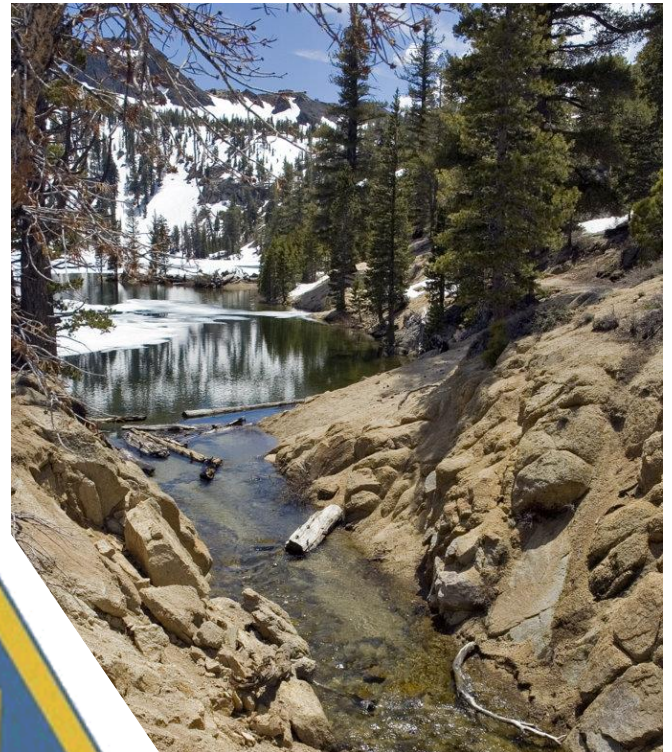


California Water and Environmental Modeling Forum

2015

ANNUAL MEETING PROGRAM

Charting the Future through Uncertain Pathways



SUMMARY OF SESSIONS

Monday, March 9

Time	Session	Moderator	Room
8:00 - 8:30	Registration		Sierra Hallway
8:30 - 10:15	1. One-Water Hydrologic Model	Randy Hanson	Sierra 1
	2. Flood Modeling	Samson Haile-Selassie	Folsom/Natoma
10:15 - 10:30	Break		
10:30 - 12:15	3. CalSim and WRIMS Development	Travis Yonts	Sierra 1
	4. Sustainable Groundwater Management	Rich Juricich & Steffen Mehl	Folsom/Natoma
12:15 - 12:45	Lunch		Restaurant
12:45 – 2:00	5. Awards	Marianne Guerin	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. 2014 DSM2 Development and Applications	Hari Rajbhandari	Sierra 1
	8. Sacramento and San Joaquin Basins Study – 2015 Update	Michael Tansey	Folsom/Natoma
5:30 - 8:00	9. Business Meeting and Social	Benjamin Bray	Sudwerk

ORGANIZATIONAL MEMBERS

California Department of Water Resources

California State Water Resources Control Board

Contra Costa Water District

East Bay Municipal Utility District

ICF International

Metropolitan Water District of Southern California

U.S. Bureau of Reclamation

Tuesday, March 10

Time	Session	Moderator	Room
7:30 - 8:00	Registration		Sierra Hallway
8:00 - 9:45	10. CalLite	Ali Abrishamchi	Sierra 1
	11. A Simulation Tool for the Bay-Delta Water Quality Control Plan	Eleanor Bartolomeo	Folsom/Natoma
9:45 - 10:00	Break		Sierra 2
10:00 - 11:45	12. Integrated Water Resources Models	Ali Taghavi	Sierra 1
	13. Historical Delta Modeling Project	Steve Andrews	Folsom/Natoma
11:45 - 12:15	Lunch		Restaurant
12:15 - 1:00	14. Keynote Speaker – John Doherty	Marianne Guerin	Sierra 1
1:00 – 2:45	15. Selected PEST Applications in California	Tariq Kadir & Jonathan Traum	Sierra 1
	16. Kaleidoscope of Modeling from Shasta, the Sacramento River, and the Delta	Jamie Anderson	Folsom/Natoma
2:45 – 3:00	Break		
3:00 - 4:45	17. A Deluge of Drought Modeling	Tara Smith & Josué Medellín-Azuara	Sierra 1
	18. Marriage of Data and Water Quality Model Output Visualization for Stakeholder Involvement and Real-time Decision Support	Nigel Quinn	Folsom/Natoma
4:45 - 6:45	19. Poster Session and Social*	Stacy Tanaka	Sierra 2
6:45 - 8:30	20. Informal Social at Q'bole		Q'bole

*Posters will be set up by 9:00 and available for viewing all day. Presenters will be available from 4:45 to 6:45 pm.

Wednesday, March 11

Time	Session	Moderator	Room
7:30 - 8:00	Registration		Sierra Hallway
8:00 - 9:45	21. California Water Rights Analyses and Modeling	Rich Satkowski	Sierra 1
	PEST 1. Model Calibration and Uncertainty Analysis: Concepts and Basic Theory	John Doherty	Folsom/Natoma
9:45 - 10:00	Break		
10:00 - 11:45	22. Modeling an Unstructured Environment: Recent Developments and Applications of Multi-Dimensional Bay-Delta Models	Kijin Nam	Sierra 1
	PEST 2. Some Implementation Challenges	John Doherty	Folsom/Natoma
11:45 - 1:15	Lunch at area restaurants		
11:45 - 1:15	23. Career Development Panel	Eleanor Bartolomeo	Sierra 1
1:15 - 3:00	24. California Water Plan Update 2013: Key Contents	Abdul Khan	Sierra 1
	PEST 3. Examples in California	John Doherty	Folsom/Natoma
3:00 - 3:15	Break		
3:15 - 5:00	25. Meet the Students and More	Josué Medellín-Azuara	Sierra 1
	PEST 4. Opportunities for New Improved Model-based Decision Support	John Doherty	Folsom/Natoma

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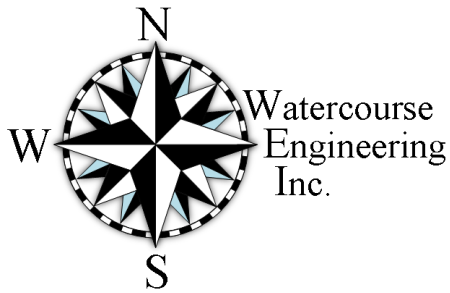
EVENING SOCIALS



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LUNCHES

POSTER SESSION



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 • www.cwemf.org

March 9th – 11th 2015

To the CWEMF members, friends, students, invited guests:

Welcome back to Folsom for the 2015 CWEMF Annual Meeting themed **Charting the Future through Uncertain Pathways**. You'll find the program for this year's annual meeting reflects a respectable balance of both new and familiar names and faces this year. I know our planning team has assembled a strong program because I would certainly like to attend all of the sessions this year!

Monday morning we've organized two groundwater-focused sessions while we also try to get your mind off the drought with a little flood modeling along with a welcome return of a familiar model, Calsim. We have scheduled a short lunch break Monday with our delightful awards program immediately following. A few more sessions follow before a relaxed business meeting and social at Sudwerk just across the river.

As dry conditions have persisted this past year, so, too, has the steering committee persisted in our pursuit of carrying out the CWEMF mission. A key effort to highlight after many many hours of dedicated effort is the CWEMF Strategic Plan, which we've also included in your meeting packet. This document formalizes CWEMF goals and objectives aligned with our mission statement and will inform an action plan for our steering committee in 2016 and beyond. I look forward to your input and support in finalizing—and hopefully adopting—this plan during our general membership business meeting. Please find a few minutes to review the plan before heading over to Sudwerk Monday evening.

On Tuesday, the mélange of familiar and new sessions continues with a wide array of topics as seen in your meeting packet. While reviewing your program, you may have also noticed CWEMF and IEP decided not to coordinate our meetings this year. CWEMF took this opportunity to revisit and build upon one of our popular workshops from 2014, *PEST Model-Independent Parameter Estimation & Uncertainty Analysis*. CWEMF has invited one of the workshop instructors, Dr. John Doherty, back to California to join us at this year's meeting. In addition to presenting our keynote Tuesday afternoon, Dr. Doherty will lead a condensed version of the PEST workshop addressing *Calibration, Uncertainty Analysis and Model-Based Decision Making* that runs concurrent with the technical sessions on Wednesday. We ask that you please be respectful and minimize interruptions while the workshop is in session.

Also on Wednesday, CWEMF is continuing something we started experimenting with last year to cater to our student and young professional membership demographic, the Career Development Panel. Our goal with this panel is to bring together experienced, professional members of our community with members just entering the field for a discussion of both the technical and interpersonal aspects of building a successful modeling career. All are encouraged to attend and participate in the discussion.

While reviewing your meeting packet, please take a few moments to note our sponsor page. When you see representatives of our sponsors during the meeting, please be sure to give them a sincere "thank you" for their support in helping us add value to our meeting while keeping registrations costs reasonably low.

In closing, as outgoing CWEMF Convener I wanted to thank you for your ongoing support of our exceptional organization. Serving in this leadership role has truly been an honor and I look forward to continuing my involvement for many years to come.

A handwritten signature in blue ink that reads "Ben Bray".

Benjamin Bray, CWEMF Convener 2013-2015

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AGENDA

Monday, March 9

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

Refreshments sponsored by LimnoTech.

8:30 – 10:15 a.m.

