of Carriage Water using CalSim II – Raymond Hoang (DWR)
3. What's Controlling Delta Outflow? – Nur Taraky (DWR)
4. CalSim and CalLite Model Updates – Chris Quan (DWR)
5. CalSim 3.0 Model Updates by Bureau of Reclamation – Nancy Parker and Jim Shannon (Reclamation)

## **Session 23. Modelers' Plethora: Retooling, Innovating, and Advancing Models and Methods**

***Moderator: Ben Bray (EBMUD)***

***Location: Folsom/Natoma***

1. A Showcase of FHWA's New Hydraulic Model SRH-2D and its Example Application – Murari Paudel (Wood Rodgers)
2. Representing California's Water System with an Open Source Model: PyVIN – Mustafa Dogan (UC Davis)
3. Nutrient and Algae Modeling for Remedial Evaluation of Lake San Marcos, CA – Justin Ibershoff (LimnoTech)
4. Improving Salmonid Restoration Efforts using Unmanned Aerial Systems and Structure – from Motion Photogrammetry, Lower American River, California – Toby Stegman (cbec eco-engineering)

**11:45 a.m. – 1:15 p.m.**

**Lunch at area restaurants**

**1:15 – 3:00 p.m.**

## **Session 24. Modeling Major Floods to Monthly Water Supply**

***Moderator: Shyamal Chowdhury (Wood Rodgers)***

***Location: Sierra 1***

1. Application and Evaluation of the HEC-RAS – Riparian Vegetation Simulation Module to the Sacramento River – Zhonglong Zhang (Limnotech)
2. Hydraulic Analysis near Fremont Weir and Yolo Bypass by 1D and 2D Hydraulic Model – Sungho Lee (DWR)
3. Rainfall-Runoff Modeling for the Garrison Dam Drainage with HEC-HMS – Melissa Larsen (WEST Consultants)
4. Potential Changes in Water Supply under Future Climate Projections in the Central Valley – Minxue (Kevin) He (DWR)

## **Session 25. Applications of 2-Dimensional HEC-RAS to Ecosystem Enhancement in the Central Valley**

***Moderator: Paul Frank (FlowWest)***

***Location: Sierra 1***

1. Using 2D Hydrodynamic Modeling to Quantify Spatio-temporal Inundation Patterns for Floodplain Restoration – William Fleenor (UC Davis)
2. Modeling the San Joaquin River Floodplain for Restoration at Great Valley Grasslands State Park – David Arrate (DWR)
3. A 1D/2D HEC-RAS model of the Yolo Bypass and the Lower Sacramento Valley: Summary and Next Steps – Lily Tomkovic (UC Davis)
4. Applying 2D HEC-RAS for Long-term Resource Management with the Cache Creek Area Plan – Paul Frank (FlowWest)

**3:15 – 5:00 p.m.**

**Session 26. A New MILP Solver for CalSim/CalLite**

*Moderator: Junaid As-Salek*

*Location: Sierra 1*

1. jCbc: An Open Source LP/MILP Solver for CalSim/CalLite – Zhaojun Bai (UC Davis)
2. Implementation of jCbc Solver for WRIMS2 and CalSim – Kevin Kao (DWR)
3. Performance Analysis of jCbc and Emerging Challenges and Opportunities – Mahdi Ghamkhari (UC Davis)

**Session 27. Modeling Floods and Human Behavior**

*Moderator: Holly Canada, David Ford Consulting Engineers*

*Location: Folsom/Natoma*

1. Flood Insurance and Flood Memory Half Life – Rui Hui (UC Davis)
2. Numerical Application of SCHISM about Flood Inundation Modeling due to Levee Breach in Idealized Channel and Field Case – Seung Oh Lee (Hongik University)
3. Maintaining a Consistent Level of Risk in Reservoir Operations also Requires Assessing Dynamic Downstream Risk and Benefits – Matthew Bates (U.S. Army Corps of Engineers)

**PLEASE RETURN YOUR NAME BADGE TO THE REGISTRATION TABLE.**



# ABSTRACTS<sup>1</sup>

## Session 1. Sustainable Groundwater Management Act

### 1. DWR Best Management Practices and Tools for Sustainable Groundwater Management

**Presenter(s):** Lisa Porta (CH2M) and Steven Springhorn( DWR)

**Presenter(s) Email Address(es):** Lisa.Porta@CH2m.com , Steven.Springhorn@water.ca.gov

**Collaborators:** Rich Juricich (DWR) and Trevor Joseph

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

As part of the Sustainable Groundwater Management Act and related Groundwater Sustainability Plan (GSP) Regulations, the California Department of Water Resources (DWR) published five best management practices (BMPs) on the following topics, monitoring protocols, monitoring networks, hydrogeologic conceptual models, water budget, and groundwater/surface water modeling. The BMPs are intended to provide clarification, guidance, and examples to help Groundwater Sustainability Agencies develop the essential elements of a GSP. BMPs rely on technical information from other groundwater management efforts, existing standards, or other guidance or reference reports. The presentation will provide a general overview of all of the BMPs with an emphasis on the water budget and modeling BMPs and related climate change data, assumptions, methodologies and recommended workflow for development of GSPs.

### 2. Incorporating Model Uncertainty Analysis into SGMA Decision Making

**Presenter(s):** Jon Traum (USGS)

**Presenter(s) Email Address(es):** jtraum@usgs.gov

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes, but I will need to relabel things as “preliminary” first

**Abstract:**

When using model results to support water-management strategies, it is important that decision makers understand the implications of uncertainty in model predictions. The typical practice in the hydrologic modeling community is to develop a model scenario for each management alternative and then perform a single model run of each scenario using the “best” calibration parameter set. The failing of this approach is the assumption that there is one single unique parameter set that matches historical observations. In fact, many different parameter sets exist that sufficiently meet calibration objectives but that may generate different predictions.

This talk utilizes the Petaluma Valley Integrated Hydrologic Model to demonstrate a predictive uncertainty analysis method. Using PEST software, the confidence limits of each estimated parameter were calculated, and random values that fall within these confidence limits were selected to generate multiple parameter sets. Some of these parameter sets did not sufficiently calibrate the model (confidence intervals assume that the model results vary linearly with changes in parameter values, but in reality the relationship is non-linear) and were discarded, resulting in a subset of parameters sets for further analysis. Each model scenario was then run multiple times, each time using a different parameter set. The results were aggregated to develop a probability distribution of predicted model

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<sup>1</sup> Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

results. By utilizing these probability distributions, decision makers can better address the uncertainty in simulated hydrologic responses to management actions.

### **3. Decisions, Decisions: Decision Support Modeling in Groundwater Sustainability Planning**

**Presenter(s):** Aaron Mead (Exponent)

**Presenter(s) Email Address(es):** amead@exponent.com

**Collaborators:** Susan C. Paulsen (Exponent) and Max Henrion (Lumina Inc.)

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes or No

**Abstract:**

California's recent Sustainable Groundwater Management Act (SGMA) requires local Groundwater Sustainability Agencies (GSAs) in medium- and high-priority basins to develop Groundwater Sustainability Plans (GSPs) by 2022. SGMA further requires GSAs to "consider the interests of all beneficial uses and users of groundwater" in developing their GSPs (§10723.2). Users of groundwater and interested parties may include the agricultural industry, landowners with overlying pumping rights, municipal water suppliers, industrial and residential water users, recreational users of surface waters, local land-use authorities, environmental groups, and representatives of county, state, federal, and tribal governments. Given the divergent concerns of these parties, the development of GSPs is expected to be highly controversial in some basins and could result in expensive and time-consuming legal proceedings or state intervention. Because of the potential for controversy and conflict, SGMA encourages stakeholders to take a collaborative, consensus-driven approach to the development of GSPs. Decision support models are ideally suited to facilitate this collaborative approach to GSP development.

This presentation will begin with a brief look at a successful application of decision support modeling to a highly controversial and structurally similar problem: the development of a decommissioning policy for oil platforms off the coast of Southern California. The presentation will show how this method can be applied to develop GSPs and will present a conceptual-level decision support model for a hypothetical groundwater basin. The conceptual model was developed using the software Analytica®. Decision support models like this offer a clear and transparent approach to developing GSPs by engaging stakeholders in model development and by rigorously integrating both quantitative and qualitative effects of proposed plan alternatives, such as infrastructure costs, water rights impacts, surface water-groundwater ecosystem impacts, and changes in groundwater storage.

### **4. DWR Water Available for Replenishment Estimates**

**Presenter(s):** Romain Maendly and Devinder Dhillon(DWR)

**Presenter(s) Email Address(es):** romain.maendly@water.ca.gov; devinder.dhillon@water.ca.gov

**Collaborators:** Jim Wieking (DWR)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

As part of the Sustainable Groundwater Management Act, the California Department of Water Resources (DWR) published a draft report that presents "DWR's best estimate, based on available information, of water available for replenishment of groundwater in the state." The notion of "Water Available for Replenishment of Groundwater" includes two parts. The first part, "Water Available," represents a quantity of water that could be developed by one water available method (surface water, conservation, recycled, desalination, etc.) and matched to specific groundwater replenishment project(s). The second term, "for Replenishment of Groundwater," designates the physical process of the augmentation of a groundwater basin, by natural or artificial means.

The presentation will focus on the tools, methodologies, and assumptions to estimate "Water Available

for Replenishment”. For surface water, two analytical approaches were used to calculate outflow: 1) Gage Data Method and 2) Water Evaluation and Planning (WEAP) tool. Conceptual or illustrative project(s) are then applied to the outflow with two essential limiting factors: 1) Instream flow requirement and 2) Project(s) diversion capacity. This method provides a simple planning estimate of water available for replenishment (as distinctive from a water available analysis as required for a water right permit). For conservation, recycled water, desalinated water, and other water available methods, available planning estimates of potential water available from The California Water Plan are used.

## **Session 2. Applications of Evapotranspiration in Water Resource Management**

### **1. A comparative study on consumptive use in the Sacramento-San Joaquin Delta**

**Presenter(s):** Josue Medellin-Azuara (UC Davis)

**Presenter(s) Email Address(es):** jmedellin@ucdavis.edu

**Collaborators:** Kyaw Tha Paw U, Yufang Jin, Jay R. Lund, Eric Kent, Jenae’ Clay, Nadya Alexander-Sanchez, Andy Wong, & Jesse Jankowski (UC Davis); Michelle M. Leinfelder-Miles (UC Cooperative Extension), A., Martha Anderson (USDA-ARS), Daniel Howes (Cal Poly), Forest Melton (NASA), Tariq Kadir, Lan Liang, and Morteza Orang (DWR)

**Permission to Post pdf of Presentation on CWEMF Website:** YES

#### **Abstract:**

Understanding consumptive water use in the Sacramento San Joaquin Delta (SSJD) is critical for water rights administration, water management and operations, and environmental and water quality protection. This study compares preliminary estimates of evapotranspiration (ET) in crops for the 2015 and 2016 water years in the SSJD employing seven different methods and direct field measurements for a selection of crops. The research project also includes the installation of additional meteorological stations in the SSJD under the California Irrigation Management Information System (CIMIS). The seven methods employed and their participating research groups are: 1) the California Simulation of Evapotranspiration of Applied Water (CalSIMETAW, DWR), 2) the Delta Evapotranspiration of Applied Water Model (DETAW, DWR), 3) the Disaggregated Atmosphere-Land Exchange Inverse (DisALEXI, USDA-ARS), 4 & 5) the Mapping Evapotranspiration at High Resolution with Internalized Calibration model (METRIC, UC Davis and ITRC CalPoly-SLO), 6) the Satellite Irrigation Management Support System (SIMS, NASA-ARC), and 7) the Priestley-Taylor method (PT, UC Davis). Preliminary results indicate that overall estimates of consumptive use are consistent with water balance estimates in the California Water Plan. Field-measured bare soil ET in areas above sea level indicates no evapotranspiration relative to grass-based reference evapotranspiration. Sources of discrepancy in ET estimations among the various methods and field measurements will be discussed, and qualitative comparison between the seven methods are provided. Further refinements and preliminary policy insights will be presented.

### **2. Google Earth Engine METRIC (GEM) Application for Remote Sensing of Evapotranspiration**

**Presenter(s):** Nadya Alexander-Sanchez (UC Davis)

**Presenter(s) Email Address(es):** nadyaa@ucdavis.edu

**Collaborators:** Justin Mertz, Quinn Hart, Josué Medellín-Azuara and Jay R. Lund (UC Davis)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

For the past ten years, the METRIC algorithm (Allen et al., 2007) has been used across a wide range of research and consulting applications to estimate evapotranspiration mostly in crops employing inputs Landsat satellite imagery, crop layer data, and local weather stations. The METRIC algorithm has been extensively researched and tested for accuracy, running its various steps and troubleshooting can be

time consuming. We present Google Earth Engine METRIC (GEM) application developed at the Center for Watershed Sciences of UC Davis which contributes to the advancement of existing METRIC processing platforms. The GEM platform dramatically reduces processing time. The application incorporates modules for a QAQC process on weather data, calculation of grass-based and alfalfa-based reference evapotranspiration, built-in cloud masking and thermal sharpening, spatial tabulation for hot and cold pixel selection, easily adjustable parameters, and statistical analysis of calibration decisions. The ease and speed of running the GEM application allows for METRIC results to be presented with a wider range sensitivity analysis compared to previous versions. Results and model inputs enhance transparency, replicability in some key METRIC model elements including the hot and cold pixel calibration. The GEM application has been employed at UC Davis to estimate evapotranspiration and vegetative indices in various applications in the Central Valley, Kern County, and the Sacramento-San Joaquin Bay Delta. The open-source GEM application combines the speed and flexibility of Google Earth Engine based remote sensing cloud processing with the transparency and customization desirable for research.

### **3. Application of Evapotranspiration Forecasting to Water Management in the Klamath Basin**

**Presenter(s):** Michael Tansey (Reclamation), David Yates (NCAR) and Zackary Leady (Reclamation)

**Presenter(s) Email Address(es):** mtansey@usbr.gov, yates@ucar.edu, zleady@usbr.gov

**Collaborators:** Kirk Nelson, Michael Wright, and Katharine Dahm (Reclamation)

Justin Huntington, Charles Morton, and Christian Dunkerly (DRI)

**Permission to Post pdf of Presentation on CWEMF Website:** YES

#### **Abstract:**

The Klamath Project developed by the United States Bureau of Reclamation provides water for irrigation, hydropower, wildlife refuges and environmental needs in the Klamath Basin located in southern Oregon and northern California. To meet these needs, Reclamation is developing a reservoir systems operations model which will use short-term (weekly) and longer-term (seasonal) forecasts of water supplies and irrigations demands to better inform water management decisions. This presentation focuses on the development and application of evapotranspiration (ET) forecasts to inform both short and long term irrigation water requirements. Short term forecasts are based on meteorological model forecasts (GFS) bias corrected and downscaled to individual agricultural meteorological stations (AgriMet) to compute daily reference ET (ET<sub>o</sub>) with lead times of up to eight days. Longer term forecasts with lead times of up to 180 days are made from probabilistic seasonal outlooks (CPC/IRI) and K-NN resampling of agricultural meteorology station data. The spatial distribution of meteorological variables is determined by the application of clustering methodologies to historic, gridded meteorological data (GridMet). Forecasted meteorology at the agricultural stations is then bias corrected to the centroid of each cluster. A daily water balance for each cluster is computed using the ET Demands model developed by DRI and Reclamation. A daily net irrigation water requirement (NIWR) is computed from these forecasts by the ET Demands model based on crop types, acreages and soil conditions. The forecasted NIWR results along with concurrent supply forecasts are simulated in the reservoir system model to inform potential operations management decisions.

## Session 3. DSM2

### 1. DSM2 Nutrients Modeling Sensitivity Analysis

**Presenter(s):** Ming-Yen Tu (DWR)

**Presenter(s) Email Address(es):** Ming-Yen.Tu@water.ca.gov

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

The California Department of Water Resources' Delta Modeling Section is developing a new DSM2 transport module, called the General Transport Model (DSM2-GTM). Part of the DSM2-GTM development process is to calibrate the dissolved oxygen (DO) module that simulates the transport and reaction of water temperature and nine non-conservative constituents that are currently included in the DSM2-QUAL. In general there are two types of model calibration approaches: automatic and manual calibration. If the manual calibration approach was decided to carry out the DSM2-GTM calibration, choosing which constituent reaction rates to calibrate the model more efficiently could be challenging. To have a better idea regarding which constituent reaction rates may possess more significant effects on the model results, a sensitivity analysis was performed to test how the model results respond when changing certain constituent reaction rates. This presentation summarizes the sensitivity analysis approach and preliminary findings to date. The constituent reactions rates under consideration included algae growth rate, ammonia decay rate, organic phosphorus decay rate, and algae mortality rate. This sensitivity analysis is an initial investigation and an on-going exercise along with the DSM2-GTM development.

### 2. Extending DSM2 V8.1.2 Historical Simulation to 1962

**Presenter(s):** Steve Micko (CH2M)

**Presenter(s) Email Address(es):** Steve.Micko@ch2m.com

**Collaborators:** Rosemarie Dimacali and Chandra Chilmakuri (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:** To aid the US Fish and Wildlife Service (USFWS) in their development of a Delta Smelt Life Cycle Model (DSLCLM), CH2M developed historical DSM2 simulations to represent the Sacramento-San Joaquin River Delta (the Delta) from 1962 through February 2015. Two simulations were conducted to account for the Delta hydrodynamic conditions before and after the flooding of Liberty Island: (1) from January 1962 through December 1998, and (2) from January 1999 through February 2016. Limited verification was conducted via comparison of predicted EC to available observations from 1964 to 1975. More recent year results have already been verified in the DSM2 V8.1.2 Calibration report by DWR. The DSM2 simulation results served as a base for particle fate and transport studies and were used to identify tidal variables coinciding with sampling times and locations of various fish surveys. DSM2 Particle Tracking Model (PTM) simulations were conducted at the start of March, April, May and June from 1962 through 2015. In each simulation, particles were inserted into one of 25 sub-regions. Thirty days after insertion, the percentages of particles in all of the sub-regions were tabulated to understand Delta particle transport in spring months. At each sampling time and location of the fish surveys provided by the USFWS, tidal information from DSM2 results were collected. These data included the nearest high, low, and slack tide for stage and velocity. The automatic multiscale-based peak detection (AMPD) algorithm was implemented to detect peaks and troughs in the DSM2 stage and tidal velocity output time series.

### **3. Juvenile Salmon Swimming Behavioral Parameter Estimation and Routing Sub-Model Development in an Enhanced Particle Tracking Model**

**Presenter(s):** Xiaochun Wang (DWR)

**Presenter(s) Email Address(es):** Xiaochun.Wang@water.ca.gov

**Collaborators:** Adam Pope (USGS), Dalton Hance (USGS), Russell Perry (USGS), Doug Jackson (ERG) and Jason Romine (USGS)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

A Particle Tracking Model (PTM) simulates the transport and fate of individual notional particles through interconnected channels in the Delta. However, the accuracy of a PTM in real-time management decision making may be limited by the discrepancy between particle and fish movement patterns. In order to meet management information needs, efforts have been made to develop fish behavior sub-models and to attach fish-like behaviors to particles. In the presentation, two components of this work will be presented: 1) the development of a fish swimming behavior sub-model using a novel method to estimate the swimming behavioral parameters, and 2) the development of a routing behavior sub-model by combining sub-models of the critical streak line and the cross-sectional distribution of juvenile salmon to predict fish routing at river junctions. Lessons learned from developing the behavioral sub-models and how these sub-models can be integrated to a more sophisticated three-dimensional hydrodynamic model will also be discussed. We expect that the knowledge gained from this work will help us develop a valuable tool for water resources managers to better understand and evaluate the potential ecosystem-level impacts of water management actions on fish movement and survival through the Delta, and ultimately help managers to make optimal decisions.

## **Session 4. MODFLOW-OWHM, Topics, and Applications of this Integrated Hydrologic Modeling Software**

### **1. Using the new FREEWAT platform for water management: development and preliminary applications**

**Presenter(s):** Laura Foglia

**Presenter(s) Email Address(es):** lfoglia@ucdavis

**Collaborators:** Iacopo Borsi, Massimiliano Cannata, Enric Vazquez-Suney, Steffen Mehl, Rudy Rossetto

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

The FREEWAT platform has been developed in the framework of a HORIZON 2020 European project. FREEWAT is an open source and public domain GIS integrated modelling environment for simulation of water quantity and quality in surface water and groundwater with an integrated water management and planning module. FREEWAT aims at promoting water resource management by simplifying the application of the Water Framework Directive and related Directives. Specific objectives of the project are: to coordinate previous EU and national funded research to integrate existing software modules for water management in a single environment into the GIS based FREEWAT and to support the FREEWAT application in an innovative participatory approach gathering technical staff and relevant stakeholders (policy and decision makers) in designing scenarios for application of water policies. The open source characteristics of the platform allow to consider this an initiative "ad includendum", as further institutions or developers may contribute to development.