Session 1. One-Water Hydrologic Model

Moderator: Randy Hanson (USGS)

Location: Sierra 1

Analysis of Pajaro Valley Water Supply and Demand using MF-OWHM – Randy Hanson (USGS)

Simulation of Agricultural and Hydrologic Processes in the Modesto Region, California, using OWHM – Steve Phillips (USGS)

Evaluating Potential Seepage Projects along the San Joaquin River Using Multiple Scale Groundwater Models – Brian Heywood (CDM Smith)

Conjunctive Use of Water in the Central Valley as Simulated using the Central Valley Hydrologic Model – Claudia Faunt (USGS)

Session 2. Flood Modeling

Moderator: Samson Haile-Selassie (DWR)

Location: Folsom/Natoma

Flood System Optimization for the Central Valley – Jay Lund (UC Davis)

Effect of Hydrology Change on Computed Design Water Surface Elevations – Mike Archer (MBK Engineers)

Sutter Bypass Two-Dimensional Hydraulic Model Development and Application – Kyle Winslow (CH2M Hill)

Developing a 2D HEC-RAS Model of the Lower Sacramento River – William Fleenor (UC Davis)

Yolo Bypass Floodplain Analyses: Multi-Objective Modeling – Jeremy Thomas (CH2M Hill) and Mark Tompkins (NewFields)

10:30 a.m. – 12:15 p.m.

Session 3. CalSim and WRIMS Development

Moderator: Travis Yonts (Reclamation)

Location: Sierra 1

Modeling to Support CVP Cost Allocation: Flow Tracking and Multiple Regulatory Environments – Nancy Parker (Reclamation)

The New California Groundwater Sustainability Legislation from a CalSim Perspective – David O'Connor (Reclamation)

CalSim 3.0 and the San Joaquin River: Where is the Model Now? – Travis Yonts (Reclamation)

WRIMS 2 GUI/IDE Development – Hao Xie (DWR)

Session 4. Sustainable Groundwater Management

Moderators: Rich Juricich (DWR) and Steffen Mehl (Chico State University)

Location: Folsom/Natoma

The State's Role in Implementing the Sustainable Groundwater Management Act – Rich Juricich (DWR) and Erik Ekdahl (SWRCB)

Methods and Examples of Sustainability Analysis – Randy Hanson (USGS)

Using Groundwater Models for Successful Groundwater Sustainability Planning – Thomas Harter (UC Davis)

Habitat Considerations in Sustainable Groundwater Management – Daniel Wendell (The Nature Conservancy)

12:15 – 12:45 p.m.

Lunch

Pick up a box lunch (if you registered by Feb 28) and then join us for the CWEMF Awards Ceremony in Sierra 1.

Lunch sponsored by cbec eco-engineering and CWEMF.

12:45 – 2:00 p.m.

Session 5. CWEMF Awards Ceremony

Moderator: Marianne Guerin (CWEMF/RMA)

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. 2014 DSM2 Development and Applications

Moderator: Hari Rajbhandari (DWR)

Location: Sierra 1

Modifying Delta Channel Depletions to Improve DSM2 EC Modeling – Lan Liang (DWR)

Water Cost of Compliance: A Robust Decision Tool for Drought Alternatives – Eli Ateljevich (DWR)

Thousands of Releases: Characterizing Lagrangian Transport and Comparing to Eulerian Metrics – Deanna Sereno (CCWD)

DSM2 Particle Tracking Model Development and Collaboration – Xiaochun Wang (DWR)

3:30 – 5:15 p.m.

Session 8. Sacramento and San Joaquin Basins Study – 2015 Update

Moderator: Michael Tansey (Reclamation)

Location: Folsom/Natoma

Overview of the Sacramento and San Joaquin Basins Study – Michael Tansey (Reclamation)

Updates to Climate Change Scenarios and Impacts on Central Valley Water Supplies – Tapash Das (CH2M Hill)

Assessing the Impacts of Socioeconomic-Climate Scenarios on Central Valley System Risk and Reliability – Brian Van Lienden (CH2M Hill)

Development and Evaluation of Adaptation Actions to Address Central Valley Water Management Risks – Armin Munévar (CH2M Hill)

Next Steps in the Sacramento-San Joaquin Basins Study – Arlan Nickel (Reclamation)

5:30 – 8:00 p.m.

Session 9. Business Meeting and Social

Moderator: Benjamin Bray (CWEMF/EBMUD)

Location: Sudwerk Brewhouse Grille

We will ask the members to vote on the CWEMF Strategic Plan. The Strategic Plan is at the end of this program.

Social sponsored by ICF International, MBK Engineers, Resource Management Associates, and MWH.

Tuesday, March 10

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

Refreshments sponsored by MWH.

8:00 – 9:45 a.m.

Session 10. CalLite

Moderator: Ali Abrishamchi (DWR)

Location: Sierra 1

CalLite 3.00 Updates – Raymond Hoang (DWR)

Drought Impact Analysis on Storage, Salinity, and Flow Using Position Analysis – Ali Abrishamchi (DWR)

Decision Scaling with CalLite to Identify Climate Change Vulnerabilities to the State Water Project – Andrew Schwarz (DWR)

Interfacing CalLite with DHI's Integrated Modeling Platform – Steve Blake (DHI US Water Resources)

Session 11. A Simulation Tool for the Bay-Delta Water Quality Control Plan

Moderator: Eleanor Bartolomeo (SWRCB)

Location: Folsom/Natoma

The Bay-Delta Water Quality Control Plan: What is it, and How are we Modeling it? – Eleanor Bartolomeo (SWRCB)

SacWAM – The Best of Both Worlds – Charles Young (SEI)

SacWAM – A Climate Driven Model of Sacramento Valley Rim Watersheds with Layered Infrastructure and Operations – Charles Young (SEI)

SacWAM – Valley Floor Hydrology and a Nested Daily FAO 56 Crop Water Demand Model in a Monthly Simulation Model – Andy Draper (MWH)

SacWAM – Managing Water for Fish, Farms, Floods, and Faucets – Brian Joyce (SEI)

10:00 – 11:45 a.m.

Session 12. Integrated Water Resources Models

Moderator: Ali Taghavi (RMC)

Location: Sierra 1

Status Update on IWFMM Activities – Emin Can Dogrul (DWR)

Assessment of Surface Water – Groundwater Interactions in the Central Valley – Mesut Cayar (RMC)

Simulation of Groundwater and Surface Water Resources in the Santa Rosa Plain Watershed using GSFLOW – Linda Woolfenden (USGS)

Coping with the Hydrologic Complexity of Surface-Groundwater Interaction – Hubert Morel-Seytoux (Hydroprose)

Session 13. Historical Delta Modeling Project

Moderator: Steve Andrews (RMA)

Location: Folsom/Natoma

Unimpaired Flows vs. Natural Flows to the Sacramento-San Joaquin Delta: What's the Difference? – Tariq Kadir (DWR)

Historical Delta Elevation Model – Logic and Methods – Andy Bell (UC Davis)

3D Modeling Comparison of Salinity in the Historical and Contemporary Delta – Steve Andrews (RMA)

Ecological Implications of Modeled Hydrodynamic Changes in the Sacramento-San Joaquin Delta since 1800 AD – Sam Safran (SFEI)

11:45 a.m. – 12:15 p.m.

Lunch

Pick up a box lunch (if you registered by Feb 28) and then join us for the keynote speech by John Doherty in Sierra 1.

Lunch sponsored by HDR and Larry Walker Associates.

12:15 – 1:00 p.m.

Session 14. Keynote Speaker

Moderator: Marianne Guerin (CWEMF/RMA)

Location: Sierra 1

John Doherty (Watermark Numerical Computing)

1:00 – 2:45 p.m.

Session 15. Selected PEST Applications in California

Moderators: Tariq Kadir (DWR) and Jonathan Traum (USGS)

Location: Sierra 1

Calibrating the Soquel-Aptos PRMS Model to Streamflow Data Using PEST – Cameron Tana (Hydrometrics, Inc.)

Using PEST to Calibrate the G Model and Inverting it to Estimate Net Delta Outflow – Nicky Sandhu (DWR)

Using Pareto Optimization to Determine Model Predictive Uncertainty of Groundwater and Surface Water Interactions for the San Joaquin River – Jonathan Traum (USGS)

Comparing Cloud Computing Resources for Model Calibration with PEST – Charlie Brush (DWR)

Session 16. Kaleidoscope of Modeling from Shasta, the Sacramento River, and the Delta

Moderator: Jamie Anderson (DWR)

Location: Folsom/Natoma

Development of a Mercury Model for the Delta and Yolo Bypass – Carol DiGiorgio (DWR)

CE-QUAL-W2 Modeling of Head-of-Reservoir Conditions at Shasta Reservoir, California – Katherine Clancey (UN Reno)

Modeling Reservoir Operations to Address Extreme Climate Impacts on the Downstream Fishery at Shasta Lake – Laurel Saito (UN Reno)

Three-Dimensional Numerical Modeling of Periodicity and Spatial Variability in Secondary Circulation in the Tidal Sacramento River – Aaron Bever (Delta Modeling Associates)

3:00 – 4:45 p.m.

Session 17. A Deluge of Drought Modeling

Moderators: Tara Smith (DWR) and Josué Medellín-Azuara (UC Davis)

Location: Sierra 1

Economic Analysis of the 2014 California Drought on Agriculture. Post-Assessment and Prospects for 2015 – Josué Medellín-Azuara (UC Davis)

Hydrology Forecasting using SWAT Hydrologic Models for the 2014 California Drought – Guobiao Huang (DWR)

Delta Coordinated Operations Model – Tracy Pettit (DWR)

2014 Drought Forecast Modeling in 1-, 2-, and 3-D – John DeGeorge (RMA)

Session 18. Marriage of Data and Water Quality Model Output Visualization for Stakeholder Involvement and Real-time Decision Support

Moderator: Nigel Quinn (Berkeley National Laboratory/Reclamation)

Location: Folsom/Natoma

Advanced Real-time Decision Support and Visualization – Jesper Kjelds (DHI)

Integration of Real-time Data Management Systems and Runoff Models in Reservoir Operations – Timothy Lee (Kisters International Inc.)

Silver Creek Watershed – Dynamic Stream Temperature Modeling and Visualization – Stephen Blake (DHI)

Real-time Decision Support and Visualization for Salinity Management in the San Joaquin River – WARMF Online – Nigel Quinn (Berkeley National Laboratory/Reclamation), Amye Osti and Nathan Hemenway (34 North, Inc.)

4:45 – 6:45 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 CH2M Hill, RMC Water and Environment, and Tetra Tech.

Poster Session Titles

Impact of Aquifer Desaturation on River Seepage – Hubert Morel-Seytoux (Hydroprose)

Quasi-decadal Oscillation in the CMIP5 and CMIP3 Climate Model Simulations: California Case – Jay Wang (DWR)

Modeling the Establishment of Riparian Habitat Vegetation with Applications to Populus Fremonti on the Sacramento River, California – Michael Tansey (Reclamation)

Five Years of Change: The Hidden Story of the Sacramento River at Georgiana Slough – Shawn Mayr (DWR)

Color Your Delta – Shawn Mayr (DWR)

Using Measured Bottom X2 to Estimate Effective Delta Outflow and Electrical Conductivity during Water Year 2014 – Anne Huber (ICF)

Mapping Decadal Change of Rice Field Extent and Phenology in the Sacramento Valley using Landsat Imagery – Liheng Zhong (DWR)

Trailing Non-Aqueous Phase Liquids (NAPL) in the Groundwater: Modeling and Application – Pavithra Prakash (Indian Institute of Technology)

Predicting Effect of Reservoir Expansion with Three-Dimensional Modeling: Case Study of Los Vaqueros Reservoir – Gang Zhao (Flow Science)

Cloud Cover Variability and its Relation to Springtime Snowmelt and Runoff – Edwin Sumargo (UC San Diego)

Planning for Sustainable Management of Groundwater Resources – Ahmad Abrishamchi (Sharif University)

Real-time Forecasting of Salt Assimilative Capacity in the San Joaquin River – Reginald Dones (Reclamation)

2D Modeling of the Salinas River to Facilitate Consensus Based Flood Protection and Conservation –
Paul Frank (Newfields)

Climates Change. That’s What They Do – Om Prakash (WEST Consultants)

Flood Warning with HEC-RTS (Real Time Simulation) – Kayson Shurtz (WEST Consultants)

**Linking Operations, Watershed, and Water Quality Models to Support Third-Party Nutrient TMDL
Review and Revision for the Truckee River, Nevada –** John Wolfe (LimnoTech)

Coarse Resolution Planning Tools for Prioritizing Central Valley Improvement Act Fisheries Activities –
Rodney Wittler (Reclamation)

**Use of UAVs in the Design, Construction Observation, and Post-Project Monitoring of Rehabilitation
Projects –** Jesse Barker (cbec eco-engineering)

6:45 – 8:30 p.m.

Session 20. Informal Social at Q’bole

Join friends and colleagues for a no-host social at Q’bole. This will be a great opportunity to end a busy day relaxing and catching up with other Annual Meeting attendees.

Wednesday, March 11

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

8:00 – 9:45 a.m.

Session 21. California Water Rights Analyses and Modeling

Moderator: Rich Satkowski (SWRCB)

Location: Sierra 1

2014 Water Right Curtailment Analyses in the Sacramento-San Joaquin, Russian River, and Eel River Watersheds – Brian Coats (SWRCB)

Drought Water Rights Allocation Tool (DWRAT) - Ben Lord (UC Davis)

WRIMS-based Sacramento Valley Water Right Model – Liheng Zhong and Richard Chen (DWR)

PEST 1. Model Calibration and Uncertainty Analysis: Concepts and Basic Theory

Moderator: John Doherty (Watermark Numerical Computing)

Location: Folsom/Natoma

This session will cover where modelling fits into the decision making process and how PEST can support this. Basic inversion theory will be discussed (not too technical). The discussion will also address issues such as how expert knowledge is necessarily stochastic, how measurements of system state can reduce parameter and predictive uncertainty, what is the best way to achieve this using present technology, and where PEST fits into all of this.

- PEST: model independent inversion, a short history
- How is expert knowledge necessarily stochastic?
- How can measurements of the system state reduce parameter and predictive uncertainty?
- Bayes equation: Why calibrate? Why not just implement Bayes equation?
- Traditional parameter estimation and highly parameterized inversion
- Why is there so much non-uniqueness?
- Regularisation, and why it is needed
- Post-calibration uncertainty analysis
- Parameter contributions to predictive uncertainty
- Worth of different types of data in reducing uncertainty
- Ramifications of uncertainty for decision-making

10:00 – 11:45 a.m.

Session 22. Modeling an Unstructured Environment: Recent Developments and Applications of Multi-Dimensional Bay-Delta Models

Moderator: Kijin Nam (DWR)

Location: Sierra 1

Open Software, Open Source, Open Data, and Open Models: San Francisco Community Model Initiative – Edwin Elias (Deltares USA Inc.)

Sediment Transport Modeling in a San Francisco Bay Salt Marsh – Yun Zhang (Stanford University)

SCHISM Salinity Modeling 2013-2014 and Recent Developments – Eli Ateljevich (DWR)

Salinity, Waves, Sediment, and X2: Recent Applications Using the UnTRIM Bay-Delta Model – Michael MacWilliams (Delta Modeling Associates)

PEST 2. Some Implementation Challenges

Moderator: John Doherty (Watermark Numerical Computing)

Location: Folsom/Natoma

This session will look at some of the problems in implementing concepts covered in Session 1, ways to overcome some of these, and problems that still remain.

- Spatial parameterization
- Pilot points in groundwater model calibration
- Models as defective simulators of real-world behavior. Can their misbehavior be “calibrated out”?
- Formulation of an appropriate objective function
- The matter of observation weights
- Models behaving badly and what to do about it
- Surrogate models and proxy models
- Model-based hypothesis-testing
- Global optimizers

11:45 a.m. – 1:15 p.m.

Lunch at area restaurants

11:45 a.m. – 1:15 p.m.

Session 23. Career Development Panel

Moderator: Eleanor Bartolomeo

Location: Sierra 1

The Career Development Panel is designed for students and young professionals. A panel of successful modelers will talk about their careers and what skills they consider important in the workplace. Participants will be asked to prepare a brief bio summarizing their interests and career goals and will have an opportunity to discuss those goals with the panelists.

1:15 – 3:00 p.m.

Session 24. California Water Plan Update 2013: Key Contents

Moderator: Abdul Khan (DWR)

Location: Sierra 1

California Water Plan Update 2013: Investing in Innovation and Infrastructure – Paul Massera (DWR)

California Water Plan Update 2013 Water Portfolios, WYs 2001-2010 – Jennifer Kofoid (DWR)

California Water Plan Update 2013 Future Scenarios: Results and Analysis – Mohammad Rayej (DWR)

Enhanced Groundwater Contents for California Water Plan Update 2013 – Abdul Khan and Mark Nordberg (DWR)

PEST 3. Examples in California

Moderator: John Doherty (Watermark Numerical Computing)

Location: Folsom/Natoma

This session will look at three PEST applications in California.

Natural Recharge Estimation and Uncertainty Analysis of Antelope Valley Groundwater Basin – Tracy Nishikawa, Adam Siade, and Peter Martin (USGS)

Using PEST's GENLINPRED Utility for Uncertainty Analysis of Groundwater and Surface Water Interaction for the San Joaquin River – Jonathan Traum (USGS)

Using PEST to Calibrate the G-model and Inverting it to Estimate Net Delta Outflow – Nicky Sandhu (DWR)

Discussion

3:15 – 5:00 p.m.

Session 25. Meet the Students and More

Moderator: Josué Medellín-Azuara (UC Davis)

Location: Sierra 1

The HOBBS Project Update – Josué Medellín-Azuara (UC Davis)

California Water Management with Upgraded Hydropower and Reservoir Operations Representation with CALVIN – Mustafa Dogan (UC Davis)

Optimal Conjunctive Use of Surface Water and Groundwater Resources: A Tale of Two Cities in the Delta – Robert Gailey (UC Davis)

Optimal Flood Hedging Pre-releases for a Single Reservoir – Rui Hui (UC Davis)

Impact of Climate Change on Ecosystem Management in the Central Valley of California – Karandev Singh (UC Davis)

PEST 4. Opportunities for New Improved Model-based Decision Support

Moderator: John Doherty (Watermark Numerical Computing)

Location: Folsom/Natoma

Bringing it all together:

- Some opportunities for “PEST-type” approaches in CA, difficulties that may be encountered, and research/development opportunities arising from these difficulties
- Changing the culture; embracing uncertainty as an essential ingredient of the decision-making process
- Role of uncertainty analysis in resolving conflict
- How should model results be presented?
- How complex should models be? When to choose complexity and when to choose simplicity.
- When complexity can do more harm than good
- Should the same model be asked to answer all questions, or should models be issue-specific?