Main expected impact of FREEWAT is to help produce scientifically and technically sound decisions and policy making based on data and innovative data analysis tools and to support participatory approach not only in the final stage of discussion but during the phase of scenario generation.

The platform currently includes specific modules for: 1) water management and planning to help managing and aggregating the distributed data coming from simulation scenarios; 2) calibration, uncertainty and sensitivity analysis; 3) solute transport in unsaturated zone; 4) crop growth and water requirements in agriculture; 5) tools for groundwater quality issues; 5) tools for analysis, interpretation and visualization of time series and hydrogeological data.

The platform is currently being tested using test cases throughout Europe, one case study in Turkey and one transboundary aquifer between South Africa and Namibia. Some preliminary results about practical applications will be presented

## **2. Implementing Available Data Streams for Better Conjunctive Use Modelling using MODFLOW-OWHM**

**Presenter(s):** Wesley Henson (USGS)

**Presenter(s) Email Address(es):** [whenson@usgs.gov](mailto:whenson@usgs.gov)

**Collaborators:** Scott Boyce and Randall Hanson (USGS)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

Current MODFLOW-OWHM (MF-OWHM) development is focusing on methods to incorporate available data streams and those that will be prevalent in the near future to better represent soil moisture and land use. Recent advances in soil moisture sensor technology will provide much needed information about feedbacks between irrigation practices, evapotranspiration, runoff and recharge. These sensor arrays provide a means to calibrate crop demands from the field to regional scale in conjunctive-use models. A new soil moisture based conceptual model is being developed for MF-OWHM to take advantage of these data streams as they become available, and to provide an additional option to include soil moisture use, storage, and movement if needed at selected scales. Similarly, changes in land use also can greatly affect the estimation of supply and demand for tightly coupled surface and subsurface processes. Thus, additional improvements in land use representation will improve estimation and analysis with integrated hydrologic models such as MF-OWHM. In highly developed areas, land use analyses are becoming more rigorous, providing more precise and systematic data. However, most historical land use was aggregated to the model grid scale and collected in punctuated snapshots in time thus losing some of the temporal and spatial dynamics of modern agriculture. The sparse spatiotemporal resolution of land-use data decreases the skill of simulating water demands and related surface-water and groundwater supplies. Representation of land use between these snapshots is a significant source of uncertainty in integrated hydrologic models. Land use change in the newest version of MF-OWHM will allow representation of sub-grid scale water demands. We are developing new methods to take advantage of long term data sets (e.g. California Pesticide Database) to improve spatiotemporal representation of land use and agriculture. These model improvements will help managers develop water portfolios that support sustainable groundwater use.

## **3. Simulating Water Availability and Sustainability in California's Central Valley**

**Presenter(s):** Claudia Faunt (USGS)

**Presenter(s) Email Address(es):** [ccfaunt@usgs.gov](mailto:ccfaunt@usgs.gov)

**Collaborators:** Jon Traum (USGS)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

California relies heavily on groundwater to meet its water needs. It provides a crucial buffer against land-use change effects, water restrictions, drought, and the impacts of climate change, including the depletion of mountain snowpack, all of which affect surface water supplies. Despite its essential role,

the state's groundwater system is under considerable strain and until recently has been largely unregulated. California's Sustainable Groundwater Management Act of 2014 (SGMA) provides a framework to comprehensively measure and manage groundwater and empowers local agencies to assess hydrologic issues that manifest as "undesirable results." California's Central Valley has many basins with "undesirable results." The Central Valley covers about 20,000 mi<sup>2</sup> and is one of the most productive agricultural regions in the world. Because the valley is semi-arid, surface-water availability varies substantially. Agricultural demand for irrigation is heavily reliant on surface water and groundwater. Starting in the 1950s, state and federal water distribution systems have eased the reliance on groundwater as dependence shifted to diverted surface water. In the last 20 years, however, land-use changes and limitations to surface-water availability—including drought and environmental flow requirements—have increased pumping, causing groundwater-level and groundwater-storage declines, subsidence, decreased stream flows, and changes to ecosystems. As these recent trends continue, monitoring and modelling are critical to understanding the dynamics of groundwater use and developing better management strategies. Modeling tools, such as the USGS Central Valley Hydrologic Model, enable managers to develop strategies to mitigate adverse impacts while also optimizing water availability.

#### **4. Salinas Valley Integrated Modeling of Agricultural Conjunctive-Use**

**Presenter(s):** Randall T. Hanson<sup>1</sup>

**Presenter(s) Email Address(es):** rthanson@usgs.gov

**Collaborators:** J. Hevesi<sup>1</sup>, W Henson<sup>1</sup>, S.E. Boyce<sup>1</sup>, A.B. Ritchie<sup>2</sup>, A. Galanter<sup>2</sup>, and A. Woodrow<sup>3</sup>

<sup>1</sup>U.S. Geological Survey, San Diego, CA, USA

<sup>2</sup>U.S. Geological Survey, Albuquerque, NM, USA

<sup>3</sup>Monterey County Water Resource Association, Salinas, CA, USA

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes or No

##### **Abstract:**

Agricultural development, including shifts to more water-intensive crops, combined with climate variability, are placing larger demands on the sustainability of water resources in many regions across the United States. In the Salinas Valley, conjunctive use has resulted in surface-water and groundwater depletion and caused related secondary effects such as reduced surface-water deliveries, streamflow depletion,, seawater intrusion, , saline irrigation practices, and potential habitat degradation. In the Salinas Valley, competing interests for flood-control, environmental, municipal, and agricultural needs are creating new challenges and demands on conjunctive use of groundwater and surface water and sustainability of the resources owing to increased crop rotation of high-value crops, salinity irrigation flushing demands, and environmental flows, and new augmentations such as the reuse of recycled water and dual-reservoir operation for flood control, water use, and enhanced dry-season releases. The "One Water" model (MODFLOW-OWHM) is used in conjunction with the Basin Characterization Model (BCM) and Hydrological Simulation Program—Fortran (HSPF) precipitation-runoff models to provide a complete simulation of the entire watershed and related aquifers, surface-water networks, and landscape. This suite of models and related analysis tools provides the integrated hydrologic framework needed to simulate and analyze these complex and changing sets of supplies and demands of conjunctive use in one of the largest agricultural settings in the USA. The "One Water" modeling framework not only embeds spatially- and temporally- varying climate into the simulation of supply and demand, but also facilitates the assessment of sustainability within the context of climate variability, and landscape changes, and related adaptation analysis. One Water is able to capture the use and movement of water across rapidly changing land and water use scenarios, and illustrates the importance of simulating fully-linked conjunctive use for evaluating the sustainability of limited water resources.



## Session 7. Integrated Water Resources Modeling

### 1. Projecting Forward: A Framework for Groundwater Model Development under the Sustainable Groundwater Management Act

**Presenter(s):** Tara Moran (Stanford)

**Presenter(s) Email Address(es):** tamoran@stanford.edu

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

Passage of the Sustainable Groundwater Management Act (SGMA) in 2014, establishes California's first statewide framework for groundwater management. The Act requires local agencies in all high and medium priority basins to develop and implement groundwater sustainability plans that ensure sustainable groundwater management within 20 years of plan implementation.

Successful development and implementation these plans will require agencies throughout the state to undertake management actions that have been necessary for many years or, in some cases, decades, but have not been politically feasible without a state mandate. Specifically, water agencies will need to work collaboratively with one another, land-use planning agencies, and interested parties within the basin to develop plans to manage groundwater sustainably in the face of uncertainties associated with changing land-use practices, water supply, population growth, climate change, and other factors over a 50-year planning and implementation horizon. Where there are multiple groundwater management agencies in a basin, basin management and data and monitoring efforts must be closely coordinated. Additionally, agencies must ensure that their efforts to manage sustainably do not adversely impact neighboring basins. Models will play a critical role in achieving these goals.

This presentation provides a framework for model development under SGMA. It offers guidance on how and when stakeholders should be engaged in model development; establishes milestones for third-party model review; and guidelines for model use based on model inputs. The framework also discusses model documentation and archiving, and communicating model outputs to nontechnical audiences.

### 2. Problem with the use of an empirical "leakance coefficient" to evaluate seepage

**Presenter(s):** Hubert J. Morel-Seytoux (Hydroprose International Consulting)

**Presenter(s) Email Address(es):** hydroprose@sonic.net

**Collaborators:** Calvin Miller (Miller Groundwater Engineering), Steffen Mehl (Chico State University)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

MODFLOW (and most commercial integrated hydrologic models) use an empirical leakance coefficient to estimate the stream-aquifer flow exchange. Typically a single value is calibrated over a historical horizon for which observed data are available. Recent work based on an exact analytical description of the interaction has shown that such leakance coefficient is not constant in time and depends upon conditions in the river, such as high or low flows, and in the aquifer. Using a realistic stream-aquifer system this hypothesis was tested. A single value of the leakance coefficient was calibrated and used to calculate river discharges. These were compared with observed values for the calibration horizon. If the leakance coefficient is perfectly calibrated the total volume of seepage over that horizon is estimated correctly, as would be expected, but its distribution in time is in error. However when used over a different (validation) horizon both the total volume and the time distribution of seepage are in error.

### **3. MercedWRM: Integrated groundwater model development and calibration**

**Presenter(s):** Dominick Amador (RMC)

**Presenter(s) Email Address(es):** damador@woodardcuran.com

**Collaborators:** Hicham ElTal (MID), Marco Bell (MID), and Ali Taghavi (RMC)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

The Merced Water Resources Model (MercedWRM) is a fully integrated surface and groundwater flow model covering 600,000 acres of the Merced Groundwater basin and vicinity. Merced County is an important region to the agricultural economy of California and the nation, with more than \$3.8 billion dollars of agricultural economy. Managing the critically overdrafted Merced groundwater basin in a sustainable manner is a vital goal for the local agencies. The Merced Area Groundwater Pool Interest (MAGPI) has recognized the need for a comprehensive integrated model to support their management decisions for the water resources of the region.

Developed using the Integrated Water Flow Model (IWFM-2015) platform to simulate hydrologic processes in the region, the model relied on data from a combination of federal, state, and local sources and is calibrated using remote sensing evapotranspiration data from METRIC process, as well as streamflow, and groundwater levels for select wells. This presentation will walk through the development and calibration of the MercedWRM and its potential applications. We plan to showcase both the developmental tools and processes used in developing IWFM input files and the resulting calibration results, highlighting key model features, such as calibration of the IDC using remote sensing data from METRIC.

### **4. Application of integrated surface-subsurface models for managed aquifer recharge**

**Presenter(s):** Mehdi Ghasemizade (UC Davis)

**Presenter(s) Email Address(es):** mghasemizade@ucdavis.edu

**Collaborators:** Helen Dahlke and Thomas Harter (University of California, Davis)

**Permission to Post pdf of Presentation on CWEMF Website:** NO

#### **Abstract:**

Intensive groundwater withdrawals for agriculture have contributed to depleted streams, rivers and lakes in some regions causing sometimes irreversible effects. Managed aquifer recharge (MAR) has been relied on as a technique to capture wet year water for storage in aquifers and its application is likely to increase under California's sustainability goal. While most MAR studies consider local effects on aquifer storage, very few consider stream flows or regional-scale effects. In this study, we apply the integrated IWFM model to evaluate the complex interaction between MAR projects and stream flows in the southern Central Valley. We consider three different spatial patterns of water distributions on agricultural lands. Results show that while the selection of the spatial pattern for recharging the aquifer leads to different downstream groundwater outflows, a more diffuse, patchier recharge pattern results in more storage in the aquifer and less downstream outflow.

## Session 8. Remote Sensing and GIS

### 1. The Evolution of GIS Assisted Water Modeling

**Presenter(s):** Tom Heinzer (MPGIS, US Bureau of Reclamation)

**Presenter(s) Email Address(es):** theinzer@usbr.gov

**Collaborators:** Diane Williams (USBR)

**Permission to Post pdf of Presentation on CWEMF Website:** No

**Abstract:**

Since the 1980's, Geographic Information Systems have been used within USBR and DWR to assist in a wide array of hydrologic and hydrodynamic modeling investigations. These efforts usually involve data vetting and manipulation for parameterization of the conceptual model, and/or model output visualization. This talk will highlight the importance of spatial projections, data reduction techniques, and software development to facilitate model interface design. Historical to recent examples will be presented to illustrate the evolution of both data and technology related to these endeavors. Additionally, early challenges will be examined. Examples include levee and dam breaches, agent-based flood evacuation and consequence analysis, web-based systems, mesh generators, and particle transport.

### 2. Comparison of Methods for Estimating Water-Budget Components in the Central Valley, CA

**Presenter(s):** Stephen Maples (Hydrologic Sciences Graduate Group, UC Davis)

**Presenter(s) Email Address(es):** srmap@ucdavis.edu

**Collaborators:** Graham Fogg (Hydrologic Sciences Graduate Group, UC Davis)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

Accurate estimation of groundwater budgets and effective management of agricultural groundwater pumping in California's Central Valley is a priority for achieving legally-mandated groundwater management goals. Groundwater depletion in many parts of the Central Valley is driven largely by evapotranspiration by crops, but because comprehensive measurements of agricultural groundwater pumpage in the Central Valley are uncommon, accurate estimation of groundwater budgets remains a challenge. CVHM and C2VSim are two regional-scale hydrologic models that couple groundwater and agricultural water budget models to provide historical and current estimates of distributed groundwater pumping, changes in groundwater storage, and ET in the Central Valley. However, both models estimate these water budget components using conceptually different representations of soil-moisture conditions, estimations of ET requirements, and prioritizations of water allocation. The uncertainties related to these conceptual differences have not been adequately investigated. Here, we evaluate differences in distributed agricultural groundwater pumping, groundwater change-in-storage, and ET estimates for both models at regional and sub-regional scales. We also compare model estimates of ET against remotely-sensed estimates. Results show wide-ranging, but typically large differences in the magnitude of simulated distributed agricultural groundwater pumping and in temporal groundwater storage trends, both at the regional and sub-regional scale. In general, model agreement is poor at the sub-regional scale that is important for water management. Because many of the input data are the same for both models, these findings suggest that estimates of these important water budget components are sensitive to conceptual differences between methods, especially at the sub-regional scale.

### **3. California Actual Evapotranspiration (CalETa) Mapping Program**

**Presenter:** George Paul (Formation Environmental LLC)

**Presenter Email Address:** GPaul@formationenv.com

**Collaborators:** Pete Townsend, Brian Schmid, Chuan-Shin Chong, Mark Roberson, Tom Hawkins, Aaron Smith, Dane Williams, Clint Keller (Formation Environmental, LLC)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

A statewide actual evapotranspiration (ETa) dataset was developed to support California water resource planning and management efforts. CalETa is a daily dataset from 2010 through present at 30-meter resolution and is the result of a robust framework that utilizes publically available satellite imagery, local meteorological data, and open source algorithms. The core of the framework uses the Surface Energy Balance System (SEBS) algorithm to provide detailed estimated surface heat fluxes and produces consistent ETa estimates over a wide range of land use types. Validation studies show excellent relationships with measured data.

CalETa improves water resource management at every scale, including: drought and water conservation planning, groundwater banking, groundwater sustainability planning and management, surface and groundwater modeling, on-farm water management, water transfer planning and implementation, plant community monitoring, and irrigation performance and land use planning.

Examples of current applications include the following:

- DWR uses CalETa to improve water balance computation in C2VSim, to support implementation of the SGMA program, and to develop water conservation objectives and metrics.
- Private companies and water districts use CalETa to develop water management, planning and conservation tools.
- Southern San Joaquin Valley water quality coalitions use CalETa to quantify reduction in nitrate leaching through improved simulation of root zone water movement.
- The SWRCB uses CalETa to quantify cannabis water use and prioritize regulatory efforts.

## **Session 10. California Water Plan Update 2018: Envisioning and Tracking California Water Sustainability**

### **1. California Water Plan Update 2018 Overview**

**Presenter(s):** Paul Massera (California Dept. of Water Resources)

**Presenter(s) Email Address(es):** Paul.Massera@water.ca.gov

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

California Water Plan Update 2018 (Update 2018) is the 12th in a series of water plans prepared since 1957. It builds upon the previous update in 2013. Update 2018 will use a new, innovative approach and leverage key State water planning and policy initiatives, including SGMA and the Governor's Water Action Plan, to identify State government's policy and investment priorities for the next five years. In addition to creating an actionable water plan, the Update 2018 approach will enhance the effectiveness of state water planning, investment, and policy by:

- Establishing a common and useful description of statewide water sustainability.
- Identifying desired/intended outcomes (including outcomes shared by stakeholders with varying and even divergent interests).
- Conducting an assessment of current and anticipated future conditions (*Sustainability Outlook*).

- Prioritizing recommendations based on intended outcomes and sustainability outlook.
- Identifying most appropriate sources of funding for recommendations (*Funding Plan*).
- Establishing schedules, funding, implementers, and progress tracking (*Implementation Plan*).

## **2. Water Budget Framework and Dashboard**

**Presenter(s):** Todd Hillaire (California Dept. of Water Resources)

**Presenter(s) Email Address(es):** Todd.Hillaire@water.ca.gov

**Collaborators:** Abdul Khan, Paul Shipman (California Dept. of Water Resources)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

A water budget is the key to assessing sustainable water conditions in a watershed, groundwater basin, or geographical region because it provides a complete picture of inflows, outflows, and change in storage. Tracking water conditions in a geographic region is essential for developing a comprehensive water management strategy to reduce undesirable results, drought vulnerability, and risks to people, economy, and environment. Comprehensive water management often requires the sharing of data and information between agencies collecting data and developing water budgets. A common understanding of water budget components is needed to share data and information effectively. To address this need, the California Department of Water Resources is developing a water budget framework to support the implementation of California's 2014 Sustainable Groundwater Management Act and to transition the developed water supply and use computations for the California Water Plan (CWP), also known as Water Portfolios, to a watershed-based water budget. The project consists of a phased approach where Phase 1, presented herein, is a pilot project being conducted for the Tulare Lake Hydrologic Region in California's Central Valley to facilitate the development of a water-budget framework. The project included a rigorous comparison and refinement of CWP and the Integrated Water Flow Model's water budget data and methodologies. This comparison and refinement facilitated the selection of water budget components, the preparation of a common schematic, and the development of clear terminology. The Water Budget Dashboard presents an accounting of these water budget components for the Tulare Lake Hydrologic Region.

## **3. California Water Plan Update 2018: Enhancing the Effectiveness of State Government Policy and Investment**

**Presenter(s):** Megan Fidell (California Dept. of Water Resources)

**Presenter(s) Email Address(es):** Megan.Fidell@water.ca.gov

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

An important purpose of California Water Plan Update 2018 (Update 2018) is to help ensure that the intended outcomes for water policy, investment, and management in California are achieved in an effective manner. For decades, water management communities have understood that effective management employs consistent methods and metrics and is extraordinarily adaptive. Because the effects of any action within California's complex and dynamic system can never be fully anticipated, the Water Management Effectiveness Framework (Framework) was developed and deployed to help managers more effectively navigate the complexity and uncertainty inherent in the system. The Framework provides a foundation for guiding policy and investments while tracking their effectiveness at moving California toward sustainability. The Framework will also enable water managers at all levels to conceptualize and communicate in more organized and consistent ways across the state's diverse regions and interests. In the Framework, effectiveness is determined by the degree to which actions

taken help bring about outcomes that are consistent with meaningfully articulated intent — beyond metrics such as rates of expenditure or number of projects completed. The Framework utilizes a consistent, cyclic method for establishing shared intent, identifying outcomes and related performance metrics, and periodically reevaluating outcomes and benefits to inform adaptation and policy refinement. To realize the full potential of the Framework, water management communities must have a common understanding of the methods and value added. In addition, policy-makers must have confidence in the Framework's viability and credibility, such that Update 2018 will materially inform and shape key policy and investment decisions.

## **Session 11. Climate Change**

### **1. Developing Data Sets and Models for California's Water Storage Investment Program**

**Presenter(s):** Robert Leaf (CH2M), alternate: Derya Sumer (CH2M)

**Presenter(s) Email Address(es):** Rob.Leaf@CH2M.com, alternate: Derya.Sumer@CH2M.com

**Collaborators:** Andrew Schwarz and Sean Sou (DWR)

Armin Munevar, Derya Sumer, Tapash Das, Craig Cooledge, Chandra Chilmakuri, and Steve Micko (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

In November 2014, California voters approved Proposition 1, a state Water Bond which will provide \$2.7 billion for water storage projects that would improve statewide water system operations and drought preparedness. The California Water Commission (Commission) oversees the Water Storage Investment Program (WSIP) that includes a competitive process by which the Commission will allocate state bond funds to pay for public benefits associated with water storage projects. The draft regulations for the WSIP require applicants to quantify the benefits and impacts of proposed water storage projects at two reference points, 2030 and 2070.