ABSTRACTS¹

Session 1. One-Water Hydrologic Model

Analysis of Pajaro Valley Water Supply and Demand using MF-OWHM – Randy Hanson (USGS)

Collaborator: Brian Lockwood (Pajaro Valley Water Management Agency)

Pajaro Valley is one of the most productive agricultural regions in the world. Increasing population, agricultural development, including shifts to more water-intensive crops, and climate variability are placing larger demands on available groundwater resources in the valley. Groundwater depletion and related seawater intrusion, especially during drought years, has resulted in decades of overdraft. Continued growth in demand required the Pajaro Valley Water Management Agency to build a 4,000 ac-ft/yr recycled water facility and managed aquifer recharge and recovery facility for supplemental irrigation supply for coastal ranches where groundwater is contaminated by seawater intrusion. These facilities have delivered over 25,500 acre-feet since 2002 and reduced seawater intrusion. While those facilities have helped, the problem persists. Thus, the Agency explored additional projects in a recent Basin Management Plan (BMP) Update (2014) to provide additional supplemental supply as a reliable and good quality alternative to coastal groundwater and pumping in excess of recharge.

Analysis of conjunctive use for historical conditions, and projections of existing and explored projects, was completed with an integrated hydrologic model that guided the evaluation of the adequacy and potential consequences of these alternative projects for the new BMP. Simulations indicate that while the current projects help reduce coastal pumping, they are not adequate to stop overdraft and seawater intrusion. This analysis has helped to develop a new BMP to further reduce groundwater pumpage and increase recharge throughout the valley to mitigate overdraft.

Simulation of Agricultural and Hydrologic Processes in the Modesto Region, California, using OWHM – Steve Phillips (USGS)

Collaborator: Jonathan Traum (USGS)

Strategies for managing groundwater in the Modesto region, California, are being formulated by the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA). To aid in evaluating management strategies, the USGS and STRGBA developed a hydrologic model that simulates monthly groundwater and surface-water flow from 1960–2004 using MODFLOW-OWHM. Private groundwater pumpage and recharge associated with irrigated agriculture were estimated using the Farm Process, which simulates landscape processes associated with various land uses. The distribution of hydraulic conductivity was constrained using data from about 3,500 drillers' logs. The model was calibrated to 4,061 measured groundwater levels in 109 wells and 2,739 mean monthly surface-water flows at 6 stream gages. Simulated groundwater levels have an absolute mean residual of 0.8 ft; 74 percent of simulated heads were within 10 ft of observed. Simulated streamflow was biased low, but reasonable; the absolute mean residual was 780 cubic feet per second (cfs), and 68 percent of simulated streamflows were within 500 cfs of observed. Simulated private agricultural pumpage averaged about 1,000,000 acre-ft/yr; deep percolation of precipitation and irrigation averaged about 1,360,000 acre-

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

ft/yr. Key limitations to estimating the water budget are uncertainty associated with irrigation deliveries and efficiencies, and no available data for private agricultural pumpage.

Evaluating Potential Seepage Projects along the San Joaquin River Using Multiple Scale Groundwater Models – Brian Heywood (CDM Smith)

Collaborators: William Fernandez and Anusha Kashyap (CDM Smith); Katrina Harrison (USBRR)

The San Joaquin River Restoration Program (SJRRP) is utilizing groundwater models of varying spatial and temporal resolutions to simulate regional and local surface water/groundwater interaction and to evaluate potential changes to groundwater levels under agricultural lands adjacent to the San Joaquin River and bypass system due to the increased and more frequent flows released by the SJRRP. The need for and effectiveness of seepage control measures (e.g., ditches, slurry walls, interceptor lines, and shallow pumping) to control groundwater levels are also being evaluated. The San Joaquin River Restoration Program groundwater model, based on the USGS's Central Valley Hydrologic Model, features a study area extending five miles from the river and bypass system, finer grid discretization, and more refined geologic representation. Local-scale models with finer grid spacing and reduced stress period lengths have been developed based on the structure of the SJRRPGW and are being used in the assessment of individual properties.

Conjunctive Use of Water in the Central Valley as Simulated using the Central Valley Hydrologic Model – Claudia Faunt (USGS)

Collaborators: Jonathan Traum, Michelle Sneed, and Randy Hanson (USGS)

California's Central Valley is one of the most productive agricultural regions in the world. However, recent drought conditions, land-use changes, and restrictions in surface-water flows have caused increased need for the conjunctive use of water. Increased demand for groundwater in the Central Valley has resulted in groundwater-level declines and associated land subsidence. Depending on local conditions, the declines and subsidence have occurred either only during droughts or during both drought and non-drought periods. Land subsidence has received increased attention during recent droughts, which have triggered high rates of groundwater withdrawal and historically high rates of land subsidence. The U.S. Geological Survey (USGS) developed the Central Valley hydrologic model (CVHM) to quantitatively assess aquifer-system responses to climatic variation, land-use changes, surface-water deliveries, artificial recharge, and groundwater pumping. Results from recent updates to the CVHM show the simulated spatial distribution, timing, and magnitudes of groundwater-level changes and land subsidence resulting from changes in these stresses. The updated CVHM provides an analysis of the spatial and temporal variability of changes in surface water and groundwater availability and subsidence. These results can be used to assist in making water management decisions necessary to achieve effective conjunctive use throughout the Central Valley.

Session 2. Flood Modeling

Flood System Optimization for the Central Valley – Jay Lund (UC Davis)

This talk summarizes two recent studies of the Sacramento Valley flood management system. 1) the results of an optimization modeling for flood operations, focusing on by-pass capacities in the system. This linear-programming based optimization found that the Yolo Bypass is probably the most important flood management bottle-neck in the system for large floods, and gives some insights into the interaction of flood infrastructure elements under optimized operations. 2) results of a multi-objective optimization of water and land management for the Yolo Bypass. This study shows potential for improving conditions for fish and birds with relatively little damage to agricultural production in the bypass and without substantially changing capacity for flood conveyance.

Effect of Hydrology Change on Computed Design Water Surface Elevations – Mike Archer (MBK Engineers)

The California Urban Levee Design Criteria specifies that the design water surface elevation for providing an “urban level of protection” is that produced by the flood that has a 1-in-200 chance of occurring in any given year (200-year flood). Generally, hydraulic routing models are used to compute the 200-year water surface with hydrologic input designed to represent a 200-year flood event at the location of interest. Until recently, the best available hydrologic data was that developed in 2002 for the Sacramento and San Joaquin River Basins Comprehensive Study (Comp Study). The State of California has recently undertaken the Central Valley Hydrologic Study (CVHS) with the purpose of developing a new hydrologic data set to replace the Comp Study data set. This presentation provides a case study of how the change in hydrology data can affect a computed design water surface elevation.

Sutter Bypass Two-Dimensional Hydraulic Model Development and Application – Kyle Winslow (CH2M Hill)

Collaborator: Sungho Lee (CVFPB)

On behalf of the Central Valley Flood Protection Board, CH2M HILL developed a 2D hydrodynamic model of the Sutter Bypass to investigate channel capacity under existing conditions and projected water levels under defined storm events such as the 100-year and 200-year events. The model was developed with a dense network of 47,000 grid cells representing the underlying surface with a unique elevation and 1 of 23 vegetative cover or land use conditions. Much of the land within the study reach has been retained as agricultural land but the Sutter Bypass National Wildlife Refuge occupies more than 2000 acres within the Bypass. The model was calibrated for the 2006 flood event with predicted water levels at 6 gauges matching observations with an error of 0.27 feet.

The calibrated model was used to investigate changes in peak flood elevations for potential management actions in the Bypass such as vegetation removal, sediment removal, land use alterations, and levee set-backs. Simulations were conducted to bound future water levels assuming either complete vegetation removal or continued growth of vegetation (no future maintenance activities). In general, results indicate that local management actions have a localized, minor effect on water level. The scale of vegetation removal necessary to impart significant changes in predicted water levels was on the order of several thousand acres.

Developing a 2D HEC-RAS Model of the Lower Sacramento River – William Fleenor (UC Davis)
Collaborators: Alessia Siclari and Lily Tomkovic (UC Davis)

Conservation measure 2 (CM2) of the Bay Delta Conservation Plan (BDCP) involves increasing flooding frequency on the Yolo Bypass and providing adequate fish passage. The approach to CM2 the formation of the Yolo Bypass Fisheries Enhancement Plan. The National Oceanographic and Atmospheric Administration (NOAA) Fisheries released a biological opinion (BO) requiring the U.S. Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) to restore salmon habitat on the lower Sacramento River Basin (possibly on the Yolo Bypass) and modify the Fremont Weir on the Yolo Bypass and other structures to provide passage of fish through the bypass. Yolo Bypass is a crucial agricultural portion of Yolo County and funded the Center for Watershed Sciences at UC Davis to create a public domain model of the lower Sacramento River to provide all stakeholders with a model to investigate proposed and alternate changes. The work presented is the development of the HEC-RAS model using 2D floodplains to represent the tidal and potentially flooded areas of the lower Sacramento River. Presentation will include boundary condition, roughness approaches, digital elevation model development, sub-grid bathymetry advantages, solution schemes, grid convergence, calibration and validation, and uncertainty metrics of the HEC-RAS 2D lower Sacramento River model.