This presentation describes how the Commission's technical team (Department of Water Resources and CH2M) developed data sets of projected precipitation, temperature, and runoff throughout the State of California for the two future reference points, and then used those projections to assess future California water operations and conditions. The paper describes the selection of global climate models, spatial downscaling using the localized constructed analog (LOCA) method, quantile mapping to develop the future hydrology sequence, rainfall-runoff modeling using the Variable Infiltration Capacity (VIC) model, and assumptions for projected sea-level rise. The paper summarizes the projected changes in climate parameters and describes how California's widely-used planning models, CalSim-II and DSM2, were used to evaluate effects on future water operations and Delta conditions.

### **2. From the Bottom Up: New Insights into State Water Project Vulnerabilities to Climate Change**

**Presenter(s):** Andrew Schwarz (DWR)

**Presenter(s) Email Address(es):** aschwarz@water.ca.gov

**Collaborators:** Dr. Casey Brown, University of Massachusetts, Dr. Patrick Ray, University of Cincinnati, Dr. Sungwook Wu, University of Massachusetts

**Permission to Post pdf of Presentation on CWEMF Website:** No.

#### **Abstract:**

The California Department of Water Resources – Climate Change Program in cooperation with the University of Massachusetts-Amherst Hydrosystems Research Group are using CalLite and the Decision Scaling approach to explore the State Water Project's operational vulnerabilities to climate change. Decision Scaling links bottom-up vulnerability assessment with multiple sources of climate information.

The Decision Scaling approach is particularly well suited to exploration of California's unique internal and external variability and can provide decision relevant metrics of change. CalLite's ability to rapidly simulate water system response to an array of hydrologic changes allows for the exploration of a wide range of internal/natural variability and external variability/imposed climate shifts (long-term changes in precipitation and temperature).

This presentation will provide an update of the work that has been completed to date including results showing SWP performance across a wide range of internal variability and climate changes. The work described in this presentation is the continuation of over 3 years of collaboration between DWR and UMass and provides the basis for information that is being used in DWR's Climate Action Plan Phase III: Climate Change Vulnerability Assessment which is currently in the final draft stages.

### **3. Climate Vulnerability and Adaptation Planning in Sonoma County**

**Presenter(s):** Armin Munévar, CH2M

**Presenter(s) Email Address(es):** armin.munevar@ch2m.com

**Collaborators:** Chris Delaney, SCWA

**Permission to Post pdf of Presentation on CWEMF Website:**

**Abstract:**

Climate variability and climate change are significant drivers influencing the future reliability of Sonoma County Water Agency's (SCWA) water supply, sanitation, and flood control systems. SCWA is developing a forward-looking climate adaptation plan to serve as a roadmap for SCWA's assessment of climate risks and potential adaptation strategies related to its water supply, sanitation, and flood control infrastructure and operations. CH2M is working with SCWA to develop a comprehensive climate adaptation plan which is evaluating climate-related vulnerabilities and developing robust adaptation strategies. The primary objective of the climate adaptation plan is to help guide SCWA activities and prioritize investments to improve the resiliency of SCWA's water supply, flood control, and sanitation infrastructure to future changes in climate. The project includes climate modeling and analysis, conducting detailed vulnerability and risk assessments to identify and evaluate climate change adaptation options to various components of SCWA water supply, sanitation, and flood systems, and development of adaptation strategies. The project also includes a robust stakeholder engagement process for each major phase of the work. This presentation will summarize the overall climate change vulnerability and adaptation approach to develop the climate adaptation plan for SCWA and present preliminary findings of climate-related risks.

### **4. Our Coast, Our Future – Communicating Sea Level Rise Estimates Across California**

**Presenter(s):** Michael Fitzgibbon, Chief Technology Officer, Point Blue Conservation Science

**Presenter(s) Email Address(es):** mfitzgibbon@pointblue.org

**Collaborators:** Patrick Barnard (USGS), Li Erikson (USGS), Maya Hayden (Point Blue), Doug Moody (Point Blue)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

Our Coast, Our Future (OCOF, <http://www.ourcoastourfuture.org>) is a collaborative, user-driven project focused on providing coastal California locally relevant, online maps and tools to understand, visualize, and anticipate vulnerabilities to sea level rise and coastal storms. Our project started in 2010 on the outer coast of San Francisco, and is currently rolling out across Southern California. Come learn how our stakeholder driven process in understanding how our communities need to use these results for coastal adaptation planning and management, allowed us to create a set of tools in OCOF that are widely used by partners.

## **Session 12. Simulating Irrigated Agriculture: Modeling Techniques and Case Studies in Demand Estimation**

### **1. Integration of Remote Sensing and Root Zone Water Balance Modeling to Estimate Daily Water Budgets for Individual Agricultural Fields**

**Presenter(s):** Byron Clark (Davids Engineering)

**Presenter(s) Email Address(es):** byron@davidsengineering.com

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

Remote sensing approaches that rely on surface energy balance analysis provide an opportunity to determine actual evapotranspiration (ET) over large areas with a degree of accuracy difficult or impossible to achieve using traditional crop coefficient approaches. Combining energy balance analysis with root zone water balance modeling can be used to develop improved estimates of water budget components for agricultural areas at high spatial and temporal resolution. These components include total actual evapotranspiration (ET), the portions of ET derived from precipitation versus applied water, deep percolation of precipitation and applied water, total applied irrigation water (when combined with estimates of application efficiency), and other water budget components.

A methodology has been developed to integrate existing remote sensing datasets that estimate actual ET based on the surface energy balance and vegetation indices with a daily root zone water balance simulation. For each field in an area of interest, precipitation and irrigation processes are simulated on a daily basis using a root zone water budget model. Each day, crop transpiration is calculated based on reference ET and a transpiration coefficient estimated from remote sensing satellite data. Then, additional ET resulting from soil evaporation is estimated using the dual crop coefficient method described by FAO Irrigation and Drainage Paper 56 (Allen et al. 1998). Irrigation and precipitation processes are then simulated using procedures based on those used by the IWFM Demand Calculator (DWR 2016).

In addition to describing the methodology, an application to apply the integrated model in the Kaweah Subbasin of the San Joaquin Valley Groundwater Basin for the Kaweah Delta Water Conservation District is described. The application was originally developed in 2012 to estimate daily, water budgets for approximately 8,000 fields making up approximately 300,000 acres for the twelve-year period from 1999 to 2010 and has been updated on an annual basis since that time. The most recent update was completed in 2016 to extend the water budgets through 2015. A key benefit of the methodology is the development of highly detailed water budgets for agricultural areas to support local and regional water management at relatively low cost.



## **2. Developing Data Consistency with Models and Local Knowledge in the Tulare Lake Hydrologic Region for Estimation of Agricultural Demand**

**Presenter(s):** Frank Qian (RMC, a Woodard & Curran Company)

**Presenter(s) Email Address(es):** fqian@woodardcurran.com

**Collaborators:** Cynthia Moffett , Steve Ewert and Morteza Orang (California Department of Water Resources)

Mesut Cayar and Saquib Najmus (RMC, a Woodard & Curran Company)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

Accurately estimating agricultural water demand is a crucial component of modeling groundwater conditions. Historically, numerous methods have been used to estimate agricultural water demands in California. The two primary tools used by the California Department of Water Resource (DWR) in California Water Plan are the California Agricultural Water Use Model (CAWU or Cal-Ag) and Cal-SIMETAW (California Simulation of Evapotranspiration of Applied Water). The Cal-Ag utilizes pan evaporation and pan coefficient data to estimate monthly ETc and ETAW by combination of Detailed Analysis Units and Counties (DAU/Co). Cal-SIMETAW uses crop information, SSURGO soil characteristic data, and daily climate data to calculate ETc and ETAW using a daily soil water balance at DAU/Co level as well. The ETAW provides an estimate of agricultural water demand assuming 100% application efficiency. DWR has decided to use Cal-SIMETAW for the 2018 Update of the California Water Plan. DWR's Bay Delta Office has been using the California Central Valley Simulation Model (C2VSim), an IWFM model, to simulate the water movement in the Central Valley. C2VSim computes agricultural water demand estimates using the IWFM Land Surface Process based on crop acreages, potential evapotranspiration, rainfall, and several soil and irrigation parameters. C2VSim reports agricultural water budget at subregion level. The model subregions are based on Depletion Study Areas (DSAs). A study was undertaken to review and identify the differences in agricultural water demand estimated using each of the 3 methods and improve the estimates through local knowledge of crop parameters and other input data. Crop parameters including crop type, acreage, irrigation efficiency, and evapotranspiration were updated using the best local knowledge to improve the models and brought consistency to the estimation methods. Through adjustment of parameters, the differences in agricultural water demand estimates between C2VSim and Cal-SIMETAW were reduced by 99% and brought to within 0.8% across the Tulare Lake Hydrologic Region. While these estimates still differ from the Cal-Ag model, the differences can be attributed to outdated data not accurately representing current conditions.

### **3. Cal-SIMETAW: A Model for Agricultural Water Demand Planning in California**

**Presenter(s):** Morteza N. Orang (California Department of Water Resources)

**Presenter(s) Email Address(es):** Morteza.Orang@water.ca.gov

**Collaborators:** Richard L. Snyder, Quinn J. Hart Sara Sarreshteh, and Dylan Beaudette (Department of Land, Air and Water Resources, University of California)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

Accurately estimating agricultural water demand is a crucial component of modeling groundwater conditions. Historically, numerous methods have been used to estimate agricultural water demands in California. The two primary tools used by the California Department of Water Resource (DWR) in California Water Plan are the California Agricultural Water Use Model (CAWU or Cal-Ag) and Cal-SIMETAW (California Simulation of Evapotranspiration of Applied Water). The Cal-Ag utilizes pan evaporation and pan coefficient data to estimate monthly ET<sub>c</sub> and ETAW by combination of Detailed Analysis Units and Counties (DAU/Co). Cal-SIMETAW uses crop information, SSURGO soil characteristic data, and daily climate data to calculate ET<sub>c</sub> and ETAW using a daily soil water balance at DAU/Co level as well. The ETAW provides an estimate of agricultural water demand assuming 100% application efficiency. DWR has decided to use Cal-SIMETAW for the 2018 Update of the California Water Plan. DWR's Bay Delta Office has been using the California Central Valley Simulation Model (C2VSim), an IWFM model, to simulate the water movement in the Central Valley. C2VSim computes agricultural water demand estimates using the IWFM Land Surface Process based on crop acreages, potential evapotranspiration, rainfall, and several soil and irrigation parameters. C2VSim reports agricultural water budget at subregion level. The model subregions are based on Depletion Study Areas (DSAs). A study was undertaken to review and identify the differences in agricultural water demand estimated using each of the 3 methods and improve the estimates through local knowledge of crop parameters and other input data. Crop parameters including crop type, acreage, irrigation efficiency, and evapotranspiration were updated using the best local knowledge to improve the models and brought consistency to the estimation methods. Through adjustment of parameters, the differences in agricultural water demand estimates between C2VSim and Cal-SIMETAW were reduced by 99% and brought to within 0.8% across the Tulare Lake Hydrologic Region. While these estimates still differ from the Cal-Ag model, the differences can be attributed to outdated data not accurately representing current conditions.

### **4. Field Application of IWFM Demand Calculator to Estimate Irrigation Water Requirement**

**Presenter(s):** Pavithra Prakash (Dept of LAWR, UC Davis)

**Presenter(s) Email Address(es):** pavi.iitm@gmail.com / pavprakash@ucdavis.edu

#### **Collaborators:**

Thomas Harter (Dept of LAWR, UC Davis), Emin Can Dogrul (Bay-Delta Office, CA DWR), Richard L. Snyder (UC Cooperative Extension, Siskiyou County), Steve Orloff (UC Cooperative Extension, Siskiyou County).

**Permission to Post pdf of Presentation on CWEMF Website:** YES

#### **Abstract:**

Irrigation and crop evapotranspiration are key drivers of hydrologic fluxes in semi-arid agricultural basins. In California, alfalfa (*Medicago sativa*) was the single largest user of water in 2010, with an estimated 5.2 million acre-feet of applied water. Irrigating alfalfa is different from most common commodities such as corn or soybeans: alfalfa is a perennial crop with a deep rooting system that can access water from deep within the soil profile. Agricultural crop water requirement is a function of

climate, soil and land surface physical properties as well as land use management practices which are spatially distributed and evolve in time. These variables can be modeled using either integrated hydrologic models and/or irrigation scheduling models. The California Department of Water Resources (CADWR) has integrated the benefits from these two approaches and has developed a new model that estimates the irrigation water requirements and routes soil moisture through root zone in the context of an integrated hydrologic modeling tool, Integrated Water Flow Model (IWFM) - Demand Calculator (IDC). This root-zone simulation engine is a standalone program that simulates land surface and root zone flow processes as well as agricultural and urban water demands under user specified land-use, soil, climate and farm management conditions. In this study, we compare applied water estimates for alfalfa crops and almond crops in different climatic regions like semi-arid northern California and central valley of California with respect to with measured water application, soil moisture data, and evapotranspiration. This research work will help us understand the current irrigation practices in these regions and also bring out the scope of improvisation in optimal water consumption without compromising on the yield.

## **Session 14. Central Valley Flood Protection Plan (CVFPP) Update 2017 Session 1**

### **1. An Overview of Modeling Approaches and Review Tools for the 2017 CVFPP Update**

**Presenter(s):** Yiguo Liang (DWR), Paul Robinson (CH2M)

**Presenter(s) Email Address(es):** paul.robinson@ch2m.com

**Collaborators:** Samson Haile-Selassie (DWR), Mary Horvath (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

In accordance with the Central Valley Flood Protection Act of 2008, DWR prepared a sustainable, integrated flood management plan, the Central Valley Flood Protection Plan (CVFPP), which was adopted by the Central Valley Flood Protection Board in 2012. The original CVFPP set out a systemwide approach to improve flood risk management and ecosystem benefits for lands protected and affected by existing facilities of the State Plan of Flood Control (SPFC). The legislation requires the CVFPP to be updated every 5 years, and the 2017 CVFPP Update fulfills this requirement. In line with State and federal policy and technical guidance, the 2017 CVFPP Update to the 2012 plan used the latest climate science and understanding.

DWR conducted Basin-Wide Feasibility Studies (BWFSs) for the Sacramento River and San Joaquin River, and each BWFS developed recommendations for refinements and improvements to the SPFC system, which have informed the 2017 CVFPP Update and its funding plan. The results of the various technical analyses provided the 2017 CVFPP Update with quantitative estimates of the expected outcomes from actions in the refined State Systemwide Investment Approach (SSIA) portfolio over the next 50 years. This presentation will provide an overview of the technical analysis approach, tools, and information supporting development of the 2017 CVFPP Update.

### **2. Changing Flood Risks in the Central Valley under Climate Change**

**Presenter(s):** Armin Munévar, CH2M

**Presenter(s) Email Address(es):** armin.munevar@ch2m.com

**Collaborators:** Tapash Das, CH2M; Michael Anderson, DWR

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

Current evaluations of Central Valley flood control improvements are based on climate and hydrologic conditions that occurred over the past 100 years. This historical period includes significant flood events

caused by intense precipitation, rapid snowmelt and watershed conditions that, in combination, result in the hydrologic conditions that have shaped our current flood infrastructure and management. Future climate projections indicate the potential for increased flood peak flows and flood volumes, which is likely to affect flood risk in the Central Valley. This presentation provides a summary of the most recent assessment of climate change impacts on the flood hydrology in the Sacramento and San Joaquin River Basins prepared as part of the Central Valley Flood Protection Program (CVFPP). Projected changes in temperature and precipitation based on climate model simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5) have been translated into streamflows and flood risks through refined hydrological modeling. Substantial changes in the flood risks are anticipated under future climate throughout the Central Valley, but the magnitude of changes are strongly dependent on the characteristics of individual watersheds. This presentation will summarize the findings and present implications to future flood management.

### **3. Development of Stage and Flow Frequency Curves for the 2017 Central Valley Flood Protection Plan Update**

**Presenter(s):** David Arrate (DWR)

**Presenter(s) Email Address(es):** David.Arrate@water.ca.gov

**Collaborators:** Devinder S. Dhillon (DWR), Chakri Malakpet (CH2M), Mary Horvath (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

The California Department of Water Resources (DWR) has released the Draft 2017 Central Valley Flood Protection Plan (CVFPP) Update. The goals of the CVFPP, which includes the Sacramento and San Joaquin River basins are to improve flood management in the Central Valley, while promoting ecosystem functions and multi-benefit projects. An important component to the 2017 CVFPP Update is the development of stage and flow frequency curves for existing and future baseline conditions as well as for a with-project condition. The frequency curves and hydraulic modeling will be used in the development of flood damage estimates, inundation mapping, multi-system benefits, and cost estimates in the 2017 CVFPP Update.

The assumptions and methodology used to develop stage and flow frequency curves throughout both basins will be presented. Tools used in the development of the frequency curves include HEC-HMS, HEC-ResSIM, HEC-RAS, and IPAST. Information and models used include the Central Valley Hydrologic Study (CVHS) and the Central Valley Floodplain Evaluation and Delineation (CVFED) hydraulic model. We present how the tools, information, and models were used and modified for use in the 2017 CVFPP Update and how they help in analyzing and improving the Central Valley flood management system.

### **4. Assessing Flood Risk Over Time Using Information from the 2017 Central Valley Flood Protection Plan Update**

**Presenter(s):** Devinder Dhillon, P.E. (California Department of Water Resources); Nathan Pingel, P.E., D.WRE (David Ford Consulting Engineers, Inc.)

**Presenter(s) Email Address(es):** Devinder.Dhillon@water.ca.gov, pingel@ford-consulting.com

**Collaborators:** Donna Lee (David Ford Consulting Engineers, Inc.); Mary Horvath, P.E. (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

California has already taken actions to reduce flood risk in the Central Valley through investments in the flood management infrastructure and emergency response systems. However, California's growing population will increase vulnerability and exposure to the flood hazard. Further, a changing climate may

expand areas subject to inundation. Lastly, the flood control system that protects Californians in the Central Valley is aging and enhancements are needed. This study tracked the State's investments and associated flood risk reduction benefits from the recent past to the future, through the planning horizon of the 2017 Central Valley Flood Protection Plan (CVFPP) Update. Here, we discuss how flood risk is assessed over time. We use two flood risk metrics: expected annual damage (EAD) and expected annual fatalities (i.e., life loss). Both are used to determine the benefit of the investment thus far and the benefit of future investments in light of changing conditions such as population growth and climate change. We describe inputs to the EAD and life loss computations and how EAD and life loss are computed using HEC-FDA, the standard-of-practice software developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center. HEC-FDA facilitates integration of hydrologic engineering and consequence analysis. We also describe how inputs to EAD and life loss computations are likely to change over time both with and without the activities included in the 2017 CVFPP Update.

## **5. Evaluation of Subsidence Impacts on Flood Risks in the San Joaquin Basin**

**Presenter(s):** Mary Horvath (CH2M)

**Presenter(s) Email Address(es):** Mary Horvath (CH2M)

**Collaborators:** David Arrate (DWR); Devinder Dhillon (DWR)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

The extensive withdrawal of groundwater and resulting compaction of the aquifer-system within the San Joaquin Basin is causing land subsidence; the situation is expected to worsen in the next 50 years. Based on measured rates of subsidence and potential alternatives from San Joaquin River Restoration Program, the California Department of Water Resources produced a projected subsidence scenario for the mid-century and analyzed likely hydraulic impacts and potential mitigation measures. The depths of this projected subsidence vary from approximately 6 feet at the Chowchilla Bifurcation structure to 17 feet in areas near the Sand Slough diversion, decreasing northward. Analysis was completed using hydraulic tools recently updated by the Department of Water Resources for the Central Valley. The analysis showed that the impacts of the projected subsidence include changes to the channel capacity, increased overbank flooding, and adjustments to flow delivery patterns. To address subsidence-related capacity and overbank flooding issues, potential mitigation measures include in-stream sediment removal, levee improvements and acquisition of agricultural easements in areas with increased exposure to flood risk. The analysis shows that these mitigation measures have variable success at limiting overbank flooding to without-subsidence conditions.