Yolo Bypass Floodplain Analyses: Multi-Objective Modeling – Jeremy Thomas (CH2M Hill) and Mark Tompkins (Newfields)
Collaborator: Rummy Shivcharan (DWR)

As part of the Central Valley Flood Protection Plan (CVFPP) formulation, our team performed a screening level analysis of expected annual habitat (EAH) in the Yolo Bypass associated with different flood management configurations, including modifications to the Fremont Weir and levee setbacks. EAH is used to quantify the potential benefits of floodplain rearing habitat for native fish species by linking the spatial and temporal characteristics of floodplains to define the functional habitat they create. EAH generates area-duration-frequency (ADF) curves to quantify the area of floodplain inundated for a specified duration, timing, and frequency and can thus be useful in determining the suitability of a floodplain as habitat for fish, wildlife, or ecosystem processes. We coordinated with the DWR and US Bureau of Reclamation Biological Opinion (BiOps) teams for the Yolo Bypass to develop consistent daily hydrology with the addition of a notch on Fremont weir and implemented EAH using Python scripts to generate two types of modeling output. First, general flow-inundation area output including ADF curves, and then more refined inundation areas for specific timing, duration, and frequency requirements of target species. The modeling output will be used to inform the development of ecosystem restoration concepts in the Yolo Bypass and the formulation of multi-benefit projects for the 2017 CVFPP.

Session 3. CalSim and WRIMS Development

Modeling to Support CVP Cost Allocation: Flow Tracking and Multiple Regulatory Environments – Nancy Parker (Reclamation)

The Bureau of Reclamation is conducting analysis to support a new cost allocation for the Central Valley Project, which will apportion project costs among the project's seven Congressionally-authorized purposes (water supply, power, flood control, fish and wildlife, recreation, navigation, and water quality). New and revisited CalSim and WRIMS applications have been developed to support this

analysis, including a suite of models depicting past regulatory environments, a flow-tracking module and a single purpose facility sizing tool. Although the final results of the Cost Allocation Study analysis are not yet available, details on the development of the CalSim studies and WRIMS applications can be shared with the broader modeling community.

The New California Groundwater Sustainability Legislation from a CalSim Perspective – David O’Connor (Reclamation)

The passage of the Sustainable Groundwater Management Act (SGMA) imposes a new regulatory landscape for groundwater use. Water supply reliability modeling for the CVP/SWP systems will soon need to account for groundwater extraction limits in greater detail. The presentation will summarize some commonly used models that simulate groundwater pumping and surface water-groundwater interaction in the Central Valley (C2VSIM, CVHM, CalSim) and will discuss plans and challenges in updating CalSim 3.0 to incorporate new groundwater extraction limits. The presentation will also show some preliminary results of groundwater pumping and surface water interaction simulated by CalSim 3.0 for the San Joaquin Basin.

CalSim 3.0 and the San Joaquin River: Where is the Model Now? – Travis Yonts (Reclamation)

Recent work has been completed to update the San Joaquin River CalSim 3.0 model representation. This work has involved the collection and comparison of CalSim 3.0 output to observed data and CalSim II output. Ultimately, these comparisons assist with the determination of the CalSim 3.0 loss factors, as well as understanding and describing differences between CalSim II and CalSim 3.0 results. This presentation will summarize how each model (CalSim II and CalSim 3.0) simulates demand units, provide an example of the abovementioned comparison analysis, and discuss how the analysis is being utilized to assist with CalSim 3.0 San Joaquin River model development.

WRIMS 2 GUI/IDE Development – Hao Xie (DWR)

The new WRIMS 2 Graphic User Interface (GUI) consists of an Integrated Development Environment (IDE), which provides comprehensive facilities, such as a Run Time Debugger, a Code Editor, and a Model Launcher, to modelers for programming CalSim/CalLite applications in Water Resources Simulation Language (WRESL). Four perspectives: WRIMS IDE, DSS Operator, Schematic Viewer, and Schematic Editor, are integrated and presented in WRIMS 2 GUI/IDE. Position Analysis Runner, Multi-Study Runner, and Batch Runner, etc, have been developed to facilitate complicated CalSim/CalLite applications. Collaborations between WRIMS 2 and other Water Resources Modeling software packages are being conducted.

Session 4. Sustainable Groundwater Management

The State’s Role in Implementing the Sustainable Groundwater Management Act – Rich Juricich (DWR) and Erik Ekdahl (SWRCB)

On September 16, 2014, California Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act. The Governor’s signing message states "a central feature of

these bills is the recognition that groundwater management in California is best accomplished locally." This new legislation defines sustainable groundwater management as the "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results." This presentation will highlight the implementation roles of the Department of Water Resources and the State Water Resources Control Board for this new legislation.

Methods and Examples of Sustainability Analysis – Randy Hanson (USGS)

Collaborator: Scott Boyce (USGS)

An analysis of the sustainability of water resources starts with a physically-based approach to simulating supply and demand components of the hydrosphere. Additional factors may constrain the conceptual framework of sustainability of water resources, including climate, the biosphere, urban and agricultural supply and demand, limits to secondary effects of overexploitation, imports and exports of water, and the level of mitigation of historical conditions. These factors contribute to the dynamic framework necessary for water-resource management, and may also affect water and food security within a watershed. Using a physically-based, demand-driven and supply-constrained integrated hydrologic model, such as MODFLOW-OWHM (One Water Hydrologic Model), provides a basis for this analysis and a tool for exploration of the effects of changing supply and demand on sustainability. Examples from the Pajaro, Cuyama, and Rio Grande Valleys will be used to demonstrate the utility of this approach to sustainability analysis. Applying the quantitative approach shown in these examples demonstrate how temporal and process-based information yields the more holistic analysis that is necessary for understanding sustainability under changing conditions. This integrated hydrologic model embodies the dynamic framework needed for future sustainability analysis and creates an impartial pathway for mediation.

Using Groundwater Models for Successful Groundwater Sustainability Planning – Thomas Harter (UC Davis)

Groundwater models for basin management first and foremost represent a physically consistent conceptual framework of a basin groundwater flow system that reflects a) the scientifically accepted physics of groundwater flow; b) the known (however limited or simplified) geologic understanding of the hydrogeological structure of a groundwater basin; c) an expert system of the known or hypothesized water fluxes into and out of the groundwater basin; d) an optimized (fine-tuned) approximation of the real system that also honors measured data about groundwater flow, groundwater levels, and other components of the groundwater system subject to the constraints imposed by a)-c). As part of groundwater management planning and implementation, a groundwater model represents aggregated "expert opinion" that may serve multiple purposes. The presentation will discuss the overall framework within which such modeling occurs, the strengths and potential pitfalls of current approaches.

Habitat Considerations in Sustainable Groundwater Management – Daniel Wendell (The Nature Conservancy)

Since Theis' seminal 1940 paper, *"The Source of Water Derived from Wells, Essential Factors Controlling the Response of an Aquifer to Development,"* we have known that there are only two sources of sustainable water supply for a pumped well: 1) induced infiltration; and 2) decreased discharge to surface water systems. In California's arid landscapes the second factor is, by far, dominant. Accordingly, *groundwater pumping is only sustainable to the degree we are willing to accept like amounts of stream*

depletion and associated impacts to surface water rights and the environment. Identification of a sustainable yield must, therefore, explicitly acknowledge these tradeoffs and be arrived at through an open, stakeholder-driven process. This process not only needs to account for economic benefits of land cultivation and development, but also economic and cultural benefits of in-stream flows, maintenance of important riparian habitat in select streams, and protection of existing surface water rights. Strategies to maximize sustainable yield revolve around deliberately increasing recharge, proactively managing the timing and location of pumping and, as needed to meet stakeholder goals, limiting the total amount of groundwater pumping from the basin.

Session 7. 2014 DSM2 Development and Applications

Modifying Delta Channel Depletions to Improve DSM2 EC Modeling – Lan Liang (DWR)

This presentation covers the work done to incorporate groundwater into the total consumptive use of Delta islands and to show how the new estimates of consumptive use and net channel depletions affect DSM2 EC modeling. DICU and DETAW are Delta consumptive use (CU) models. Their output is used as input by DSM2 to represent water diverted from and drained back to channels due to agricultural practices in the Delta. The models use evapotranspiration calculations based on crop type to determine the amount of applied water. When using either model, DSM2 overestimates EC in the summers of most drought years. In drought conditions, when net delta outflow is less, small changes in the estimate of net delta outflow can result in large differences in salinity transport within the Delta. Better estimates of net channel depletions have been targeted as a possible reason for the differences between DSM2 model results and observed data. By incorporating groundwater into the consumptive use estimates, DSM2 models better salinity transport in Drought years without negatively impacting salinity transport results in other year types.

Water Cost of Compliance: A Robust Decision Tool for Drought Alternatives – Eli Ateljevich (DWR)

When water supply is critically low, sensitivities and uncertainties emerge that stress models beyond the norm in operational planning. Agricultural water use is a dominant and uncertain component of outflow and the salinity field is positioned precariously close to the north-south passageway into the Central Delta. This talk juxtaposes two approaches to modeling under these circumstances. In the first, hydrology scenarios are fixed a priori and used to generate salinity results under two scenarios (e.g. with and without emergency barriers). In the second, salinity compliance is assumed and an inverse problem is solved to generate the water cost and schedule discretionary flow for each alternative. The approaches create very different impressions about the scenarios under investigation.

Thousands of Releases: Characterizing Lagrangian Transport and Comparing to Eulerian Metrics – Deanna Sereno (CCWD)

Abstract not available.