## **Session 15. Environmental Flows Modeling**

### **1. The Structure of Compromise and Conflict in Setting Environmental Flows**

**Presenter(s):** Jay Lund (UC Davis)

**Presenter(s) Email Address(es):** jrlund@ucdavis.edu

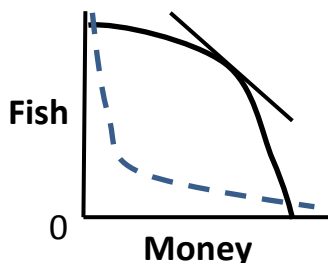
**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes or No

### **Abstract:**

The establishment, management, and performance of environmental flows are controversial in most basins. Generally speaking, the management of flows for environmental purposes is a multi-objective problem – involving trade-offs. This presentation will discuss the origins of trade-offs between ecosystem and economic objectives in environmental flow and how management of non-flow stressors should affect these trade-offs. The properties of economic and ecosystem performance functions

fundamentally shape trade-offs in environmental flows. This work examines the effects of performance shape, thresholds, and non-flow effects on the shape of trade-off curves. The shape of the trade-off curves, shown below, has implications for how environmental flows should be managed in a system of tributary and mainstem streams.



## 2. A coordinated approach for developing statewide environmental flow regulations in California

**Presenter(s):** Julie Zimmerman (The Nature Conservancy)

**Presenter(s) Email Address(es):** julie.zimmerman@tnc.org

**Collaborators:** Eric Stein (Southern California Coastal Water Research Project). Sarah Yarnell (UC Davis). Sam Sandoval (UC Davis). Belize Lane (UC Davis). Jeanette Howard (The Nature Conservancy). Ted Grantham (UC Berkeley). Larry Brown (USGS).

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes or No

**Abstract:** Establishing environmental flow targets is a priority for numerous programs in California. Although methods vary, each effort aims to determine flow conditions necessary to protect ecological integrity in light of competing water uses. Methods vary based on the ecological endpoint of management concern (e.g. fish, macroinvertebrates, habitat), stream type, and preferences of the implementing agency, and include a variety of established methods. Unfortunately, lack of coordination among programs and efforts leads to inefficiencies, difficulty in comparing approaches, inability to share outputs, and creates potential for competing recommendations.

An ad-hoc statewide technical workgroup consisting of UC Davis, Southern California Coastal Water Research Project, The Nature Conservancy, UC Berkeley, and the US Geological Survey has convened to develop a framework for organizing environmental flow analyses across California and providing consistent science-based recommendations for applying appropriate methods to inform setting and managing of environmental flows. We propose a tiered approach that promotes consistency and coordination in establishing, maintaining, and monitoring in-stream flow requirements for California. The overall goal of this effort is to support various regulatory and management agencies in developing and implementing local, regional, and statewide in-stream flow targets to protect aquatic life beneficial uses.

A tiered approach allows for rapid development of statewide environmental flow recommendations based on natural variability of ecologically-relevant flow metrics (Tier 1), and guidance on appropriate methods for developing more refined and site-specific flow targets depending on stream class, management context, and desired ecological outcomes (Tier 2). We propose to use case studies to demonstrate implementation of the framework in different stream classes, spatial scales, and management contexts, and to compare flow recommendations using the rapid functional flows approach and other, more site-specific and detailed approaches.

### **3. Optimal Reservoir Releases for Downstream Environmental Purposes**

**Presenter(s):** Lauren Adams

**Presenter(s) Email Address(es):** leadams@ucdavis.edu

**Collaborators:** Jay Lund

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

A generalizable operating rule theory and method to optimize the timing and magnitude of reservoir release decisions for environmental benefit was developed. The method accounts for seasonal uncertainty and water storage impact. Benefit is measured in terms of fish survival; maintaining self-sustaining native fish populations is a significant indicator of ecosystem function. A multi-stage stochastic mixed-integer non-linear program with Markov Chains was developed to optimize release decisions conditional on previous hydrologic conditions, current and future fish population dynamics, economic and human storage needs, infrastructural limitations, and the river's carrying capacity. This method was then extended to develop cold water pool storage rules to maximize downstream ecological benefits in temperature sensitive river systems. Seasonal releases are determined with a stochastic dynamic program given seasonal downstream temperature requirements and reservoir storage limitations. Cold water pool storage goals minimize the risk of downstream ecological extirpation or maximize the expected value of fish population. Hedging cold water releases from the reservoir frees up some water for other uses. The basic method of operations is applied to maximize fish survival below Folsom Dam on the American River and cold water pool hedging is applied to maximize fish survival below Shasta reservoir in the Sacramento River.

### **4. Achilles' Heel of Integrated Hydrologic Models: the Stream-Aquifer Flow Exchange**

**Presenter(s):** Hubert J. Morel-Seytoux (Hydroprose International Consulting)

**Presenter(s) Email Address(es):** hydroprose@sonic.net

**Collaborators:** Steffen Mehl (Chico State University)

**Permission to Post pdf of Presentation on CWEMF Website:** No

**Abstract:** "Due to the relationship between surface water flow and groundwater use, a scientifically defensible surface water - groundwater model is a crucial component and transparent management tool" (recent USGS proposal to the State Water Resources Control Board of California for a study of the Russian River basin). It is needed to develop plans for a sustainable use of the groundwater without undesirable effects. Most groundwater models currently in use like to claim that they are physically based and, by extension, scientifically defensible. The question we like to address is: "to what degree and under what circumstances are they really?" and precisely what does it mean to be physically based? Is there a robust correlation between being physically based and being accurate? This presentation reports an investigation of several such groundwater models (MODFLOW, MIKE-SHE, PIHM, HYDROGEOSPHERES). The study indicates that they may not be really physically based when used in large-scale regional studies. Regardless can they still be sufficiently accurate? Finally several mitigation alternatives to the use of the empirical leakance coefficient, used to calculate seepage, are suggested.

## Session 16. Central Valley Flood Protection Plan (CVFPP Update 2017 Session 2

### 1. Assessing ecological benefits of river and floodplain restoration using targeted processes, habitats, species, and stressors

**Presenter(s):** Craig Williams (California Department of Water Resources)

**Presenter(s) Email Address(es):** craig.williams@water.ca.gov

**Collaborators:** John Hunter (WSP / Parsons Brinckerhoff), Michael Yun (Anderson Krygier), Mary Jo Kealy (CH2M), Ron Melcer (Delta Stewardship Council), Kirstin Skadberg (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

Restoring the natural vegetation and ecosystem processes of floodplains provides multiple ecological benefits, including habitat for numerous species with varied needs. A synthesis of these benefits would improve upon raw tabulations of changes in land cover and better inform the development and comparison of restoration concepts. To provide such a synthesis for the Basin-Wide Feasibility Studies, we used ecosystem processes, habitats (ecosystems), species, and stressors that are targets of the Central Valley Flood System Conservation Strategy. For target habitats, changes were synthesized into units of “functional acres” that were based on the area restored, the targeted processes and stressors affecting that area, and one to several additional attributes of the restored vegetation. For target species, benefits were measured by associating predicted restoration outcomes to species conservation needs. Results showed that adding natural vegetation to a site increased its functional value generally in proportion to the amount of acreage added, but value varied based on the extent to which a site could accommodate additional hydrogeomorphic processes, such as increased floodplain inundation and meander potential in riparian areas. Results demonstrated the importance of valuing potential restoration based not just on raw acreage, but also on important ecological processes. For target species, the assessment identified species with potential to use a site and whether the site at least partially addressed its conservation needs. This tool could be used to assess restoration cost-effectiveness, refine or optimize restoration concepts, and serve as a yardstick for compliance or effectiveness monitoring.

### 2. CVFPP Lower San Joaquin Basin 2D Modeling

**Presenter(s):** Clark Churchill (DWR)

**Presenter(s) Email Address(es):** clark.churchill@water.ca.gov

**Collaborators:** Devinder Dhillon (DWR), David Arrate (DWR), Romain Maendly (DWR)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

The California Department of Water Resources (DWR) has completed an updated Hydrologic and Hydraulic (H&H) model of the Lower San Joaquin Basin. The updates in this model apply the latest 2D modeling applications available in HEC-RAS 5.0. Prior to HEC-RAS 5.0, 2D modeling was handled outside of HEC-RAS in applications such as FLO 2D. This model served to evaluate how flows pass through the Lower San Joaquin Basin both with and without activities included in the 2017 Central Valley Flood Protection Plan (CVFPP) Update. More specifically, this model sought to evaluate how flows will pass through Paradise Cut and Reclamation District (RD)-17 both with and without activities included in the 2017 CVFPP Update. Indirectly, this model also served as a test case to demonstrate the 2D capabilities of HEC-RAS to DWR.

In order to develop this model, a large amount of hydrologic data had to be compiled from the prior Central Valley Hydrology Study (CVHS). In addition, the hydraulic models developed for the Central Valley Floodplain Evaluation and Delineation Program (CVFED) were used as a baseline on which to build



the new 2D model. Some data, specifically Delta inputs, had to be specially developed in collaboration between DWR and Resource Management Associates (RMA). Completing this model involved overcoming numerous technical challenges related to the release of new modeling software and use at such a large scale. The completion of the model allowed DWR to develop inundation maps which will be used to inform the 2017 Central Valley Flood Protection Plan.

### **3. Integrated HEC-RAS 2D Hydraulic Models for the Sacramento River Basin Floodplains and Bypass systems for improved Flood Risk and Ecosystem Management Analyses**

**Presenter(s):** Chakri Malakpet (CH2M )

**Presenter(s) Email Address(es):** chakradhar.malakpet@ch2m.com

**Collaborators:** Yiguo Liang, Rajmani Subedi, and Ricky Doung, (CA Department of Water Resources) Mary Horvath and Paul Robinson (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

The California Department of Water Resources (DWR) and CH2M consultant team are developing integrated HEC-RAS 2D hydraulic models for the Sacramento River basin floodplains and Bypass systems. These models will function as foundational tools to improve and support flood risk and ecosystem management studies conducted for the Central Valley. The Sacramento River basin flood control system is a complex network of reservoirs, levees, flood relief structures, weirs and bypass systems constructed to protect populated areas in the Central Valley. The Sutter Bypass, Yolo Bypass and Butte Basin are the key elements of the flood control system that convey flood waters by relieving the pressure on the urban levee system. These bypass systems also provide ecosystem habitat for numerous species of wildlife. HEC-RAS 2D models are developed for the floodplains to accurately represent the complex overland flow hydraulics to support flood risk management studies. HEC-RAS 2D models are developed for the bypass systems to accurately model the flow splits, inundation patterns, depths and velocities for flood flow conditions and low flow conditions to support both flood risk and ecosystem management studies. These models are integrated with the riverine system network represented as 1D channels in the existing CVFED HEC-RAS model. The integration creates continuity between 1D and 2D systems and enables the models to be efficiently applied for the studies. This presentation includes background of the model development, methodologies used in 2D modeling, lessons learned and potential applications of the integrated models.

### **4. Wave Runup and Wind Setup Analysis for the Lower Elkhorn Setback Levees**

**Presenter(s):** Mahesh Gautam (DWR)

**Presenter(s) Email Address(es):** mahesh.gautam@water.ca.gov

**Collaborators:** Yiguo Liang , Jeremy Hill (DWR), Tom Moll (David Ford Consulting Engineers)

**Permission to Post pdf of Presentation on CWEMF Website:** No

#### **Abstract:**

The 2017 Central Valley Flood Protection Plan Update refines the State Systemwide Investment Approach (SSIA) for flood management improvements in the Central Valley. Levee setbacks in the bypasses are one of the key management actions identified in the SSIA. This study presents the procedures and considerations required in the estimation of wave runup and wind setup for the proposed setback levees. Wind data from both Sacramento Executive Airport and Sacramento International Airport were analyzed and frequency analysis of the annual maximum wind speeds was conducted. Multiple sites were considered to maximize fetch length and wave runup and wind setup were estimated based on the design wind and the fetch length. The presentation will discuss the approach and key issues related to the analysis with an example from the Lower Elkhorn Basin area.

## **5. Development of Stage-Frequency Curves in the Sacramento - San Joaquin Bay Delta for Current Climate, Sea Level Rise and Climate Change Conditions**

**Presenter(s):** Romain Maendly(DWR)

**Presenter(s) Email Address(es):** romain.maendly@water.ca.gov

**Collaborators:** Clark Churchill, DWR and Richard Rachiele, RMA

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

The California Department of Water Resources has released a Draft 2017 Central Valley Flood Protection Plan (CVFPP) Update. The CVFPP, which includes the Sacramento and San Joaquin river basins and to some extent the Sacramento - San Joaquin Bay Delta (Delta), will add specificity about recommended near and longer-term investment and financing approach, provide broad guidance about more resilient flood risk management actions with the overall goal to improve the overall flood management of the system.

An important component of the study is the development of stage-frequency curves for current climate and future conditions which includes inland climate change and sea level rise. Developing Delta stage frequency curves that are consistent with the development of the upstream stage frequency curves is complex. One needs to account for the flows coming into the Delta boundary and the effect of tides and tidal surge from the advancing storm fronts coming from the Pacific Ocean. Key assumptions include the determination to use in-channel vs. at-latitude regulated flow frequency curves, the phase of the surge tide with the peak flow hydrographs and the tidal boundary conditions setting with and without sea level rise. The tools used are the Central Valley Hydrologic Study (CVHS), Central Valley Floodplain Evaluation and Delineation (CVFED) hydraulic model and RMA 2-D Bay Delta model.

The presentation will lay out the assumption and methodology used in the CVFPP to develop stage-frequency curves in the Delta for with and without climate change and sea level rise, and will also recommend methodology improvements to the stage-frequency curves for future studies.

## **Session 17. A Kaleidoscope of Modeling**

### **1. Comparison of Drought Severity, Intensity and Duration in Sacramento, San Joaquin, and Tulare River Basins**

**Presenter(s):** Ramesh Gautam, Mitch Russo, Michael Anderson

**Presenter(s) Email Address(es):** Ramesh.gautam@water.ca.gov

**Collaborators:** River Forecasting Section, Division of Flood Management, DWR

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

Standardized Precipitation Index (SPI) is defined as a measure of standard deviations of observed cumulative precipitation on a pre-defined timescale that helps to infer the deviation of precipitation from climatological average. It is a tool which was developed primarily for defining and monitoring drought. It allows to determine the rarity of a drought at a given time scale of interest for any rainfall station with historic data.

SPI was estimated for Sacramento, San Joaquin, and Tulare River Basins based on individual stations as well as eight, five and six station index precipitation time series data. Observed monthly precipitation data was used to calculate SPI. The duration, severity and intensity of current drought were compared with similar previous droughts in these river basins.

It was found that the recent drought in San Joaquin and Tulare River Basins is more severe than the worst historic drought of 1976-1977. On the other hand, the drought of 1976-1977 was worse than the present drought in Sacramento River Basin.

Key words: Standard Precipitation Index (SPI), time series, Rainfall, Sacramento River Basin, San Joaquin River Basin, Tulare River Basin.

## **2. Drought Water Right Curtailment**

**Presenter(s):** Jeff Laird (UC Davis)

**Presenter(s) Email Address(es):** jtlaird@ucdavis.edu

**Collaborators:** Wesley Walker (UC Davis), Jesse Jankowski (UC Davis), Jay Lund (UC Davis)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

California's water rights system allocates water to users based on priority, where lower priority, "junior" rights are curtailed first in a drought. The Drought Water Rights Allocation Tool (DWRAT) was developed to suggest surface water right curtailments during drought, by mathematically representing water law and hydrology. DWRAT incorporates water right uses, priorities, and a statistical-flow forecasting model into a pair of linear programs, to suggest water allocations among water rights holders. In doing so, DWRAT implements California water rights law as an algorithm, and thus provides a precise and transparent framework for the complicated and often controversial technical aspects of curtailing water rights use during drought. DWRAT is compiled within an Excel workbook, with a user-friendly interface and an open-source solver. Models have been developed for use in California's Eel, Russian, San Joaquin, and Sacramento River basins. DWRAT's framework allows for model development and implementation in any basin where hydrologic and water right user data is available. Additionally, DWRAT can be used to assess water allocation reliability by determining the probability of rights holders' curtailment over a range of hydrologic conditions. Current or forecasted flow values can be input to the model to provide decision makers with the ability to make curtailment and water supply strategy decisions. Environmental flow allocations will be further integrated into the model to meet and improve ecosystem water reliability.

## **3. Enhancing Los Vaqueros Expansion Project Operations with Optimization-based Smart Searches**

**Presenter(s):** Thomas FitzHugh (MWH)

**Presenter(s) Email Address(es):** thomas.fitzhugh@stantec.com

**Collaborators:** Enrique Triana (MWH), Samantha Mauzy (MWH)

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes or No YES

**Abstract:** The use of multi objective optimization to perform Smart Searches on CalSim simulation model parameters to improve system performance for the Los Vaqueros Expansion project is presented. In this application, Smart Searches are efficiently implemented using a generalized Data Management System (DMS) concept that consists of customized simulation model adapters to connect simulation models with an optimization module (ExplorerDV) and a central database. With this system, the optimization module automatically guides the parameter search for improved solutions as evaluated by the simulation model, while the database logs the search process, including runs, performances and tradeoff results. We developed a new model adapter for the CalSim II model, which simulates water operations in the Central Valley of California. This model adapter was embedded with previously developed libraries into a CalSim DMS. The DMS allows programmatic manipulation of CalSim input files for monthly demands and facility sizes, and uses the ExplorerDV optimization capabilities to implement Smart Searches to improve water supply operations. Two analyses have been conducted using the tool. First was to optimize demand patterns for refugees in order to maximize refugee deliveries without reducing deliveries to M&I customers. Because refugees can be flexible in terms of when they take deliveries, adjusting their delivery schedule can be used to increase overall project yield. Second was to conduct a cost-effectiveness analysis for facility sizing. Combinations of different facility sizes were

evaluated for CCWD's Delta intakes, Neroly pump station, the Mokelumne Intertie, and the Transfer-Bethany pipeline. The system was used to identify trade-offs between costs, facility sizes, and project yield. Finally, use of the CalSim DMS to improve operations under climate change is also being investigated.

## **Session 19. Poster Session**

### **1. Development of Integrated HEC-RAS 2D Hydraulic Models for the Sacramento River Basin Floodplains and Bypass Systems**

**Presenter(s):** Chakri Malakpet and Steve Micko (CH2M)

**Presenter(s) Email Address(es):** chakradhar.malakpet@ch2m.com, [steve.micko@ch2m.com](mailto:steve.micko@ch2m.com)

**Collaborators:** Yiguo Liang, Rajmani Subedi, and Ricky Doung (CA Department of Water Resources) Mary Horvath and Paul Robinson (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

The California Department of Water Resources (DWR) and CH2M consultant team are developing integrated HEC-RAS 2D hydraulic models for the Sacramento River basin floodplains and Bypass systems. These models will function as foundational tools to improve and support flood risk and ecosystem management studies conducted for the Central Valley. The Sacramento River basin flood control system is a complex network of reservoirs, levees, flood relief structures, weirs and bypass systems constructed to protect populated areas in the Central Valley. The Sutter Bypass, Yolo Bypass and Butte Basin are the key elements of the flood control system that convey flood waters by relieving the pressure on the urban levee system. These bypass systems also provide ecosystem habitat for numerous species of wildlife. HEC-RAS 2D models are developed for the floodplains to accurately represent the complex overland flow hydraulics to support flood risk management studies. HEC-RAS 2D models are developed for the bypass systems to accurately model the flow splits, inundation patterns, depths and velocities for flood flow conditions and low flow conditions to support both flood risk and ecosystem management studies. These models are integrated with the riverine system network represented as 1D channels in the existing CVFED HEC-RAS model. The integration creates continuity between 1D and 2D systems and enables the models to be efficiently applied for the studies. This poster exhibits methodologies used in 2D modeling, tips for solving modeling challenges, lessons learned and potential applications of the integrated models.

### **2. Successfully Integrating of Central Valley Hydrology Study (CVHS) to DWR systemwide studies**

**Presenter(s):** Nathan Pingel (David Ford Consulting Engineers), Devinder S. Dhillon and Mahesh Gautam (DWR), and Chakri Malakpet (CH2M)

**Presenter(s) Email Address(es):** [pingel@ford-consulting.com](mailto:pingel@ford-consulting.com), [Devinder.Dhillon@water.ca.gov](mailto:Devinder.Dhillon@water.ca.gov), [Mahesh.Gautam@water.ca.gov](mailto:Mahesh.Gautam@water.ca.gov), [Chakradhar.Malakpet@CH2M.com](mailto:Chakradhar.Malakpet@CH2M.com)

**Collaborators:** n/a

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

The Central Valley Hydrology Study (CVHS) was a multi-agency cooperation to complete the latest Central Valley hydrology—which could be the basis for flood risk assessment and reduction studies for years to come. The study was a partnership between the California Department of Water Resources (DWR) and U.S. Army Corps of Engineers (USACE), Sacramento District (SPK).

The first application of CVHS was to support the development of “200-year” informational floodplain maps. Now, those products and procedures have been fully-integrated into the DWR planning process,

specifically the Sacramento and San Joaquin Basinwide Feasibility studies and the 2017 Central Valley Flood Protection Plan update.

The key CVHS products include unregulated-volume-frequency curves throughout the valley, system-wide reservoir and channel simulation models, large datasets to feed the models based on historical inflows, and detailed documentation on the development and use of the products.

These tools have now been used to develop peak-regulated flow-frequency curves at index points throughout the valley representing various states of the system, including both current and potential future system improvements. The tools have also been used to develop channel water surface elevation to floodplain water surface elevation relationships at the key index points throughout the system. Thus, the flood hazard component of the system flood risk analysis has been fully updated based on the CVHS tools.

Here, we will describe the products and procedures developed by the CVHS team and discuss the key steps of the integration process.

### **3. Assessing Flood Risk Over Time Using Information from the 2017 Central Valley Flood Protection Plan Update**

**Presenter(s):** Devinder Dhillon (DWR,) and Nathan Pingel (David Ford Consulting Engineers, Inc.)

**Presenter(s) Email Address(es):** Devinder.Dhillon@water.ca.gov, pingel@ford-consulting.com

**Collaborators:** Donna Lee (David Ford Consulting Engineers, Inc.) and Mary Horvath (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

California has already taken actions to reduce flood risk in the Central Valley through investments in the flood management infrastructure and emergency response systems. However, California's growing population will increase vulnerability and exposure to the flood hazard. Further, a changing climate may expand areas subject to inundation. Lastly, the flood control system that protects Californians in the Central Valley is aging and enhancements are needed. This study tracked the State's investments and associated flood risk reduction benefits from the recent past to the future, through the planning horizon of the 2017 Central Valley Flood Protection Plan (CVFPP) Update. Here, we discuss how flood risk is assessed over time. We use two flood risk metrics: expected annual damage (EAD) and expected annual fatalities (i.e., life loss). Both are used to determine the benefit of the investment thus far and the benefit of future investments in light of changing conditions such as population growth and climate change. We describe inputs to the EAD and life loss computations and how EAD and life loss are computed using HEC-FDA, the standard-of-practice software developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center. HEC-FDA facilitates integration of hydrologic engineering and consequence analysis. We also describe how inputs to EAD and life loss computations are likely to change over time both with and without the activities included in the 2017 CVFPP Update.

### **4. An Outcome-Driven Approach to Flood Management in California's Central Valley**

**Presenter(s):** Paul Robinson and Robyn Grimm (CH2M)

**Presenter(s) Email Address(es):** paul.robinson@ch2m.com

**Collaborators:** Mary Jimenez, Mike Mierzwa and Robyn Grimm (CA Department of Water Resources)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

The Central Valley Flood Protection Plan (CVFPP) is a long-range plan originally adopted in 2012 that guides the California's participation in managing flood risk in areas protected by the State-federal flood management system in the Central Valley. The 2017 Update to the CVFPP incorporates an outcome-driven approach that will help the State move towards sustainable flood management while

delivering the best value for public investment. Application of this outcome-driven approach includes identification of flood-specific outcomes that help to accomplish societal goals (including public safety, economic stability, ecosystem vitality, and enriching experiences). To help build efficiency into the flood management system, the CVFPP identifies and supports implementation of a comprehensive set of individual but interrelated management actions that – when implemented together – work in concert to contribute to these flood-specific outcomes and societal goals to improve management of the State-federal flood management system. To accomplish multiple intended outcomes and contribute in a resilient way towards all societal goals, it is necessary to invest in a diversity of actions (including both large-scale multi-benefit projects and smaller scale local projects) with varying strengths that complement and balance one another. The 2017 CVFPP Update describes what effective and resilient management action portfolios would look like on a system wide scale and for urban, rural and small community regions in order to reconcile public safety, economic and environmental goals across the Central Valley flood management system.

## **5. Changing Flood Risks in the Central Valley under Climate Change**

**Presenter(s):** Armin Munévar (CH2M)

**Presenter(s) Email Address(es):** armin.munevar@ch2m.com

**Collaborators:** Tapash Das (CH2M) and Michael Anderson (CA Department of Water Resources)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

Current evaluations of Central Valley flood control improvements are based on climate and hydrologic conditions that occurred over the past 100 years. This historical period includes significant flood events caused by intense precipitation, rapid snowmelt and watershed conditions that, in combination, result in the hydrologic conditions that have shaped our current flood infrastructure and management. Future climate projections indicate the potential for increased flood peak flows and flood volumes, which is likely to affect flood risk in the Central Valley. The poster will summarize of the most recent assessment of climate change impacts on the flood hydrology in the Sacramento and San Joaquin River Basins prepared as part of the Central Valley Flood Protection Program (CVFPP). Projected changes in temperature and precipitation based on climate model simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5) have been translated into streamflows and flood risks through refined hydrological modeling. Substantial changes in the flood risks are anticipated under future climate throughout the Central Valley, but the magnitude of changes are strongly dependent on the characteristics of individual watersheds. This poster will present the findings and implications for future flood management.

## **6. Development of Stage-Frequency Curves in the Sacramento - San Joaquin Bay Delta for Current Climate, Sea Level Rise and Climate Change Conditions**

**Presenter(s):** Romain Maendly (CA Department of Water Resources)

**Presenter(s) Email Address(es):** romain.maendly@water.ca.gov

**Collaborators:** Clark Churchill (CA Department of Water Resources) and Richard Rachiele (RMA)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

The California Department of Water Resources has released a Draft 2017 Central Valley Flood Protection Plan (CVFPP) Update. The CVFPP, which includes the Sacramento and San Joaquin river basins and to some extent the Sacramento - San Joaquin Bay Delta (Delta), will add specificity about recommended near and longer-term investment and financing approach, provide broad guidance about more resilient flood risk management actions with the overall goal to improve the overall flood management of the

system.

An important component of the study is the development of stage-frequency curves for current climate and future conditions which includes inland climate change and sea level rise. Developing Delta stage frequency curves that are consistent with the development of the upstream stage frequency curves is complex. One needs to account for the flows coming into the Delta boundary and the effect of tides and tidal surge from the advancing storm fronts coming from the Pacific Ocean. Key assumptions include the determination to use in-channel vs. at-latitude regulated flow frequency curves, the phase of the surge tide with the peak flow hydrographs and the tidal boundary conditions setting with and without sea level rise. The tools used are the Central Valley Hydrologic Study (CVHS), Central Valley Floodplain Evaluation and Delineation (CVFED) hydraulic model and RMA 2-D Bay Delta model.

The poster will present the assumptions and methodology used in the CVFPP to develop stage-frequency curves in the Delta for with and without climate change and sea level rise. It will also show long-section profile results.

## **7. Evolution of the Technical Tools utilized in development of the 2017 CVFPP Update**

**Presenter(s):** Paul Robinson (CH2M)

**Presenter(s) Email Address(es):** paul.robinson@ch2m.com

**Collaborators:** Yiguo Liang and David Arrate (CA Department of Water Resources)  
Mary Horvath (CH2M)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

The 2017 Update of the Central Valley Flood Protection Plan (CVFPP) is informed by a large body of technical work. DWR conducted Basin-Wide Feasibility Studies (BWFS) for the Sacramento River and San Joaquin River, and each BWFS developed recommendations for refinements and improvements to the State Plan of Flood Control system, which have informed and supported the analyses for the 2017 CVFPP Update and its funding plan.

For the BWFS and the 2017 CVFPP Update, new technical tools from the Central Valley Hydrological Study (CVHS), Central Valley Floodplain Evaluation and Delineation (CVFED) program, and Urban Levee Evaluation/Non-Urban Levee Evaluation (ULE/NULE) were used and, updated. These tools are largely available for agency and public use for ongoing and future studies in the Central Valley. The poster will describe the evolution of the various tools and models that were used for hydrologic, reservoir, hydraulic, , and flood risk analysis in the Central Valley in the last few decades, and also show how the tools have been updated and modified as the 2017 CVFPP Update work has advanced. Additionally, the poster will present suggested uses for the tools in future flood management work.

## **8. Evaluation of Subsidence Impacts on Flood Risks in the San Joaquin Basin**

**Presenter(s):** Mary Horvath (CH2M)

**Presenter(s) Email Address(es):**

**Collaborators:** David Arrate and Devinder Dhillon (CA Department of Water Resources)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

Portions of the San Joaquin River Basin are experiencing significant land subsidence due to the withdrawal of groundwater and resulting compaction of the aquifer-system; the situation is expected to worsen in the next 50 years. The subsidence will likely negatively impact the flood management system in the basin, particularly the Eastside Bypass. As part of the San Joaquin Basin Wide Feasibility Study and the 2017 Central Valley Flood Protection Plan Update, the California Department of Water Resources studied the expected flood impacts of the subsidence. Based on measured rates of subsidence

throughout the basin, projected variable mid-century depths of subsidence were produced and hydraulic analysis of the altered system was completed using tools recently updated for the Central Valley. Potential mitigation measures taken from alternatives generated by the San Joaquin River Restoration Program, including in-stream sediment removal, levee improvements and acquisition of agricultural easements, were then analyzed to demonstrate their possible lessening of the impact. The poster will explain the hydraulic analysis and probable flood impacts of the subsidence including decreased channel capacity and increased overbank flood potential. Additionally, the predicted impacts of the various mitigation measures will be shown.

#### **9. California's Fourth Climate Change Assessment: An Overview of Research to Inform Climate-Resilient Policy and Action in California**

**Presenter(s):** Jamie Anderson (California Department of Water Resources)

**Presenter(s) Email Address(es):** Jamie.Anderson@water.ca.gov

**Collaborators:** Susan Wilhelm and Guido Franco (California Energy Commission)

Joey Wall (California Natural Resources Agency)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

##### **Abstract:**

California's Fourth Climate Change Assessment (Fourth Assessment) will provide critical information on local and regional climate change impacts as well as adaptation options to support decisions that will safeguard the people, economy and resources of California. The Fourth Assessment builds on the success of three prior assessments (2006, 2009, 2012) to address California-specific policy questions and information needs. This latest assessment is being supported through two funding sources, one managed by the California Energy Commission (CEC) and another by the California Natural Resources Agency (CNRA). Energy sector research for the Fourth Assessment explores a number of themes as they relate to the electricity, natural gas, and petroleum sectors: scenario development, probabilistic forecasting, climate-related extremes (e.g., wildfires, urban heat islands, coastal flooding, prolonged droughts), regional vulnerability and resilience, and making results actionable. Natural resources themes for the Fourth Assessment include adapting management to new wildfire regimes, carbon sequestration on working lands, coastal strategies for coping with sea level rise, water security and long droughts, emergency management, and funding and implementing adaptation measures. Additionally, external collaborators are providing important additional cutting-edge research on coastal resilience, community engagement, ecological vulnerability, ecosystem carbon modeling, energy use projections, urban heat mitigation, and drought preparedness and response. The suite of Fourth Assessment research prominently advances the best available science that serves as the foundation for California's global leadership on climate change policy.



#### **10. Development of a Database for Tracking High Speed Rail Submittals to the Bureau of Reclamation**

**Presenter(s):** James Lu (Bureau of Reclamation, Mid-Pacific Region)

**Presenter(s) Email Address(es):** jlu@usbr.gov

**Collaborators:** Lauren Frye, Jacqueline Keeler, Thomas Heinzer and Barbara Simpson (Bureau of Reclamation, Mid-Pacific Region)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

##### **Abstract:**

The planned California High Speed Rail (HSR) alignment will have numerous crossings over the federal land managed by Bureau of Reclamation (Reclamation). Sooner or later, HSR will need to work on these crossings. Typically HSR will submit requests for permissions to the Reclamation Point of Contact (POC) overseeing the review and permitting process. Each request is identified by the HSR alignment section, submittal date, type of request, and individual potentially impacted Reclamation feature. The review and permitting activity will be coordinated with various Mid Pacific Region divisions of Reclamation and local water districts. For minimizing review time a submittal tracking system is being developed. The front end of the system is being developed using Visual Studio 2015 and the backend using Access database. The database development began in November 2016 and will be completed in August 2017.

#### **11. CWMS Flood Forecasting Model for the Neches River, Texas**

**Presenter(s):** Om Prakash (WEST Consultants, Inc.)

**Presenter(s) Email Address(es):** oprakash@westconsultants.com

**Collaborators:** Allen Avance (Fort Worth District, USACE) and Jeff Harris (WEST Consultants)

**Permission to Post pdf of Presentation on CWEMF Website:** No

##### **Abstract:**

The US Army Corps of Engineers, Fort Worth District has developed the Corps Water Management System (CWMS) model for Neches River basin to manage the forecasts. A gridded HEC-HMS model was created from HEC-GeoHMS, with subbasin breaks at the major stream gages and control points. HEC-ResSim model was created for the Neches River Basin, incorporating the rules for flood operations in the water control manuals. HEC-RAS model for the Neches and Angelina Rivers was created and then calibrated to the observed rating curves. HEC-FIA model was created from the HEC-RAS layout and adjusted using best available data to provide a reasonable representation of flood impacts. These models were then integrated in the CWMS Control and Visualization Interface (CAVI) for real-time forecasting. In this poster, we will show the flow of CWMS CAVI integration and how it is being applied to the Neches River. A public version of CWMS model is HEC-RTS (Real Time Simulation).

#### **12 Estimating Field Scale Crop Evapotranspiration using Landsat and MODIS Satellite Observations**

**Presenter(s):** Andy Wong (University of California, Davis)

**Presenter(s) Email Address(es):** ajywong@ucdavis.edu

**Collaborators:** Yufang Jin, Richard Snyder, Daniele Zaccaria, Josue Medellin-Azuara,, Quinn Hart, and Jay Lund (UC Davis) and Feng Gao (Department of Agriculture)

**Permission to Post pdf of Presentation on CWEMF Website:** n/a

##### **Abstract:**

Irrigation accounts for 80% of human freshwater consumption, and most of it return to the atmosphere through Evapotranspiration (ET). Given the challenges of already-stressed water resources and ground water regulation in California, a cost-effective, timely, and consistent spatial estimate of crop ET, from the farm to watershed level, is becoming increasingly important. The Priestley-Taylor (PT) approach, calibrated with field data and driven by satellite observations, shows great promise for accurate ET estimates across diverse ecosystems. We here aim to improve the robustness of the PT approach in

agricultural lands, to enable growers and farm managers to tailor irrigation management based on in-field spatial variability and in-season variation. We optimized the PT coefficients for each crop type with available ET measurements from eddy covariance towers and/or surface renewal stations at six crop fields (Alfalfa, Almond, Citrus, Corn, Pistachio and Rice) in California. Good agreement was found between satellite-based estimates and field measurements of net radiation and crop type specific optimization. The RMSE of the estimated ET was less than 1.6 mm/day. The calibrated algorithm was used to estimate ET at 30 m resolution over the Sacramento-San Joaquin Delta region for 2015 and 2016 water year. It captures well the seasonal dynamics and spatial distribution of ET in Sacramento-San Joaquin Delta. A continuous monitoring of the dynamics and spatial heterogeneity of canopy and consumptive water use at a field scale, will help prepare and inform to adaptively manage water, canopy, and grove density to maximize yield with least amount of water.

### **13. Effects of Climate Uncertainty on the Development and Evaluation of Adaptation Strategies**

**Presenter(s):** Michael Tansey (Bureau of Reclamation( Sacramento))

**Presenter(s) Email Address(es):** mtansey@usbr.gov

**Collaborators:** Katharine Dahm (Bureau of Reclamation (Denver))

**Permission to Post pdf of Presentation on CWEMF Website:** n/a

#### **Abstract:**

The Sacramento-San Joaquin Basins Study was performed to address the effects 21st century uncertainties in climate and socioeconomic conditions on the management of urban, agricultural and water related resources in the Central Valley and Central Coast regions of California. To account for future uncertainties, a suite of scenarios reflecting a combination of potential future climate and socioeconomic conditions was developed. A system risk and reliability assessment was performed. To address the identified risks, a diverse variety of water management actions including demand management, supply augmentation, reuse, desalination, watershed management, storage and conveyance, and adaptive system operations were evaluated relative to multiple screening criteria. Combinations the most promising actions were organized into seven adaptation portfolios. These portfolios were evaluated to determine their effectiveness in addressing potential risks in seven major water resource management categories including water deliveries, water quality, hydropower, flood control, recreation, fish and wildlife habitats, ESA species, flow dependent ecological resiliency and economic impacts. The robustness of the portfolios relative to future socioeconomic and climate uncertainties as well as tradeoffs between their performances were examined. This work explores the effects of climate uncertainty on the effectiveness and tradeoffs between the portfolios and demonstrates how this information may be used in developing and evaluating multi-objective adaptation strategies.

#### **14. A comparative study on consumptive use in the Sacramento-San Joaquin Delta**

**Presenter(s):** Josue Medellin-Azuara (UC Davis)

**Presenter(s) Email Address(es):** jmedellin@ucdavis.edu

**Collaborators:** Josue Medellin-Azuara, Kyaw Tha Paw U, Yufang Jin, Jay R. Lund, Eric Kent, Jenae' Clay, Nadya Alexander-Sanchez, Andy Wong, & Jesse Jankowski (UC Davis); Michelle M. Leinfelder-Miles (UC Cooperative Extension), A., Martha Anderson (USDA-ARS), Daniel Howes (Cal Poly), Forest Melton (NASA), Tariq Kadir, Lan Liang, and Morteza Orang (DWR)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

##### **Abstract:**

Understanding consumptive water use in the Sacramento San Joaquin Delta (SSJD) is critical for water rights administration, water management and operations, and environmental and water quality protection. This study compares preliminary estimates of evapotranspiration (ET) in crops for the 2015 and 2016 water years in the SSJD employing seven different methods and direct field measurements for a selection of crops. The research project also includes the installation of additional meteorological stations in the SSJD under the California Irrigation Management Information System (CIMIS). The seven methods employed and their participating research groups are: 1) the California Simulation of Evapotranspiration of Applied Water (CalSIMETAW, DWR), 2) the Delta Evapotranspiration of Applied Water Model (DETAW, DWR), 3) the Disaggregated Atmosphere-Land Exchange Inverse (DisALEXI, USDA-ARS), 4 & 5) the Mapping Evapotranspiration at High Resolution with Internalized Calibration model (METRIC, UC Davis and ITRC CalPoly-SLO), 6) the Satellite Irrigation Management Support System (SIMS, NASA-ARC), and 7) the Priestley-Taylor method (PT, UC Davis). Preliminary results indicate that overall estimates of consumptive use are consistent with water balance estimates in the California Water Plan. Field-measured bare soil ET in areas above sea level indicates no evapotranspiration relative to grass-based reference evapotranspiration. Sources of discrepancy in ET estimations among the various methods and field measurements will be discussed, and qualitative comparison between the seven methods are provided. Further refinements and preliminary policy insights will be presented.

#### **15. Scientific Progress Goes "Boink": EBMUD's 3-Year Drought Operations in Comic Prose**

**Presenter(s):** Kevin Fung (EBMUD)

**Presenter(s) Email Address(es):** kfung@ebmud.com

**Collaborators:** n/a

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

##### **Abstract:**

From 2013 – 2015, EBMUD entered into drought operations. The major events and decisions leading up to those events are presented from the perspectives of a 6 year-old boy (Calvin), his tiger (Hobbes), and their modeling projections. Calvin and Hobbes represent EBMUD's decision making process and customer reactions through comic satire. Themes include implementing customer rationing, attempting to save cold water for fish, the pitfalls of using the Freeport Water Project for water transfers, and praying for rain. In the end there are lower demands, higher water rates, and too much water!