DSM2 Particle Tracking Model Development and Collaboration – Xiaochun Wang (DWR)
Collaborators: Doug Jackson (NOAA) and Russell Perry (USGS)

In order to evaluate possible impacts of project operations and new construction on fish migration and survival through the Delta, NMFS and DWR have been developing fish behavior particle tracking models with USGS providing expertise on developing methodologies for calibration and fish behavior sub-models. Although the scope of the development differs between NMFS and DWR, it is agreed that the two agencies will merge the development efforts and produce a single set of behavior sub-models for Chinook smolts. Three behavior sub-models (swimming, survival, and route selection) are under development. The parameters of these behavior sub-models are calibrated using acoustic telemetry tag data and optimization techniques. This presentation will provide an overview of the project background, the modeling methodologies, the current status of the development, and the collaboration plan between NMFS and DWR.

Session 8. Sacramento and San Joaquin Basins Study – 2015 Update

Overview of the Sacramento and San Joaquin Basins Study – Michael Tansey (Reclamation)

An overview of the Sacramento and San Joaquin Basins Study will be presented including a discussion of Reclamation's climate change program and recent activities in the Mid Pacific Region. The presentation will also include background information on the methods and models used in the study.

Updates to Climate Change Scenarios and Impacts on Central Valley Water Supplies – Tapash Das (CH2M Hill)

Collaborators: Armin Munévar and Brian Van Lienden (CH2M Hill); Charles Young and Michael Tansey (Reclamation)

The amount of water available throughout the Sacramento and San Joaquin basins over the twenty-first century are highly uncertain and dependent upon several factors, including the potential impacts of future climate variability. Phase 1 of the Basins Study has been completed using a suite of climate scenarios to reflect a range of future conditions. The climate scenarios used in the Phase I relied on Coupled Model Intercomparison Project, Phase 3 (CMIP3). Currently newer climate projections available from CMIP5 climate model simulations are consistent with the most recent Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR5). The climate scenarios for Phase 2 are being updated based on CMIP5 climate model simulations to perform assessments of current and future water supplies in the Central Valley. The water supply assessment characterizes and quantifies the probable magnitude and variability of historical and future natural flows in the basins to evaluate the potential effects of future climate variability and climate change and to estimate quantified projections of future hydrology.

Assessing the Impacts of Socioeconomic-Climate Scenarios on Central Valley System Risk and Reliability – Brian Van Lienden (CH2M Hill)

Collaborators: Heidi Chou and Armin Munévar (CH2M Hill)

A system risk and reliability assessment is being performed on water dependent resources in California's Central Valley through a broad scenario planning approach combined with integrated systems analysis. To account for a range of uncertainty in future conditions through 2100, a suite of scenarios reflecting a

combination of socioeconomic-climate futures has been developed. The performance of the Central Valley water system is being evaluated for water delivery, water quality, recreation, flood control, hydroelectric power, and ecological resource areas using an integrated model package that simulates CVP, SWP and local system operations and regulatory requirements using the CVP IRP CalLite Model and other performance assessment tools. Performance metrics for each resource area have been developed to articulate existing and future system vulnerabilities under the range of potential future conditions. The results from the suite of models will be used to guide the development of water management actions to address system risks.

Development and Evaluation of Adaptation Actions to Address Central Valley Water Management Risks – Armin Munévar (CH2M Hill)

Collaborators: Arlan Nickel (Reclamation) and Brain Van Lienden (CH2M Hill)

The Sacramento-San Joaquin Basins Study seeks to explore a range of water management actions that can help reduce or manage future risks posed by potential changes in climate and socioeconomic conditions. The Basins Study will include a range of water management actions including demand management, supply augmentation, reuse, desalination, watershed management, storage and conveyance, and adaptive system operations. Each of these measures has the potential to create a more resilient water management system to respond to future changes and threats. In addition, exploration of combinations of such actions, or portfolios, may suggest robust sets of actions or pathways to manage risk while achieving differing levels of economic, environmental, and social benefits. This presentation will outline the approach and initial results for the development and evaluation of adaptation actions in the Basins Study.

Next Steps in the Sacramento-San Joaquin Basins Study – Arlan Nickel (Reclamation)

The status of tasks and schedule of completion for the Sacramento and San Joaquin Basins Study will be presented.

Session 10. CalLite

CalLite 3.00 Updates – Raymond Hoang (DWR)

Collaborators: Nazrul Islam, Erik Reyes, Francis Chung, Richard Chen, Hao Xie, Kevin Kao, and Ali Abrishamchi (DWR); Nancy Parker, Tom FitzHugh, and Travis Yonts (Reclamation); Dan Easton (MBK Engineers); Tad Slawewski (LimnoTech); Holly Canada (David Ford Consulting)

The California Department of Water Resources and the U.S. Bureau of Reclamation Mid-Pacific Region have developed CalLite as an interactive screening model for evaluating various Central Valley water management alternatives. CalLite simulates the hydrology of the Central Valley, reservoir operations, delivery allocation decisions, delta salinity, and habitat-ecosystem flow indices over an 82 year planning period. The model achieves this with a short run time (<10 minutes) and maintains the hydrologic and operational integrity of its parent model, CalSim.

CalLite 3.00 is the latest version of the model and was released to the public in November 2014. Major updates from CalLite 2.01 include: (1) utilization of the latest WRIMS 2 engine, (2) expanded simulation capabilities for exploring water management alternatives, climate change and regulatory options, (3)

improved allocation methods, (4) dynamic San Joaquin River simulation and (5) an updated graphical user interface (GUI). The updated GUI includes new post-processing tools and batch run capability to further assist in the screening of a broad range of water management options in California.

Drought Impact Analysis on Storage, Salinity, and Flow Using Position Analysis – Ali Abrishamchi (DWR)

Collaborators: Nazrul Islam, Raymond Hoang, and Erik Reyes (DWR)

CalLite, an interactive screening model to evaluate Central Valley water management alternatives, is used to examine the impact of the potential future drought sequences. CalLite model uses the existing conditions with Biological Opinions (BO) in a position analysis. Position analysis is a simulation method in which varying hydrologic input sequences are run from a fixed starting condition. CalLite simulations were performed for historical critical water years of 1924, 1929, 1931, 1933, 1934, 1976, 1977, 1988, 1990, 1991, 1992, and 1994. Forecasted end-of-September 2014 storage and X2 Positions were used as initial conditions when running the model for the abovementioned critical water years and BO Reasonable and Prudent Alternative (RPA) base simulation data for drought years was used as initial conditions for all other variables. The impact of the drought on storage, salinity, and flow was analyzed by using the Position Analysis technique.

Decision Scaling with CalLite to Identify Climate Change Vulnerabilities to the State Water Project – Andrew Schwarz (DWR)

Collaborators: Matt Correa (DWR); Patrick Ray and Sungwook Wi (University of Massachusetts-Amherst)

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).

In this study, the CalLite inputs have been systematically reconfigured so that new hydrologies (beyond what has previously been explored) can be analyzed by the model. All input time series are synthetically generated to be consistent with the hydrologic and climatological inputs. After identifying specific areas of vulnerability the same analysis process will be used to explore potential adaptation strategies that reduce identified vulnerabilities.

Interfacing CalLite with DHI’s Integrated Modeling Platform – Steve Blake (DHI US Water Resources)

Collaborators: Arnold Engelmann, Jesper Overgaard, Sunny Mittal (DHI US Water Resources)

DHI develops and uses technology for decision support and water resources information management around the world. This presentation will demonstrate the application of a model and information management platform to expand and extend the capabilities of DWR’s CalLite v.3 towards enhanced spatial and temporal scales and included processes. These capabilities can be used to localize specific studies, verify inputs and build connections to real time observations and forecasts, and represent phenomena of importance to decision makers and stakeholders in California’s water environments.

Using DHI's Platform for real-time data management and visualization, we will demonstrate an application connecting and extending CalLite for information management, modeling and decision support using a specifically tailored, extensible interface. Steps to implement database connectivity, model interoperability and results presentation will be reviewed.

Using this approach and the ECOLab interface, DHI's open equation editor and solver, a typical WQ process can be described, modeled and displayed to build consensus on model formulation and parameterization. This development will extend CalLite's inherent capabilities to provide scenario development, situational context and boundaries. The approach can be used to implement solutions for in-stream temperature modeling, salinity modeling, or simulation of fish behaviors and management impacts to select species.

Session 11. A Simulation Tool for the Bay-Delta Water Quality Control Plan

The Bay-Delta Water Quality Control Plan: What is it, and How are we Modeling it? – Eleanor Bartolomeo (SWRCB)

The current Bay-Delta Water Quality Control Plan, more commonly known as D-1641, sets instream flow requirements, salinity limits, and export restrictions for the Sacramento – San Joaquin River Delta and its tributaries. The State Water Resources Control Board (Board) is in the process of revising these standards to protect beneficial uses in the Bay-Delta watershed, including fish and wildlife, agricultural, and municipal and industrial uses. To evaluate the water supply impacts of alternative levels of beneficial protection, the Board is developing a combined hydrology / system operations model of the Sacramento River Basin called the Sacramento Valley Water Allocation Model (SacWAM). The goal is to develop a flexible, user friendly model that allows for efficient analysis of multiple scenarios. This talk presents an overview of the Bay-Delta Water Quality Control planning process as well as the goals and motivation in the development of SacWAM.

SacWAM – The Best of Both Worlds – Charles Young (SEI)

The State Water Resources Control Board, Stockholm Environment Institute, and MWH have developed the Sacramento Valley Water Allocation Model (SacWAM) to support water allocation analyses for the Board's Bay-Delta Water Quality Control Plan. The model, developed in the WEAP software, draws features from both the Central Valley Planning Area (CVPA) model used in the Water Plan and CalSim. The upper watersheds of the Sacramento Hydrologic Region are represented using a refined hydrology representation based on the CVPA model. The valley floor demands are simulated at a spatial scale similar to that found in the CalSim model. In this presentation the approach taken in the development of the model will be discussed.

SacWAM – A Climate Driven Model of Sacramento Valley Rim Watersheds with Layered Infrastructure and Operations – Charles Young (SEI)

The representation of the Sacramento Valley Rim watersheds in the Sacramento Valley Water Allocation Model (SacWAM) is based on a refined version of the Central Valley Planning Area model developed for the State Water Plan. The refinements include representation of storage reservoirs and inter-basin

transfers. In this presentation the approach taken in developing the upper watershed hydrology, infrastructure, and operations will be discussed. Model performance will also be presented.

SacWAM – Valley Floor Hydrology and a Nested Daily FAO 56 Crop Water Demand Model in a Monthly Simulation Model – Andy Draper (MWH)

Irrigated agriculture in the Sacramento Valley covers approximately 2 million acres and consumes about 5 million acre-feet of water each year. Accurate representation of crop water use is a critical part of modeling the water resources of this region. The WEAP software allows the model user to directly simulate agricultural water demands based on land use, soil, and agronomic inputs. The direct embedding of a crop water model within a river-reservoir simulation model facilitates model calibration and provides greater flexibility in modeling different land-use and climate scenarios. The “MABIA” module of the WEAP software is a daily accounting of soil moisture in the root zone through simulation of crop transpiration, soil evaporation, and irrigation scheduling. MABIA uses the standard dual-crop coefficient method established by Richard Allen et al. (1998) in FAO Irrigation and Drainage Paper No. 56. The dual-crop approach better represents ET in the non-growing season and during the initial stages of plant growth. The MABIA module also offers various options for simulating the timing of irrigation events. Routines have been added for rice cultivation, including daily schedules of flood-up, maintenance, and drawdown. Effective precipitation is estimated using the Soil Conservation Service (SCS) Curve Number method.

SacWAM – Managing Water for Fish, Farms, Floods, and Faucets – Brian Joyce (SEI)

The Sacramento Valley Water Allocation Model (SacWAM) has been developed to account for the competing demands for water that exist in the Sacramento Valley and the Delta. Operations rules have been developed to account for flow requirements for fishery protection, water allocation for agricultural users, flood control, Delta water quality, and urban water demands. In this presentation a summary of the operations rules included in the model will be discussed as well as a presentation of model performance.

Session 12. Integrated Water Resources Models

Status Update on IWFM Activities – Emin Can Dogrul (DWR)

The IWFM numerical engine undergoes constant improvements to allow the users address complex questions in an efficient way. In the past year, new simulation features such as stream flow routing using kinematic wave approach and root water uptake from groundwater have been implemented, and used in modeling studies. A new version of IWFM, IWFM-2015, was made available to the public last year. IWFM-2015 is based on a new modeling framework that is fully modular and extensible, and is designed to improve linkage to other water resources planning tools such as CalSim, Statewide Agricultural Model (SWAP) and groundwater transport models. IWFM pre- and post-processor tools are also going through enhancements to improve user experience and workflow efficiency. Recently, a new mixed triangular-quadrilateral mesh generator was developed and integrated into the ArcGIS platform. This presentation will give a detailed explanation of the IWFM improvements and activities with examples from several modeling studies.

Assessment of Surface Water – Groundwater Interactions in the Central Valley – Mesut Cayar (RMC)
Collaborators: Ali Taghavi and Jim Blanke (RMC); Dan Wendell and Maurice Hall (The Nature Conservancy)

The California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) is a leading Central Valley-wide integrated hydrologic model adopted by California DWR and many other regional and state-wide agencies, as well as non-governmental organizations (NGOs) to evaluate various water management scenarios throughout the Valley. In an effort to evaluate and quantify the interaction between the groundwater and surface water system, C2VSim was employed. Three potential future management scenarios were developed and simulated: (i) Groundwater Substitution Scenario; (ii) Increased Agricultural Water Demand Scenario, (iii) Increased Irrigation Efficiency Scenario.

The results of this study contribute significantly to the understanding of how management of groundwater and surface water are interrelated and will inform the development of more effective integrated water management in the Central Valley and throughout California.

Simulation of Groundwater and Surface Water Resources in the Santa Rosa Plain Watershed using GSFLOW – Linda Woolfenden (USGS)

Collaborators: Joseph Hevesi and Tracy Nishikawa (USGS)

Water managers in the Santa Rosa Plain (SRP) face the challenge of meeting increasing water demand with a combination of surface water (which has uncertainties in future availability), local groundwater resources, ongoing and expanding recycled water, and water from other conservation programs. To better understand and to help manage the hydrologic resources in the SRP watershed, GSFLOW (a coupled groundwater and surface-water model) was developed. The GSFLOW model was used to analyze selected components of water budgets and to determine the effects of specified pumping and future-climate on the hydrologic system. Selected results indicated that despite the variation in streamflow discharge from the SRP watershed, the relative average contributions of surface runoff and interflow to streamflow were similar for most years. Pumping resulted in an average reduction of streamflow of about 8 percent. This quantity contributed 53 percent of the total groundwater pumped in the SRP watershed. Increased recharge during wet years was insufficient for groundwater storage to recover from increased pumping and reduced recharge during dry periods, resulting in an overall decline in groundwater storage. In the future-climate scenarios, water levels generally declined from historical conditions, resulting in reduced baseflows, increased losing-stream reaches, and reduced riparian evapotranspiration.

Coping with the Hydrologic Complexity of Surface-Groundwater Interaction – Hubert Morel-Seytoux (Hydroprose)

Flow exchange between surface and ground water is of great importance for beneficial allocation and use of the water resources or for the proper exercise of water rights in large-scale regional studies. That exchange can take place under a saturated or unsaturated flow regime. Which regimes occur depend on conditions right in the interactive area (e.g. case of irrigation) or in its near vicinity (seepage from a river). In large-scale regional studies to simulate the complex hydrological processes it is necessary, for practical reasons, to simplify them. The difficulty is to do so without affecting greatly the accuracy of the results. This presentation suggests a few methods to identify which processes are actually taking place and to describe them in an efficient and accurate way. It also shows that Numerical (i.e. Finite differences or elements) Integrated Hydrologic Models currently in use can lead to significant errors if

grid sizes are too coarse. Much of the discussion has to do with a condition of steady-state. It is meant as a first step toward a simple, yet accurate and physically based treatment of the transient situations.

Session 13. Historical Delta Modeling Project

Unimpaired Flows vs. Natural Flows to the Sacramento-San Joaquin Delta: What's the Difference? –

Tariq Kadir (DWR)

Collaborator: Guobiao Huang (DWR)

CA DWR is in process of finalizing estimates of daily natural flows in the Sacramento – San Joaquin Valley for WY 1922-2013. In the California water community, the terms “unimpaired flows” and “natural flows” have often been used interchangeably to reflect stream flows prior to agricultural and urban land use development. However, the two physical processes are quite different and, depending how they are interpreted and used, may lead to erroneous conclusions on availability of water supply in the Central Valley. This presentation will summarize the key differences between the two concepts and also compare results between natural flows and unimpaired flows (as estimated by CA DWR) into the Sacramento–San Joaquin Delta.

Historical Delta Elevation Model – Logic and Methods – Andy Bell (UC Davis)

Collaborator: William Fleenor (UC Davis)

Since the mid-19th century, the landscape of the Sacramento–San Joaquin River Delta has been heavily altered through human modifications. Artificial levees for flood control, debris from hydraulic mining, deepwater shipping channels, and water exports have all fundamentally altered the form and function of the Delta. To characterize the hydrodynamics of the Delta under natural conditions (prior to modifications of the Delta's geometry and hydrology), a bathymetric-topographic digital elevation model (DEM) was created to represent the Delta circa the early 1800s. Primary inputs to the elevation model include 2D historical Delta channels and land cover data from previous historical ecology mapping efforts (Whipple et al. 2012), along with data from historical sources, including the US Coast Survey hydrographic sheets and early rivers surveys. Novel techniques were developed to work with historical data, including methods to interpolate between sparse historical soundings, infer the depths of non-navigable channels from channel width, and convert historical tidal datums to modern fixed datums. The resulting 2-meter resolution digital elevation model covers the Delta's historical channels, tidal and non-tidal wetlands, ponds, and natural levees (800,000 acres total).

3D Modeling Comparison of Salinity in the Historical and Contemporary Delta – Steve Andrews (RMA)

Collaborators: Ed Gross and John DeGeorge (RMA)

Many changes have taken place in the Delta between the early 1800s and today, including channel deepening and straightening, levee construction, marsh removal, and inflow alterations in magnitude and timing, among others. In order to examine how these changes affected characteristics of the low salinity zone, we constructed and calibrated three-dimensional models of the Delta as it was in the early 1800s (the “natural” condition) and its current condition. Inflow boundary conditions, developed using the C2VSim model, and early 1800s bathymetry, developed from historical maps and sounding data, were used to recreate conditions for the natural Delta. Earlier presentations in this session discuss this development in detail. Yearly flow and salinity simulations were performed for both an above average

precipitation year and a below average one. The character of the effects of inflow changes versus changes in Delta geometry was assessed by simulating both natural and contemporary inflow hydrologies on each Delta grid.