## **16 Ensemble Flow Forecasts for Risk Based Reservoir Operations of Lake Mendocino in Mendocino County, California**

**Presenter(s):** Chris Delaney (Sonoma County Water Agency)

**Presenter(s) Email Address(es):** Chris.Delaney@scwa.ca.gov

**Collaborators:** John Mendoza (Sonoma County Water Agency)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

Forecast informed reservoir operations (FIRO) is a methodology that incorporates short to mid-range precipitation or flow forecasts to inform the flood operations of reservoirs. The Ensemble Forecast Operations (EFO) alternative is a risk based method of FIRO that incorporates flow forecasts made by NOAA's California-Nevada River Forecast Center (CNRFC) to model and assess risk of meeting or exceeding identified management targets or thresholds. Forecasted risk is evaluated against set risk tolerances to set reservoir flood releases. A water management model was developed for Lake Mendocino, a 116,500 acre-foot reservoir located near Ukiah, California. Lake Mendocino is a dual use reservoir, which is owned and operated for flood control by the United State Army Corps of Engineers and is operated by the Sonoma County Water Agency for water supply. FIRO is applied to Lake Mendocino by simulating daily hydrologic conditions from 1985 to 2010 in the Upper Russian River from Lake Mendocino to the City of Healdsburg approximately 50 miles downstream. The EFO alternative is simulated using a 15-day, 61 member streamflow hindcast by the CNRFC. Model simulation results of risk-based flood operations demonstrate a 23% increase in average end of water year (September 30) storage levels over current operations. Model results show no increase in occurrence of flood damages for points downstream of Lake Mendocino. This investigation demonstrates that EFO may be a viable flood control operations approach for Lake Mendocino and warrants further investigation through additional modeling and analysis.

## **17 Analysis of flood bypasses around the world**

**Presenter(s):** Alessia Siclari (UC Davis)

**Presenter(s) Email Address(es):** asiclari@ucdavis.edu

**Collaborators:** Rui Hui and Jay R. Lund (UC Davis)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

The technique of using flood bypasses to reduce flood risk is well established all over the world. Different cases in different countries, such as the United States, China, and European countries, illustrate why it is preferable the use of bypasses to levees protection systems, when possible. A linear model has been developed to explore flood bypasses optimal capacity. The method used is based on a benefit-costs and risk analysis. The model has been applied to several bypasses. Preliminary results show optimal capacity for different bypasses follows the same trend, with most influential parameter being the coefficient of variation of the river mean peak flow.

## Session 20. Multi-D Modeling

### 1. Tides, Salinity, and Transport in the Pre-development San Francisco Estuary

**Presenter(s):** Steve Andrews (Resource Management Associates)

**Presenter(s) Email Address(es):** steve@rmanet.com

**Collaborators:** Ed Gross and John DeGeorge (Resource Management Associates), Sam Safran (San Francisco Estuary Institute)

**Permission to Post pdf of Presentation on CWEMF Website:** No

**Abstract:**

Many changes have taken place in the San Francisco Estuary between the pre-development period (c. 1850) and today, including island reclamation, channel widening/deepening/straightening for navigation, sea level rise, and the construction of water control infrastructure. These have affected the flow, salinity, and transport through the upper estuary in ways that have important effects on native aquatic biota. Here we look at how changes in the tidal structure between the pre-development and contemporary systems have influenced in-channel velocities, the physical mechanisms that bring salt into the Delta, and the transport of materials out of the Delta. 3-D hydrodynamic model results are presented along with an analysis of observed historical data.

### 2. Evaluation of the Effects of Long-Term Trends in Sediment Supply and Wind Speed on Turbidity in Suisun Bay and the Delta

**Presenter(s):** Aaron Bever (Anchor QEA)

**Presenter(s) Email Address(es):** abever@anchorqea.com

**Collaborators:** Michael MacWilliams (Anchor QEA), David Fullerton (Metropolitan Water District)

**Permission to Post pdf of Presentation on CWEMF Website:** No

**Abstract:**

Observed long-term trends indicate a decline in sediment supply to the Delta on the order of 1.3% per year, which corresponds to a decline of 23% over the past 20 years. In addition, recent analysis of historical wind data in Suisun Bay and the Sacramento-San Joaquin Delta indicates a statistically significant decline in wind speeds over the past two decades, which is most pronounced in fall. Both the long-term decline in sediment supply and the long-term trends in wind speed have the potential to influence sediment transport and turbidity in Suisun Bay and the Delta. The 3-D UnTRIM Bay-Delta model was applied together with the SWAN wave model and the SediMorph morphodynamic model to evaluate the relative effect of long-term trends in wind speed and Delta sediment supply on turbidity both during wet and dry water years. Declines in both wind speed and sediment supply result in lower turbidity throughout Suisun Bay and the Delta. The effect of wind speed on turbidity is largest in Suisun Bay and decreases into the Delta, while the effect of a reduced sediment supply is largest in the Sacramento River near Sherman Island.

### 3. The influence of estuarine circulation on recruitment from the ocean to low salinity habitat

**Presenter(s):** Edward Gross

**Presenter(s) Email Address(es):** ed@rmanet.com

**Collaborators:** Wim Kimmerer, Rusty Holleman

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

Abundance of estuarine organisms can vary with freshwater inflow through several mechanisms. One proposed mechanism is increased recruitment of downward sinking organisms with increased freshwater inflow. We used a particle-tracking model to investigate recruitment of plankton from the

coastal ocean to the low salinity zone of the San Francisco Estuary. The particle tracking model was run with 6 alternative behaviors for 5 different steady tributary inflow conditions covering a wide range of observed hydrology. The behaviors included passive behavior and constant sinking with sinking rates appropriate for starry flounder, *Platichthys stellatus*, and bay shrimp, *Crangon franciscorum*, organisms which recruit into the estuary as juveniles and move up into the low-salinity zone to rear. The specified sinking behaviors caused increased recruitment into the low salinity zone of the San Francisco Estuary relative to passive particles. The numbers of downward sinking organisms recruited generally increased with freshwater outflow and the time to arrive in the low salinity zone decreased. The results can be largely understood by the relationship between vertical distribution of plankton and the residual velocity field in the San Francisco Estuary. We conclude that increased recruitment with increased freshwater flow could explain the observed increase in abundance of these downward sinking organisms with increased freshwater outflow.

#### **4. Title: Effect of Geometry Configuration and Vegetation Removal on Transport and Tidal Energy Near Franks Tract**

**Presenter(s):** Kijin Nam (DWR)

**Presenter(s) Email Address(es):** Kijin.Nam@water.ca.gov

**Collaborators:** Eli Ateljevich (DWR), Joseph Zhang (VIMS)

**Permission to Post pdf of Presentation on CWEMF Website:** No

**Abstract:**

Franks Tract occupies a unique location where estuarine meets water project conveyance, and the Tract itself contributes to salinity intrusion through the mechanism of tidal pumping. Local hydrodynamics vary with the seasonality of submerged aquatic vegetation (SAV) and wind. Over the years, reconfiguration and vegetation removal projects have been proposed around Franks Tract targeting water quality, restoration, habitat, and fish migration. In this talk we compare aspects of several recent proposals that grow out of the drought barrier and brainstorming for Delta smelt resiliency. We do not focus on impacts from individual projects, but rather compare on how barrier placement and "hardening" actions (transformation of vegetation patches to fill) change transport and energy dissipation around Franks Tract. We also introduce features in the Bay-Delta SCHISM model being developed to better model SAV.

## **Session 21. The Surface-Groundwater Continuum: A Modeling Challenge**

### **1. A hydrologic and geomorphic classification of Rivers in California**

**Presenter(s):** Samuel Sandoval Solis, Ph.D. Assistant Professor, University of California, Davis

**Presenter(s) Email Address(es):** samsandoval@ucdavis.edu

**Collaborators:** Belize A. Lane, Helen H. Dahlke, Gregory B. Pasternack

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes

**Abstract:**

Climate and landscape processes affect streamflow patterns and geomorphic settings, playing a major role in river ecosystem function for aquatic and riparian ecosystems. Understanding the feedbacks between these processes is complicated in California due to extreme hydrologic variability and extensive hydrologic alteration for human water management objectives. Improved understanding of natural streamflow patterns and their ecological functions in various geomorphic settings is needed to understand hydrologic and geomorphic dynamics.

The present study addresses this gap by developing a spatially explicit hydrologic classification for California. We calculated 67 hydrologic metrics from 20 years of continuous daily discharge data for 91

unimpaired or naturalized gauge stations, which were entered into a k-means cluster analysis to classify flow regimes into seven major classes. We then used a recursive partitioning algorithm to predict flow class based on a suite of topographic, climatic, and geologic variables using available geospatial data. Overall classification success was 87%, and the model was used to predict natural flow classes at the reach scale for the entire state. This methodology identified eight natural flow classes representing distinct flow sources, hydrologic characteristics, and catchment controls over rainfall-runoff response. We further investigated the reach-scale geomorphic variability of individual hydrologic classes within the Sacramento Basin to develop a nested geomorphic classification of river reaches based on cross-sectional and longitudinal morphology and sediment composition. This study provides a process-based hydrologic and hydrogeomorphic framework upon which flow – form – ecological function relationships can be drawn and related for California with minimal resource and data requirements.

## **2. Impact of agricultural groundwater recharge on soil water balance and crop productivity of alfalfa and almonds**

**Presenter(s):** Helen E. Dahlke, Tiffany Kocis, Andrew Brown

**Presenter(s) Email Address(es):** hdahlke@ucdavis.edu

**Collaborators:** Thomas Harter, Dan Putnam, Steve Orloff, Astrid Volder, Ken Shackel

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

### **Abstract:**

On-farm recharge (agricultural groundwater banking) is a promising form of managed aquifer recharge where agricultural land is flooded during the winter using surface water to recharge the underlying groundwater. Flooding agricultural fields while the crop is dormant in winter or during fallow periods provides vast land areas connected to irrigation infrastructure that could allow capturing substantial amounts of surface water during wet periods. However, little is known about how much water can be recharged on fields planted with perennial crops like alfalfa or almonds without causing crop injury. The study presented here considers experiments conducted in the Central Valley and the Scott Valley, Siskiyou County between 2014-2016 to test the effect of different winter water application amounts (totals of 2-26 ft) and timings (January through April) on the water balance and crop health of established alfalfa stands and mature almond orchards. Using a water balance model and field observed soil moisture data we estimated that the majority of the applied water (>90%) went to deep percolation within less than 48 hours after the winter water application ceased. Further, yield measurements from the two alfalfa fields and two almond orchards indicate no significant yields loss for both crops. Together these results highlight the opportunity and potential benefits for growers and water districts to implement on-farm recharge as part of their sustainable groundwater management plans.

## **3. MODFLOW-OWHM Version 2: Discussion of New Features, Updates, and Improvements**

**Presenter(s):** Scott E. Boyce; US Geological Survey, California Water Science Center

**Presenter(s) Email Address(es):** seboyce@usgs.gov

**Collaborators:** Randall T. Hanson, Ian Ferguson, Stanley Leake and Wesley Henson (USGS), Steffen Mehl (CSU Chico), Thomas Reimann, and Thomas Maddock

**Permission to Post pdf of Presentation on CWEMF Website:** YES

### **Abstract:**

The One-Water Hydrologic Flow Model (One-Water) is a MODFLOW-based integrated hydrologic flow model designed for the analysis of a broad range of conjunctive-use and climate-related issues. One-Water fully links the movement and use of groundwater, surface water, and imported water for consumption by agriculture and natural vegetation on the landscape, and for potable and other uses within a supply-and-demand framework.

The next version of One-Water, currently under development with an intended release of Summer 2017, will include a new surface-water operations module that simulates dynamic reservoir operations, a new sustainability analysis package that facilitates the estimation and simulation of reduced storage depletion and captured discharge, a conduit-flow process for karst aquifers and leaky pipe networks, a soil zone process that adds an enhanced infiltration process, interflow, deep percolation and soil moisture, and a new subsidence and aquifer compaction package. It will also include enhancements to local grid refinement, and additional features to facilitate easier model updates, faster execution, better error messages, and more integration/cross communication between the traditional MODFLOW packages.

By retaining and tracking the water within the hydrosphere, One-Water accounts for “all of the water everywhere and all of the time.” This philosophy provides more confidence in the water accounting by the scientific community and provides the public a foundation needed to address wider classes of problems. Ultimately, more complex questions are being asked about water resources, so they require a more complete answer about conjunctive-use and climate-related issues.

#### **4. The Untold Story of Taggart Aston’s Fight for Hetch Hetchy**

**Presenter(s):** Max Fefer (UC Davis)

**Presenter(s) Email Address(es):** mafefer@ucdavis.edu

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

At the dawn of the 20th century, San Francisco’s rapid growth began exhausting the City’s water supply. San Francisco aimed to capture the Tuolumne River running through the Hetch Hetchy Valley, leading to a hard fought political battle that gave San Francisco control over the Valley. Since Hetch Hetchy is located in Yosemite National Park, San Francisco required congressional approval to dam the valley. San Francisco created the Freeman Report, a compelling document created to convince Congress that Hetch Hetchy was the only viable water source to satisfy San Francisco’s needs. A close examination of the historical record reveals genuine dissent within the City’s Engineering department regarding whether other viable alternatives existed for the city’s water supply. Prior to the completion of the Freeman Report, Max Bartell, Assistant City Engineer, wrote a report dated April 24th, 1912 stating the Mokelumne River was a valid alternative to Hetch Hetchy. Researching various letters, engineering reports, court cases, and historical newspapers shows the Bartell report was withheld from the federal government to protect San Francisco’s plea for Hetch Hetchy. Taggart Aston, a respected hydraulic engineer, exposed the Bartell report to the Senate Public Lands Committee but ultimately failed to stop San Francisco because of false testimony by his client, Eugene J. Sullivan, at the committee hearing. This research renews controversy regarding San Francisco’s acquisition of Hetch Hetchy and questions whether political pressure imposed by San Francisco advocates trumped documented engineering findings.



## Session 22. CalSim and CalLite Model Applications

### 1. Scenarios by the Hundreds: Using CalLite's Fast Run Capability to Probe Uncertainty

**Presenter(s):** Andrew Schwarz (DWR)

**Presenter(s) Email Address(es):** aschwarz@water.ca.gov

**Collaborators:** Dr. Casey Brown, University of Massachusetts, Dr. Patrick Ray, University of Cincinnati, Dr. Sungwook Wu, University of Massachusetts

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

The California Department of Water Resources – Climate Change Program in cooperation with the University of Massachusetts-Amherst Hydrosystems Research Group are using CalLite and the Decision Scaling approach to explore the State Water Project's operational vulnerabilities to climate change. Decision Scaling links bottom-up vulnerability assessment with multiple sources of climate information. The Decision Scaling approach is particularly well suited to exploration of California's unique internal and external variability and can provide decision relevant metrics of change. CalLite's ability to rapidly simulate water system response to an array of hydrologic changes allows for the exploration of a wide range of internal/natural variability and external variability/imposed climate shifts (long-term changes in precipitation and temperature).

This presentation will build on presentations made in for this session of CWEMF in each of the last two years. New results showing SWP performance across a wide range of internal variability and climate changes will be presented. A discussion of CalLite's benefits as a fast run tool to show proof of concept and to develop analytical methods will be provided.

### 2. Quantification of Carriage Water Using CalSim II

**Presenter(s):** Raymond Hoang (DWR)

**Presenter(s) Email Address(es):** Raymond.hoang@water.ca.gov

**Collaborators:** Nazrul Islam and Karandev Singh (DWR)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

Carriage water, sometimes referred to as marginal export cost, is the extra water necessary to carry one additional unit of water across the Delta for export while maintaining all agricultural and water quality standards – it may be characterized as a “tax” on exporting water from the Delta. The quantification of carriage water is important from an operational and regulatory standpoint, but its quantification presents technical challenges. The purpose of this presentation is to provide a conceptual and operational understanding of carriage water, highlight some of the technical challenges facing its calculation, introduce a method for quantifying carriage water in CalSim II, and corroborate the results with established values from alternative quantification methods.

### **3. What's controlling Delta Outflow?**

**Presenter(s):** Nur Taraky (DWR)

**Presenter(s) Email Address(es):** Nur.Taraky@water.ca.gov

**Collaborators:** Nazrul Islam and Karandev Singh (DWR)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

Unique hydrology and climate of California has created a challenging situation for the current water resources system to manage the water rationing between the struggling ecosystem, growing population, and agricultural needs. Extreme weather due to climate change has amplified the need for more stringent water accounting system. One of the hot topic on water accounting is the Delta outflow to the Pacific Ocean which results from maintaining water quality for agricultural and municipal need and protecting fish and wildlife habitat. This analysis breaks down the delta outflow volume into two different account – water used to maintain the water quality for agricultural and municipal use, and water used to protect fish and wildlife habitat. Different methods are used to determine the factors that control delta outflow and the results between different approaches are compared to quantify the water usage for the two different accounts.

### **4. Calsim and CalLite Model Updates**

**Presenter(s):** Chris Quan (DWR)

**Presenter(s) Email Address(es):** cquan@water.ca.gov

**Collaborators:** Nazrul Islam), Raymond Hoang) Ali Abrishamchi, Karandev Singh, and Nur Taraky (DWR)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

This presentation will provide an overview of model updates pertaining to the CalSim and CalLite models. DWR is currently developing the 2017 Delivery Capability Report (DCR), a biannual report prepared by CA Department of Water Resources to provide an estimate of the existing overall delivery capability of the State Water Project (SWP) system and the allocation of that capacity to each of the contractors under a range of hydrologic and regulatory conditions. Several, ongoing developments are happening with the CalLite model as well. An updated GUI is being developed for improved functionality and usability. A set of additional Water Management Actions (WMAs) is being incorporated into CalLite. Finally, an effort is being made to implement dynamically-simulated groundwater interactions in CalLite.

### **5. CalSim 3.0 Model Updates by Bureau of Reclamation**

**Presenter(s):** Nancy Parker and Jim Shannon (U.S. Bureau of Reclamation)

**Presenter(s) Email Address(es):** doconnor@usbr.gov, jshannon@usbr.gov

**Collaborators:** Kenneth Wright, Michael Wright, Zach Leady, & Nancy Parker (U.S. Bureau of Reclamation); Andy Draper (Stantec/MWH Global)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

This presentation summarizes work completed on CalSim 3.0 for the Sacramento and San Joaquin river basins since the last annual meeting. The updated model now successfully simulates water years 1922 - 2015. Completed work has included updated San Joaquin applied-water demands, extension of input data, disaggregation of stream-aquifer seepage terms and imposition of soft constraints thereof, general QA/QC, and coordination of model logic updates between DWR and USBR. In progress work includes cycle reformulation, removal of the Sacramento/San Joaquin groundwater boundary condition, redistribution of groundwater pumping and deep percolation volumes in the San Joaquin basin, and development of the Vernalis Closure Term.

## **Session 23. Modelers' Plethora: Retooling, Innovating, and Advancing Models and Methods**

### **1 A showcase of FHWA's new hydraulic model SRH-2D and its example application**

**Presenter(s):** Murari Paudel (Wood Rodgers)

**Presenter(s) Email Address(es):** mpaudel@woodrogers.com

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

The Federal Highway Administration (FHWA) recently adopted the U.S. Bureau of Reclamation's SRH-2D hydraulic model in lieu of its long used FST2DH model. The SRH-2D (Sedimentation and River Hydraulics), with its capability to use hybrid irregular grid and a robust computational engine based on implicit finite volume solution scheme, presents a tremendous potential in solving complex hydrodynamic problems. SRH-2D can perform mobile sediment transport modeling over the 2D mesh. Its efficient handling of wetting/drying phenomenon, integration of structures such as culverts, gates, weirs, etc. make it a serious contender to other existing hydraulic models. Some of its functional but yet not public modules including SRH-W (to simulate rainfall-runoff on the mesh), and its temperature and vegetation modules will make SRH-2D an even better choice of application for analysis of aquatic organism passage through hydraulic structures, TMDL estimation etc. This presentation will discuss about some of the capabilities and potential application of SRH-2D in transportation related hydraulic projects.

An example application of SRH-2D that simulates pressure flow through a CON/SPAN bottomless precast concrete arch culvert will be presented. The culvert in the example exhibited a series of flow regime changes at entrance, through and at the tail end of the structure. This example will also illustrate how SRH-2D because of its capacity to compute momentum transfer and drag losses, was used to design an energy dissipation structure at the tail end of the culvert, overcoming several limitations posed by 1D and 1D/2D coupled solutions.

### **2. Representing California's Water System with an Open Source Model: PyVIN**

**Presenter(s):** Mustafa Dogan (UC Davis)

**Presenter(s) Email Address(es):** msdogan@ucdavis.edu

**Collaborators:** Max Fefer, Jon Herman, Justin Merz, Quinn Hart, Josue Medellin-Azuara, Jay Lund

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

Hydroeconomic models help decision makers easily compare different policy and management scenarios and are useful tools to increase benefits or decrease costs of managing water. Bringing hydrology and economics together, these models provide a framework for multidisciplinary approaches. This work proposes a new open source model to evaluate operation and adaptation strategies under existing and future hydrologic conditions for California's interconnected water system. A common modeling platform, Pyomo, is used to build PyVIN, which makes data collaboration and communication with other models built on the similar environment easier. The model combines the network structure of CALVIN, a statewide optimization model for California's water infrastructure, along with an open source solver written in the Python programming language. And the model is not solver-specific; any compatible state-of-the-art solver can be used. With the flexibilities of the model, reservoir operations, including water supply and hydropower, groundwater pumping, and the Delta water operations and requirements can now be better represented. Water market operations also represented in the model, allocating water from lower-valued users to higher-valued users. PyVIN serves as a cross-platform,

extensible model to evaluate systemwide water operations. PyVIN separates data from the model structure, enabling model to be easily applied to other parts of the world where water is a scarce resource.

### **3. Nutrient and Algae Modeling for Remedial Evaluation of Lake San Marcos, CA**

**Presenter(s):** Justin Ibershoff (LimnoTech)

**Presenter(s) Email Address(es):** jibershoff@limno.com

**Collaborators:** Dave Dilks and Amanda Flynn (LimnoTech)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

Lake San Marcos is an 80 acre impoundment in San Diego County experiencing algal blooms resulting in summertime depletion of dissolved oxygen, and is listed as impaired for ammonia and nutrients. LimnoTech is currently assisting with modeling and remedy planning for a Remedial Investigation and Feasibility Study of the lake. A three-dimensional linked hydrodynamic-water quality model using EFDC and RCA has been developed for simulating the growth of three algae species, as well as dissolved oxygen and the movement of solids and nutrients. LimnoTech has also enhanced and extended the simulation period for an LSPC watershed model (originally developed by TetraTech) for quantifying solids and nutrient loads to the lake. Simulations of remedial scenarios with the models indicate that both watershed and lake remedies would be needed to restore the health of the lake. Simulated watershed remedies include stream restoration and agricultural BMPs, and simulated lake remedies include sediment inactivation, aeration, and selective withdrawal from the hypolimnion for golf course irrigation. A fifteen year hindcast of this model is being used to support design of a watershed pilot study. The lake and watershed modeling efforts will be discussed along with some historical context and future outlook.

### **4. Improving Salmonid Restoration Efforts using Unmanned Aerial Systems and Structure-from-Motion Photogrammetry, Lower American River, California.**

**Presenter(s):** Toby Stegman (cbec eco-engineering)

**Presenter(s) Email Address(es):** t.stegman@cbecoeng.com

**Collaborators:** Ben Taber and Chris Hammersmark (cbec eco-engineering) and, John Hannon (U.S. Bureau of Reclamation)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

The use of unmanned aerial systems (UAS) has exploded in the last several years. To even further accelerate the use of UAS within the private sector, the Federal Aviation Administration implemented new regulations for commercial UAS in the late summer of 2016. These streamlined regulations opened the door to new uses of the technology, and a rapidly growing market. Recent advancements in Structure-from-Motion photogrammetry and the use of UAS holds great potential for salmonid restoration planning and monitoring. Here we present our use of UAS and Structure-from-Motion to support salmonid restoration along the Lower American River, CA. We employed this technology to develop a high resolution existing conditions digital elevation model for use in project design and hydraulic modeling. During the project construction phase, sediment sorting operations were tracked using weekly UAS flights, where volumes of gravel stockpiles were calculated. UAS data was also used for interim grade check surveys to rapidly produce an elevation difference surface during side channel and floodplain grading operations. Post construction monitoring was accomplished using UAS and Structure-from-Motion, where we investigated and applied depth retrieval methods to generate bathymetric data. We implemented a recently published method of refraction correction for bathymetric returns in the

Structure-from-Motion point cloud, and assess their accuracy with real-time kinematic global positioning systems survey data. We also test a more conventional method of photogrammetric depth retrieval, using UAS ortho-images with limited field data. Obtaining an understanding of the limitations and opportunities of both terrestrial and bathymetric topographic UAS mapping in the riverscape will continue to advance the field of salmonid restoration, with significant potential cost savings related to design, implementation and post-project assessment.

## **Session 24. Modeling Major Floods to Monthly Water Supply**

### **1. Application and evaluation of the HEC-RAS - riparian vegetation simulation module to the Sacramento River**

**Presenter(s):** Zhonglong Zhang (LimnoTech, U.S. Army Engineer Research and Development Center)

**Presenter(s) Email Address(es):** zhonglong.zhang@erdc.dren.mil

**Collaborators:** Blair Greimann, Victor Huang, Billy Johnson

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

The RVSM is a dynamic riparian vegetation simulation module and predicts spatially-explicit seed dispersal, establishment, growth, and mortality in response to riverine hydraulic conditions. The RVSM was integrated into HEC-RAS for simulating the interactions between flow and riparian vegetation on the flood plain and aiding the science, economics, and policy of riparian ecosystem management and restoration. In this study, the HEC-RAS – RVSM system was applied to the Sacramento River reach for modeling the interactions between flow and riparian vegetation dynamics. Five vegetation types were simulated using RVSM and the HEC-RAS model simulation was conducted for eight-year period (1999-2007). The HEC-RAS flow model was calibrated using observed flow, river stage, groundwater data. The RVSM was calibrated and evaluated using survey data and vegetation mapping in 1999 and 2007. Cottonwood seedling establishment and desiccation were calibrated and validated using cottonwood seedling density data collected in 2005 at two sites. The HEC-RAS – RVSM system was able to predict the spatial distribution of cottonwood spread over the 8 years. The predicted change rates in areas of cottonwood, mixed forest and invasive species from 1999 to 2007 matched well with mapped data compiled from field survey. This paper presents the HEC-RAS – RVSM and its application and evaluation using the Sacramento River data sets.

### **2. Hydraulic Analysis near Fremont Weir and Yolo Bypass by 1D and 2D Hydraulic Model**

**Presenter(s):** Sungho Lee (Central Valley Flood Protection Board), DWR

**Presenter(s) Email Address(es):** Sungho.Lee@CVFlood.ca.gov

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

**Abstract:**

The hydraulic analysis near Fremont Weir (Left and Right) for high flood condition has been studied using 1-dimensional (1D) HEC-RAS model (CVFED) and 2-dimensional (2D) hydraulic model (RMA2). The maximum water surface elevation (WSEL) and velocity of 1D CVFED model at Fremont Weir are 40.99 ft and 3.34 ft/s for 1997 flood discharge of 382,704 cfs.

The average WSEL of East (Left) Fremont Weir and West (Right) Fremont Weir of 2D model are 41.20 ft and 40.25 ft for 1997 flood discharge of 397,000 cfs. The WSEL of 1D CVFED model ranges between that of 2D model of East and West Fremont Weir.

The maximum velocity of 2D model at the east end of East Fremont Weir is about 7.01 ft/s. The average velocities of 2D model for East and West Fremont Weir are 6.51 ft/s and 3.78 ft/s. The average velocity

of East Fremont Weir is about 2.73 ft/s higher than that of West Fremont Weir. The maximum velocity of 2D model at East West Fremont Weir is more than two times higher than that of 1D CVFED model. The flow of East Fremont Weir by 2D model shows lower WSEL and higher velocity than that of West Fremont Weir. About 88% of Fremont Weir flood discharge flows through East Fremont Weir. The topography of existing 1D CVFED model is not enough to represent the real existing Fremont Weir condition and it should be updated considering Rattle Snake Island. The hydraulic result of 1D model is not proper to handle the super-elevation and flow split issues with one WSEL and velocity value. 2D model should be applied to get more detailed hydraulic analysis near Fremont Weir and Yolo Bypass. The result of this study will be used to support discharge split, sediment transport, fish ladder project, levee repair, and alternatives study near Fremont Weir and Yolo Bypass.

### **3. Rainfall-Runoff Modeling for the Garrison Dam Drainage with HEC-HMS**

**Presenter(s):** Melissa Larsen (WEST Consultants, Inc.)

**Presenter(s) Email Address(es):** mlarsen@WESTconsultants.com

**Collaborators:** Jeff Harris (WEST Consultants, Inc.) and Josh Melliger (USACE Army Corps of Engineers)

**Permission to Post pdf of Presentation on CWEMF Website:** No

**Abstract:**

The US Army Corps of Engineers (USACE) Dam Safety Office and the Office of Homeland Security has tasked the USACE Hydrology and Hydraulics Community of Practice to update hydrology for various USACE flood risk reduction projects. WEST Consultants was contracted by the USACE to create rainfall-runoff models with the Hydrologic Engineering Center's (HEC) Hydrologic Modeling System (HMS) software for the 50,000 sq. mi Fort Peck Dam drainage and the 130,000 sq. mi Garrison Dam drainage in the upper Missouri River Basin. This effort was a precursor to updating the Probable Maximum Flood (PMF) for both Dams. This presentation will detail the collection of data and the effort to calibrate the HEC-HMS models for the two basins for spring snowmelt events.

### **4. Potential Changes in Water Supply under Future Climate Projections in the Central Valley**

**Presenter(s):** Minxue (Kevin) He

**Presenter(s) Email Address(es):** kevin.he@water.ca.gov

**Collaborators:** Mitchel Russo, Michael Anderson

**Permission to Post pdf of Presentation on CWEMF Website:** No

**Abstract:**

The Central Valley is a major water supply source for the State Water Project and Central Valley Project in California. Reliable water supply from this area has tremendous social, economic, and environmental value to the state. The goal of this study is to assess potential changes in water supply under projected climate change scenarios in the Central Valley. The study employs climate model projections from the Coupled Model Inter-comparison Project Phase 5 (CMIP5), which are consistent with the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR5) and thus represent the current state of the climate change science. Specifically, 20 individual downscaled projections (1/16 degree, approximately 6 by 6 kilometers) from 10 Climate Circulation Models (GCMs) (selected by the Climate Change Technical Advisory Group (CCTAG) of California Department of Water Resources) under two Representative Concentration Pathways (RCP 4.5 and RCP 8.5) over three hydrologic regions in the Central Valley (Sacramento Region, San Joaquin Region, and Tulare Region) are utilized to drive the distributed Variable Infiltration Capacity (VIC) model to generate daily runoff simulations from 2020-2099 for those regions. Annual runoff, monthly runoff and runoff during the typical water supply season (i.e. April-July) are aggregated from daily simulations for the analysis. The results indicate that annual runoff increases on average when compared to the historical baseline (1951-1990) for the Sacramento

and San Joaquin regions, while annual runoff of the Tulare region decreases in general. April-July runoff at three regions generally increases except for the scenario for late 21<sup>st</sup> century (2060-2099) under PCR 8.5 pathway. At the seasonal scale, projected runoff volume during Summer and Fall generally decreases, while it is the opposite for Winter and Spring. Runoff peak timing remains largely unchanged for the San Joaquin and Tulare regions. However, for Sacramento Region under RCP 8.5 pathway, peak timing is shifted one month earlier. During the period from 2020-2099, there is no significant trend in the annual runoff for any of those three regions. Under RCP 8.5 pathway, in contrast, the April-July runoff shows decreasing tendency for all regions (with a significance level at 0.05). Overall, this study is meaningful in terms of guiding adaptive water planning and management practices to maximize water supply reliability for the state in a changing climate in the future.

## **Session 25. Applications of 2-Dimensional HEC-RAS to Ecosystem Enhancement in the Central Valley**

### **1. Using 2D Hydrodynamic Modeling to Quantify Spatio-temporal Inundation Patterns for Floodplain Restoration**

**Presenter(s):** Alison Whipple (UC Davis)

**Presenter(s) Email Address(es):** aawhipple@ucdavis.edu

**Collaborators:** Bill Fleenor (UC Davis)

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes or No

#### **Abstract:**

Complex and dynamic physical processes drive floodplain ecosystems. Natural flood regimes to which species are adapted have been altered by water management, land use change, and climate change. Improved understanding of spatial and temporal variability of floodplain inundation patterns aids the planning and evaluation of restoration alternatives. The research presented here uses 2D hydrodynamic modeling (HEC-RAS 5.0) of representative flood types to develop a spatio-temporally resolved approach to quantify and visualize floodplain inundation patterns within the Oneto-Denier restoration site (~1 km<sup>2</sup>) along the lower Cosumnes River, California. Model development and calibration relies upon LiDAR and RTK datasets to establish pre- and post-restoration geometry, and flow and stage datasets from upstream and within the site to establish boundary conditions and perform calibration. Modeling output is analyzed and compared within and across flood events and restoration scenarios in space and time using metrics relating to depth, duration, connectivity, and spatial heterogeneity. This research advances floodplain hydroecology and restoration sciences, extending readily-applied methods using 2D modeling output to provide useful information and tools to better manage floodplains for variable conditions that benefit ecosystems.

### **2. Two Dimensional Modeling of Great Valley Grasslands State Park**

**Presenter(s):** David Arrate (DWR)

**Presenter(s) Email Address(es):** David.Arrate@water.ca.gov

**Collaborators:** Devinder Dhillon, Romain Maendly

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

In 2010, the California Department of Parks and Recreation, Central Valley District, identified a portion of the Great Valley Grasslands State Park (GVGSP) for potential floodplain reconnection with the San Joaquin River. Restoring connectivity between the GVGSP floodplain and the San Joaquin River could provide more natural floodplain processes to help control exotic species, restore ecological conditions that are more similar to the pre-levee conditions at GVGSP and help reduce nearby flood impacts.

The Department of Water Resources was asked to help examine the GVGSP site primarily for flood impact benefits. Multiple reconnective scenarios were modeled using tools, information, and methodology developed for the 2017 Central Valley Flood Protection Plan Update. Specifically, HEC-RAS 2D was used to model the GVGSP site. Multiple iterations were done to improve and expand the modeling at GVGSP and surrounding areas. This presentation will present what tools and information were used and how they were applied to model this area.

### **3. A 1D/2D HEC-RAS model of the Yolo Bypass and the Lower Sacramento Valley: summary and next steps**

**Presenter(s):** Lily Tomkovic (UC Davis)

**Presenter(s) Email Address(es):** latomkovic@ucdavis.edu

**Collaborators:** Bill Fleenor and Fabian Bombardelli (UC Davis)

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes or No

**Abstract:**

The Yolo Bypass provides 59,000 acres for flood pulses from the Sacramento, Feather, and American Rivers. Routing flow onto the Bypass also creates habitat and fish passage for Delta species. However, the Bypass currently only is utilized for large flood events. Efforts under California's EcoRestore could increase the frequency of flows to the Bypass, allowing smaller events to route flow onto the floodplain. Researchers at UC Davis' Center for Watershed Sciences have built a 1D/2D hydrodynamic model of the Yolo Bypass and lower Sacramento Valley using HEC-RAS, a public software that allows the work to be shared freely. Yolo County commissioned the model for use by all stakeholders to investigate alternatives for flood frequency modifications.

Now with a calibrated model, there is a call for further research. Intricacies of the Bypass can now be investigated. Topics such as the dynamics of the receding limb, ability of bladder dams to increase residence time, levee changes, and a look at land use modification can all be evaluated using the HEC-RAS 2D model. Because the model is free, these call to arms can be accomplished by a wide variety of interested parties.

### **4. Applying 2D HEC-RAS for Long-Term Resource Management with The Cache Creek Area Plan**

**Presenter(s):** Paul Frank

**Presenter(s) Email Address(es):** pfrank@flowwest.com

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Indicate Yes or No

**Abstract:**

The Cache Creek Area Plan (CCAP) was implemented in 1996 by Yolo County to reverse the impacts that in-channel gravel mining had on Cache Creek in prior decades. The CCAP consists of stopping in-channel mining, regulating off-channel mining, and implementing a suite of biologic, geomorphic, and hydrologic monitoring actions aimed at understanding the function of the ecosystem and implementing projects that enhance it. The underlying analyses that were the foundation for the CCAP included hydraulic and sediment transport models developed with HEC software available at the time. In 2016, Yolo County embarked on a 20-year retrospective of the CCAP which included development of a new 2D HEC-RAS model of Lower Cache Creek. This model will be used to evaluate flow patterns, understand forces that contribute to channel instabilities and sediment transport, and design future projects implemented under the CCAP.

## **Session 26. A New MILP Solver for CalSim/CalLite**



### **1. jCbc: An Open-Source LP/MILP Solver for CalSim/CalLite**

**Presenters:** Zhaojun Bai (UC Davis)

**Presenters Email Addresses:** bai@cs.ucdavis.edu

**Collaborators:** Junaid As-Salek (USBR), Tariq Kadir, Kuo-Cheng Kao, Prabhjot Sandhu, and Sanjaya Seneviratne (DWR), Mahdi Ghamkhari and Matthias Koeppe (UC Davis), Babak Moazzez (Kennesaw State University)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

In this talk we present an open-source linear programming (LP) and mixed integer linear programming (MILP) solver, called jCBC, developed for CalSim/CalLite models. jCBC is a Java Native Interface (JNI) for COIN-OR MILP solver CBC and COIN-OR LP solver CLP with modifications and new capabilities. The development of jCBC is based on a comprehensive review and performance test of commercial and open-source LP and MILP solvers for CalSim/CalLite models. jCBC exploits the domain-specific features in CalSim/CalLite models. We will present a suite of test problems to demonstrate the accuracy and efficiency of jCBC. The first public release of jCBC is scheduled in Spring of 2017.

### **2. Implementation of jCBC solver for WRIMS2 and CalSim**

**Presenter(s):** Kevin Kao (DWR)

**Presenter(s) Email Address(es):** kkao@water.ca.gov

**Collaborators:** Junaid As-Salek (USBR), Tariq Kadir, Prabhjot Sandhu, Hao Xie, and Sanjaya Seneviratne (DWR), Zhaojun Bai, Mahdi Ghamkhari, and Matthias Koeppe (UC Davis), Babak Moazzez (Kennesaw State University)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

USBR, DWR, and UC Davis have been collaborating on WRIMS2 open-source solver development. After years' effort, the implementation of jCBC solver in WRIMS2 is no longer in Beta stage and is capable of running full-scale CalSim3 studies. The challenges encountered in the development as well as the solutions and recommended plans will be discussed in the presentation.

### **3. Performance Analysis of jCbc and Emerging Challenges and Opportunities**

**Presenters:** Mahdi Ghamkhari (UC Davis)

**Presenters Email Addresses:** mahdi.ghamkhari@gmail.com

**Collaborators:** Junaid As-Salek (USBR), Tariq Kadir, Kuo-Cheng Kao, Prabhjot Sandhu, and Sanjaya Seneviratne (DWR), Zhaojun Bai and Matthias Koeppe (UC Davis), Babak Moazzez (Kennesaw State University)

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

We present our recent in-depth performance analysis of newly developed LP and MILP solver jCbc for CalSim and WRIMS models. jCbc is a Java Native Interface for COIN-OR MILP solver CBC and COIN-OR LP solver CLP with modifications and new capabilities. The analysis has provided us further insights about the complexity of MILPs in CalSim and WRIMS models. We discuss a number of strategies to improve the solution quality and speed up solution time. In addition we discuss our on-going effort on full integration of jCbc solvers with CalSim and WRIMS and performance tuning and optimization on various computing platforms, and our plan to develop a sensitivity analyzer module in jCbc so that it will reveal the sensitivity of the optimal values to the perturbations of key parameters in CalSim and WRIMS model.

### **Session 27. Modeling Floods and Human Behavior**

### **1. Flood Insurance and Flood Memory Half-life**

**Presenter(s):** Rui Hui (Postdoctoral Researcher, Center for Watershed Sciences, UC Davis)

**Presenter(s) Email Address(es):** rhui@ucdavis.edu

**Collaborators:** Nicholas Pinter, Kathy Schaefer

**Permission to Post pdf of Presentation on CWEMF Website:** No

#### **Abstract:**

Flood events can cause loss of life and property, disrupt society and economy, and degrade the environment. A catastrophic flood event will significantly raise individual and public awareness of floods and interests in flood mitigation actions, for example flood insurance as a preparatory vulnerability reduction action. However, individual and public memories of flooding do not last long. The half-life, a term indicating the interval for a quantity declining to its half, of flood memory is short. To estimate flood memory half-life, we are using the flood insurance coverage from National Flood Insurance Program database to represent and quantify the flood memory. In general, the flood insurance rate increases immediately after a flood disaster, and then decreases from a peak value to half of the peak within a few months or a few years. Our data analysis shows clearly the immediate increase and subsequent decay in many counties in California after the 1997 flooding. Despite the fact that social factors such as income and population density would affect flood insurance coverage, our flood memory half-life is remarkably short.

### **2. Numerical application of SCHISM about flood inundation modeling due to levee breach in idealized channel and field case**

**Presenter(s):** Seung Oh Lee (Hongik University, Korea)

**Presenter(s) Email Address(es):** seungoh.lee@hongik.ac.kr

**Collaborators:** Nam, Kijin (Bay Delta office, DWR, CA); Yoo, Hyungzu (Hongik University, Korea)

**Permission to Post pdf of Presentation on CWEMF Website:** YES

#### **Abstract:**

Overflow due to levee breach has occasionally been occurred to inundate overland outer levee during and/or post flood events and its dreadful damages on infra-structures near floodplains, and life has grown up because of abnormal climate change. Most related studies have been conducted to simulate flood inundation in overland due to levee breach under steady state of flood event even though its phenomenon was highly dependent on time scale such as hydrograph and process of breach. We applied the SCHISM (Semi-implicit Cross-scale Hydroscience Integrated System Model), an open source-community supported modeling system, to understand and estimate flood inundation including unsteady effect. First, idealized channel with a conjunction was adopted to show the effect of hydrograph between main channel and tributary under steady and unsteady condition and we employed the process of levee change to cause the overflow into land. And we applied to real geometry of Saemangeum region in Korea under several flood event scenarios with unsteadiness.

### **3. Maintaining a consistent level of risk in reservoir operations also requires assessing dynamic downstream risk and benefits**

**Presenter(s):** Matthew E. Bates

**Presenter(s) Email Address(es):** Matthew.e.bates@usace.army.mil, mebates@ucdavis.edu

**Collaborators:**

**Permission to Post pdf of Presentation on CWEMF Website:** Yes

#### **Abstract:**

Forecast-informed reservoir operations (FIRO) have been proposed for multi-purpose reservoirs as a way to enable additional water supply benefit without substantially increasing flood risks. This is fundamentally a decision-analytic problem, seeking to accurately and dynamically assess tradeoffs between risk and benefit parameters over time. Specifically, there is increasing interest to have flood risk calculations and associated reservoir operations be informed by sophisticated hydrometeorological modeling. These suggestions have merit. There are, however, other portions of the risks and benefits calculations that can be informed by different types of models and data and which have received much less attention in the FIRO context.

This presentation presents a framework for incorporating seasonal forecasts about changing levels of value-at-risk or water-supply-benefit downstream of a reservoir alongside changes in flood probability from advanced weather modeling. As a function of both probability and consequence, flood risk analysis requires knowledge of both of probability and consequence components. Dynamic consequence factors, for example, could include changes in downstream value related to variability in agricultural production, environmental needs, urban water supply, hydropower opportunities, tourism, recreation, population growth, etc. Incorporating these factors alongside hydrometeorological predictions is necessary to ensure uniform application of risk-benefit tradeoffs and to allow dynamic hedging to best match the consistent risk preferences of the public or the relevant water agency.

# ANNUAL MEETING PARTICIPANTS

No	Last	First	Organization	Email Address
1	Abrishamchi	Ali	Department of Water Resources	Ali.Abrishamchi@water.ca.gov
2	Adams	Lauren	UC Davis	leadams@ucdavis.edu
3	Alexander-Sanchez	Nadya	UC Davis	nadyaa@ucdavis.edu
4	Altare	Craig	Department of Water Resources	craig.altare@water.ca.gov
5	Altare	David	State Water Resources Control Board	David.Altare@waterboards.ca.gov
6	Amador	Dominick	RMC	damador@woodardcurran.com
7	Anderson	Jamie	Department of Water Resources	Jamie.Anderson@water.ca.gov
8	Anderson	Michael	Department of Water Resources	michael.anderson@water.ca.gov
9	Anderson	Will	State Water Resources Control Board	wanderson@waterboards.ca.gov
10	Andrews	Steve	RMA	steve@rmanet.com
11	Archibald	Elaine	CWEMF	elaine.archibald@comcast.net
12	Arrate	David	Department of Water Resources	david.arrate@water.ca.gov
13	As-Salek	Junaid	U.S. Bureau of Reclamation	Jassalek@usbr.gov
14	Ateljevich	Eli	Department of Water Resources	Eli.Ateljevich@water.ca.gov
15	Babb	Ryan	State Water Resources Control Board	Ryan.babb@waterboards.ca.gov
16	Bachman	Matthew	MWH	matthew.bachman@stantec.com
17	Bai	Zhaojun	UC Davis	bai@cs.ucdavis.edu
18	Bates	Matthew	U.S. Army Corps of Engineers	Matthew.e.bates@usace.army.mil
19	Bell	Marco	Merced Irrigation District	mbell@mercedid.org
20	Bergfeld	Lee	MBK Engineers	bergfeld@mbkengineers.com
21	Bettencourt	Mark	Department of Water Resources	mark.bettencourt@water.ca.gov
22	Bever	Aaron	Anchor QEA	abever@anchorqea.com
23	Bindra	Amy	Department of Water Resources	Amarjot.Bindra@water.ca.gov
24	Bourez	Walter	MBK Engineers	bourez@mbkengineers.com
25	Boyce	Scott	USGS	seboyce@usgs.gov
26	Bray	Benjamin	East Bay Municipal Utility District	bbray@ebmud.com
27	Brown	Russ	ICF International	Russell.Brown@ICFI.com
28	Burke	Thomas	Hydrologic Systems	office@hydrologic-systems.com
29	Canada	Holly	David Ford Consulting Engineers	hcanada@ford-consulting.com
30	Cayar	Mesut	RMC Water & Environment	mcayar@rmcwater.com
31	Chen	Z.Q. Richard	Department of Water Resources	Zhiqiang.Chen@water.ca.gov
32	Chilmakuri	Chandra	CH2M	chandra.chilmakuri@ch2m.com
33	Chowdhury	Shyamal	Wood Rodgers	schowdhury@woodrodgers.com
34	Churchill	Clark	Department of Water Resources	clark.churchill@water.ca.gov
35	Clark	Byron	Davids Engineering	byron@davidsengineering.com
36	Cooledge	Craig	CH2M	craig.cooledge@ch2m.com

No	Last	First	Organization	Email Address
37	Dahlke	Helen	UC Davis	hdahlke@ucdavis.edu
38	Das	Tapash	CH2M	tapash.das@CH2M.com
39	Deas	Mike	Watercourse Engineering	mike.deas@watercourseinc.com
40	DeGeorge	John	Resource Management Associates	jfdegeorge@rmanet.com
41	Delaney	Chris	Sonoma County Water Agency	Chris.Delaney@scwa.ca.gov
42	Demchuk	Vadim	State Water Resources Control Board	vadim.demchuk@waterboards.ca.gov
43	Dhillon	Devinder	Department of Water Resources	Devinder.Dhillon@water.ca.gov
44	Dietl	Mike	U.S. Bureau of Reclamation	mdietl@usbr.gov
45	Dogan	Mustafa	UC Davis	msdogan@ucdavis.edu
46	Dogrul	Emin	Department of Water Resources	Can.Dogrul@water.ca.gov
47	Donigian	Anthony	RESPEC	tony.donigian@respec.com
48	Draper	Andy	MWH	andy.draper@mwhglobal.com
49	Easton	Daniel	MBK Engineers	easton@mbkengineers.com
50	Edwards	James	Department of Water Resources	James.Edwards@water.ca.gov
51	Emery	Jared	ECORP Consulting, Inc.	jemery@ecorpconsulting.com
52	Faunt	Claudia	U.S. Geological Survey	ccfaunt@usgs.gov
53	Fefer	Max	UC Davis	mafefer@ucdavis.edu
54	Ferreira	Ines	Department of Water Resources	Ines.Ferreira@water.ca.gov
55	Fidell	Megan	Department of Water Resources	Megan.Fidell@water.ca.gov
56	Figueroa	Vibeke	Placer County Water Agency	vfigueroa@pcwa.net
57	Fischer	Frances		
58	Fitzgibbon	Michael	Point Blue Conservation Science	mfitzgibbon@pointblue.org
59	FitzHugh	Tom	MWH	thomas.w.fitzhugh@stantec.com
60	Fleenor	Bill	UC Davis	wefleenor@ucdavis.edu
61	Foglia	Laura	UC Davis	lfoglia@ucdavis.edu
62	Frank	Paul	FlowWest	pfrank@flowwest.com
63	Fryjoff-Hung	Anna		afryjoffhung@gmail.com
64	Fung	Kevin	East Bay Municipal Utility District	kfung@ebmud.com
65	Gailey	Robert	UC Davis	rmgailey@ucdavis.edu
66	Gailey	Robert	UC Davis	rmgailey@ucdavis.edu
67	Galef	Jeff	Department of Water Resources	jeff.galef@water.ca.gov
68	Gautam	Mahesh	Department of Water Resources	mahesh.gautam@water.ca.gov
69	Gautam	Ramesh	Department of Water Resources	ramesh.gautam@water.ca.gov
70	Ghamkhari	Mahdi	UC Davis	mahdi.ghamkhari@gmail.com
71	Ghasemizade	Mehdi	UC Davis	mghasemizade@ucdavis.edu
72	Gilbert	James	U.S. Bureau of Reclamation	jmgilbert@usbr.gov
73	Grimm	Robyn	CH2M	robyn.grimm@ch2m.org
74	Gross	Ed	RMA	ed@rmanet.com
75	Guerin	Marianne	Resource Management Associates	maguerin@rmanet.com
76	Haile-Selassie	Samson	Department of Water Resources	samson.haile-selassie@water.ca.gov

No	Last	First	Organization	Email Address
77	Hall	Austin	State Water Resources Control Board	Austin.Hall@waterboards.ca.gov
78	Hanson	Randy	U.S. Geological Survey	rthanson@usgs.gov
79	Harrison	Katrina	U.S. Bureau of Reclamation	kharrison@usbr.gov
80	Hassan	Rajaa	State Water Resources Control Board	Rajaa.Hassan@waterboards.ca.gov
81	Hatch	Tyler	Department of Water Resources	tyler.hatch@water.ca.gov
82	He	Kevin	Department of Water Resources	kevin.he@water.ca.gov
83	Heinzer	Tom	U.S. Bureau of Reclamation	theinzer@usbr.gov
84	Henson	Wesley	U.S. Geological Survey	whenson@usgs.gov
85	Herr	Joel	Systech	joel@systechwater.com
86	Herrera	Stephanie	Department of Water Resources	stephanie.herrera@water.ca.gov
87	Hillaire	Todd	Department of Water Resources	todd.hillaire@water.ca.gov
88	Hoag	Lyle		
89	Hoang	Raymond	Department of Water Resources	Raymond.Hoang@water.ca.gov
90	Horvath	Mary	CH2M	Mary.Horvath@ch2m.com
91	Howitt	Richard	ERA Economics	richard@eraecon.com
92	Hsu	En-Ching	Department of Water Resources	En-Ching.Hsu@water.ca.gov
93	Huang	Guobiao	Department of Water Resources	Guobiao.Huang@water.ca.gov
94	Hubbard	Patrick	Aqueous Pathfinding	patrick@aqpath.net
95	Huber	Anne	ICF International	Ahuber@jsanet.com
96	Hughes	Brian	U.S. Bureau of Reclamation	bhughes@usbr.gov
97	Hui	Rui	UC Davis	rhui@ucdavis.edu
98	Hutton	Paul	Metropolitan Water District of Southern California	paul.hutton@tetrattech.com
99	Ibershoff	Justin	LimnoTech	jibershoff@limno.com
100	Isenberg	Phil		
101	Islam	Nazrul	Department of Water Resources	Nazrul.Islam@water.ca.gov
102	Jankowski	Jesse	UC Davis	jessejanko@yahoo.com
103	Jayasundara	Nimal	Department of Water Resources	Nimal.Jayasundara@water.ca.gov
104	Johannis	Mary	U.S. Geological Survey	mjohannis@usgs.gov
105	Juricich	Richard	Department of Water Resources	rich.juricich@water.ca.gov
106	Kadir	Tariq	Department of Water Resources	Tariq.Kadir@water.ca.gov
107	Kao	Kevin	Department of Water Resources	Kuo-Cheng.Kao@water.ca.gov
108	Khan	Abdul	Department of Water Resources	Abdul.Khan@water.ca.gov
109	Laird	Jeff	UC Davis	jtlaird@ucdavis.edu
110	Larsen	Melissa	West Consultants	mlarsen@westconsultants.com
111	Le	Kate	Department of Water Resources	Kate.Le@water.ca.gov
112	Leady	Zachary	U.S. Bureau of Reclamation	zlead@usbr.gov
113	Leaf	Rob	CH2M	Rob.Leaf@CH2M.com
114	Lee	Seung Oh	Hongik University	seungoh.lee@hongik.ac.kr
115	Lee	Sungho	Department of Water Resources	Sungho.Lee@water.ca.gov

No	Last	First	Organization	Email Address
116	Liang	Yiguo	Department of Water Resources	yiguo.liang@water.ca.gov
117	Ligare	Scott	State Water Resources Control Board	scott.ligare@waterboards.ca.gov
118	Liu	Chloe	State Water Resources Control Board	Chloe.Liu@waterboards.ca.gov
119	Liu	Siqing	Department of Water Resources	Siqing.Liu@water.ca.gov
120	Lu	James	U.S. Bureau of Reclamation	jlu@usbr.gov
121	Lui	Mei (Idy)	Department of Water Resources	Mei.Lui@water.ca.gov
122	Lund	Jay	UC Davis	jrlund@ucdavis.edu
123	Maendly	Romain	Department of Water Resources	romain.maendly@water.ca.gov
124	Malakpet	Chakradhar	CH2M	chakradhar.malakpet@ch2m.com
125	Maples	Stephen	UC Davis	srmap@ucdavis.edu
126	Massera	Paul	Department of Water Resources	paul.massera@water.ca.gov
127	Mead	Aaron	Exponent	amead@exponent.com
128	Medellin-Azuara	Josue	UC Davis	jmedellin@ucdavis.edu
129	Mehl	Steffen	CSU Chico	smehl@csuchico.edu
130	Meza	Michael	State Water Resources Control Board	mmeza@waterboards.ca.gov
131	Micko	Steve	CH2M	Steve.Micko@ch2m.com
132	Moran	Tara	Stanford University	tamoran@stanford.edu
133	Morel-Seytoux	Hubert	Hydroprose	hydroprose@sonic.net
134	Mueller-Solger	Anke	U.S. Geological Survey	amueller-solger@usgs.gov
135	Munévar	Armin	CH2M	armin.munevar@CH2M.com
136	Muralidharan	Daya	Department of Water Resources	daya.muralidharan@water.ca.gov
137	Nam	Kijin	Department of Water Resources	Kijin.Nam@water.ca.gov
138	Nichol	George	Distinguished Life Member	george.nichol@comcast.net
139	Niiya	Karen	State Water Resources Control Board	Karen.niiya@waterboards.ca.gov
140	Olson	Eric	Santa Clara Valley Water District	eolson@valleywater.org
141	Orang	Morteza	Department of Water Resources	Morteza.Orang@water.ca.gov
142	Parker	Nancy	U.S. Bureau of Reclamation	nparker@usbr.gov
143	Parvathinathan	Shankar	MBK Engineers	Shankar@mbkengineers.com
144	Pate	Thomas	Solano County Water Agency	tpate@scwa2.com
145	Paudel	Murari	Wood Rodgers	mpaudel@woodrodgers.com
146	Paul	George	Formation Environmental	gpaul@formationenv.com
147	Pingle	Nathan	David Ford Consulting Engineers	pingel@ford-consulting.com
148	Porta	Lisa	CH2M	lisa.porta@ch2m.com
149	Prakash	Om	West Consultants	oprakash@westconsultants.com
150	Prakash	Pavithra	UC Davis	pavi.iitm@gmail.com
151	Qian	Frank	RMC	fqian@woodardcurran.com
152	Quan	Chris	Department of Water Resources	Chris.Quan@water.ca.gov
153	Quinn	Nigel	Berkeley National Laboratory/Reclamation	nwquinn@lbl.gov
154	Rajsekhar	Deepthi	Department of Water Resources	Deepthi.Rajsekhar@water.ca.gov

No	Last	First	Organization	Email Address
155	Robinson	Paul	CH2M	paul.robinson@ch2m.com
156	Roos	Maury	Department of Water Resources	maury.roos@water.ca.gov
157	Sandoval Solis	Samuel	UC Davis	samsandoval@ucdavis.edu
158	Satkowski	Rich	State Water Resources Control Board	rich.satkowski@waterboards.ca.gov
159	Schmidt	Andria	Fish and Wildlife Service	andria_schmidt@fws.gov
160	Schmidt	Andria	U.S. Fish and Wildlife Service	andria_schmidt@fws.gov
161	Schwarz	Andrew	Department of Water Resources	Andrew.Schwarz@water.ca.gov
162	Seabrook	Kristi	U.S. Bureau of Reclamation	kseabrook@usbr.gov
163	Seneviratne	Sanjaya	Department of Water Resources	Sanjaya.Seneviratne@water.ca.gov
164	Shahcheraghi	Reza	Department of Water Resources	rezas@water.ca.gov
165	Shannon	Jim	U.S. Bureau of Reclamation	jshannon@usbr.gov
166	Sherrick	Robert	CSU Sacramento	robsherrick@gmail.com
167	Shu	Jon	Department of Water Resources	Qiang.Shu@water.ca.gov
168	Siclari	Alessia	UC Davis	asiclari@ucdavis.edu
169	Singh	Amninder	CSU Fresno	amnindersingh@mail.fresnostate.edu
170	Singh	Karandev	Department of Water Resources	Karandev.Singh@water.ca.gov
171	Slawewski	Tad	LimnoTech	tad@limno.com
172	Smith	Pete	U.S. Geological Survey (Retired)	pesmith07@comcast.net
173	Smith	Tara	Department of Water Resources	Tara.Smith@water.ca.gov
174	Springhorn	Steven	Department of Water Resources	Steven.Springhorn@water.ca.gov
175	Stegman	Toby	cbec ecoengineering	t.stegman@cbecoeng.com
176	Stygar	Shem	Department of Water Resources	shem.stygar@water.ca.gov
177	Sumer	Derya	CH2M	dsumer@ch2m.com
178	Surucu	Elif	UC Davis	esurucu@ucdavis.edu
179	Swift	Ted	Department of Water Resources	ted.swift@water.ca.gov
180	Tagavi	Ali	RMC Water & Environment	ataghavi@woodardcurran.com
181	Tanaka	Stacy	Watercourse Engineering	stacy.tanaka@watercourseinc.com
182	Tansey	Michael	U.S. Bureau of Reclamation	mtansey@usbr.gov
183	Taraky	Nur	Department of Water Resources	Nur.Taraky@water.ca.gov
184	Thayer	Reed	CH2M	reed.thayer@ch2m.com
185	Tomkovic	Lily	UC Davis	latomkovic@ucdavis.edu
186	Townsend	Peter	Formation Environmental	ptownsend@formationenv.com
187	Traum	Jon	U.S. Geological Survey	jtraum@usgs.gov
188	Tu	Ming-Yen	Department of Water Resources	Ming-Yen.Tu@water.ca.gov
189	Van Camp	Mark	State Water Resources Control Board	marc.vancamp@waterboards.ca.gov
190	Vdovichenko	Aleksander	Department of Water Resources	aleksander.vdovichenko@water.ca.gov
191	Wang	Chuching	MWD	cwang@mw2h2o.com
192	Wang	Jianzhong (Jay)	Department of Water Resources	Jianzhong.Wang@water.ca.gov
193	Wang	Jun	U.S. Bureau of Reclamation	junwang@usbr.gov
194	Wang	Xiaochun	Department of Water Resources	Xiaochun.Wang@water.ca.gov



<b>No</b>	<b>Last</b>	<b>First</b>	<b>Organization</b>	<b>Email Address</b>
195	Whipple	Alison	UC Davis	aawhipple@ucdavis.edu
196	Williams	Craig	Department of Water Resources	craig.williams@water.ca.gov
197	Williams	Diane	U.S. Bureau of Reclamation	marywilliams@usbr.gov
198	Wittler	Rod	U.S. Bureau of Reclamation	rwittler@usbr.gov
199	Wong	Andy	UC Davis	ajywong@ucdavis.edu
200	Wright	Kenneth	U.S. Bureau of Reclamation	kwright@usbr.gov
201	Xie	Hao	Department of Water Resources	Hao.Xie@water.ca.gov
202	Yamanaka	Dan	Department of Water Resources	Dan.Yamanaka@water.ca.gov
203	Yates	David	NCAR	yates@ucar.edu
204	Yin	Hongbing	Department of Water Resources	Hongbing.Yin@water.ca.gov
205	Yu	Min	Department of Water Resources	Min.Yu@water.ca.gov
206	Zhang	Zhonglong	LimnoTech	zhonglong.zhang@erdc.dren.mil
207	Zhong	Liheng	Department of Water Resources	Liheng.Zhong@water.ca.gov
208	Zimmer	Valerie	State Water Resources Control Board	valerie.zimmer@waterboards.ca.gov
209	Zimmerman	Julie	The Nature Conservancy	julie.zimmerman@tnc.org