Ecological Implications of Modeled Hydrodynamic Changes in the Sacramento-San Joaquin Delta since 1800 AD – Sam Safran (SFEI)

Collaborator: Robin Grossinger (SFEI)

A broad team has recently developed a pair of three dimensional, stratified flow hydrodynamic models of the Sacramento-San Joaquin Delta: one representing conditions circa 1800 (the “historical” Delta model), the other representing conditions circa 2012 (the “modern” Delta model). To assess how alterations to Delta geometry since 1800 AD have affected Delta hydrodynamics, we used these models to evaluate a series of hydrodynamic metrics under historical and modern conditions. To isolate the effects of altered geometry, both the natural and modern models were run under conditions of identical Delta inflow. Hydrodynamic metrics—including residence time, tidal prism, tidal excursion, average cross-sectional velocity, and tracer distributions—were chosen based on their known or assumed relationship to the provision of key ecological functions (e.g., fish rearing and migration, food supply and nutrient cycling). Accordingly, in addition to presenting model results, we discuss the implications of the modeled changes through a review of the available literature tying hydrodynamics to ecological function. By providing an improved regional-scale understanding of changes in physical drivers/gradients over time and the implications for wildlife, this work supports the development of management and restoration guidelines grounded in a deeper understanding of system characteristics.

Session 15. Selected PEST Applications in California

Calibrating the Soquel-Aptos PRMS Model to Streamflow Data Using PEST – Cameron Tana (Hydrometrics, Inc.)

Collaborator: Georgina King (Hydrometrics, Inc.)

A model was developed using the U.S. Geological Survey’s (USGS) Precipitation-Runoff Modeling System (PRMS) to estimate deep recharge from watersheds overlying the Soquel-Aptos groundwater basin. The model is a distributed-parameter, physically based hydrologic model that uses precipitation and temperature data to calculate runoff, evapotranspiration, and deep groundwater recharge.

Following guidance from the USGS, we calibrated PRMS parameters using a step-wise approach. The first step was to manually calibrate solar radiation and potential evapotranspiration. The second step is to use PEST to calibrate soil-zone parameters to achieve the best match between measured and simulated streamflow at ten gages throughout the model area. We used the PestGui, a Java-based graphical user interface developed by the USGS to create files for PEST.

Calibration accuracy was first estimated by visually comparing measured streamflow with simulated streamflow at each of the ten gages. Calibration was also assessed by calculating the Nash-Sutcliffe goodness of fit statistics. The visual and statistical assessments showed that the model was well calibrated.

Using PEST to Calibrate the G Model and Inverting it to Estimate Net Delta Outflow – Nicky Sandhu (DWR)

Collaborator: Yu Zhou (DWR)

Salinity is estimated at Martinez with flow and stage inputs using a combination of G-model and its convolution with a linear model. PEST was used to calibrate this non-linear model that involves about 14 parameters with the objective of meeting observation salinity. PEST allowed ease of model exploration of additional complexity and parameter analysis helped to identify correlated parameters. In addition, PEST was used to estimate the Delta outflow using the salinity model by specifying daily flow as parameters. This approach results in an ill-posed problem with large amount of parameters, which PEST can solve for by using Tikhonov regularization or truncated SVD without over-fitting.

Using Pareto Optimization to Determine Model Predictive Uncertainty of Groundwater and Surface Water Interactions for the San Joaquin River – Jonathan Traum (USGS)

Through the software PEST, Pareto optimization was used to estimate the predictive uncertainty of average stream seepage simulated by the San Joaquin River Restoration Program Groundwater Model (SJRRPGW). The SJRRPGW is an integrated hydrologic model developed to support the SJRRP by estimating the groundwater and surface-water interaction along a 150-mile reach of the San Joaquin River below Friant Dam. The average annual net stream seepage to groundwater simulated by the model is 370,000 acre-feet per year (AFY) (510 cfs) within the 1,300-square-mile model domain during the model's calibration period from 1962 to 2003. The median seepage rate is 280,000 AFY, with a range from 900,000 AFY in 1983 to 170,000 AFY in 1985. The average stream seepage can range from 230,000 acre-feet per year to 520,000 AFY with less than a 10% rise in the calibration objective function. In addition, the results define confidence levels of predicted model parameter values and were used to reveal which observation data sets provide information in reducing seepage estimate uncertainty. This additional knowledge was useful for identifying model parameters that were critical to the simulation of groundwater and surface-water interaction and were used to inform management decisions regarding SJRRP flow targets.

Comparing Cloud Computing Resources for Model Calibration with PEST – Charlie Brush (DWR)

The computational resources required to calibrate hydrologic models increases with their scale and complexity. We tested the performance of Parallel PEST on four computer systems: multiple linked Office PC computers, the USDOE NERSC Carver system, the Amazon Web Services Elastic Compute Cloud (AWS EC2), and Windstream Hosted Solutions (WHS). Metrics were developed to compare the four systems based on technical assistance, ease of use, system performance, and costs. The four systems were tested with an example Parallel PEST calibration run using the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) coarse-grid model. The Office PC and Carver systems do not have the capacity to calibrate complex models within a reasonable time frame, and the AWS EC2 and Windstream HS systems can both scale nearly infinitely. The performance of Parallel PEST appears to be inversely proportional to network latency and contention. AWS EC2 is more flexible than Windstream HS, has lower base pricing, is more difficult to set up and operate, has high network latency and contention, and has limited technical assistance. Windstream HS has a limited number of configurations, is very easy to set up and operate, has excellent performance and technical assistance, and has significantly lower life-time costs.

Session 16. Kaleidoscope of Modeling from Shasta, the Sacramento River, and the Delta

Development of a Mercury Model for the Delta and Yolo Bypass – Carol DiGiorgio (DWR)

Collaborators: Jamie Anderson, David Bosworth, En-Ching Hsu, Hari Rajbhandari, Nicky Sandhu, and Tara Smith (DWR); Cody Beals, Reed Harris, and David Hutchinson (Reed Harris Environmental, Ltd.)

A modeling team, consisting of Department of Water Resources' modelers and outside consultants, are creating a mercury model for the Delta and applying an existing mercury model to the Yolo Bypass. These models support the open water workgroup's regulatory compliance with the Central Valley Regional Water Quality Control Board's Delta Mercury Control Program. As part of this regulation, the workgroup must examine the methylmercury impacts associated with operation of the State and Federal Water Projects and conveyance of flood waters in the Yolo Bypass. This presentation provides an overview of the group's efforts to date. For the Delta, a mercury module is being developed that will be used in conjunction with upgrades to DSM2. For the Yolo Bypass, the Dynamic Mercury Cycling Model is being used in conjunction with the Tuflow hydrodynamics model. Currently Department modelers are working on the General Transport Model of DSM2 and mercury related processes, while consultants are assembling mercury algorithms including mercury reactions and partitioning. In the Yolo Bypass, consultants have created base layer maps and, by the time of this talk, may have begun calibration of the model using currently available data.

CE-QUAL-W2 Modeling of Head-of-Reservoir Conditions at Shasta Reservoir, California – Katherine Clancey (UN Reno)

Collaborators: Laurel Saito (UN Reno); C. Svoboda, M. Bender, and J. Hannon (Reclamation)

Restoration of Chinook salmon and steelhead is a priority in the Sacramento River Basin since they were listed under the Endangered Species Act in 1989 and 1998, respectively. Construction of Shasta Dam and Reservoir obstructed fish migration, resulting in severe population declines. Efforts have been undertaken to restore the fisheries, including evaluation of opportunities for reintroducing Chinook salmon upstream of the dam and providing juvenile fish passage downstream past Shasta Dam. Shasta Reservoir and the Sacramento River and McCloud River tributaries have been modeled with CE-QUAL-W2 (W2) to assess hydrodynamic and temperature conditions with and without surface curtains to be deployed in the tributaries. Expected head-of-reservoir tributary conditions of temperature and water depth are being simulated under dry, median, and wet year conditions. Model output is analyzed during months of downstream migration of fish from upstream Sacramento and McCloud River tributaries. W2 will be used to determine presence of favorable conditions for juvenile rearing with proposed surface temperature curtains. Evaluation of favorable conditions for fish includes assessment of water temperature, velocities, and depth. Preliminary results for head-of-reservoir conditions and the influence of temperature curtains modeled with W2 will be presented. Study findings may assist in formulation of juvenile fish passage alternatives for Shasta Lake.

Modeling Reservoir Operations to Address Extreme Climate Impacts on the Downstream Fishery at Shasta Lake – Laurel Saito (UN Reno)

Collaborators: Joseph Sapin and Derek Kauneckis (UN Reno); Balaji Rajagopalan (University of Colorado at Boulder); Arthur Dai (University of Arizona)

Dams can have large impacts on freshwater ecosystems, changing natural river systems into fragmented networks of regulated flows and artificial reservoirs. However, dam operations and management can be adjusted to lessen impacts to aquatic ecosystems while still maintaining multi-purpose reservoir needs. We have been using a two-dimensional hydrodynamic model (CE-QUAL-W2) to examine downstream impacts of reservoir operations at Shasta Lake in northern California. Shasta Dam has a unique operations tool, the temperature control device (TCD) that became operational in 1997. The TCD enables releases from multiple levels of the dam to generate hydropower and control downstream temperatures. We have coupled CE-QUAL-W2 with stochastic input generation techniques to examine impacts of extreme flow scenarios on meeting downstream temperature guidelines for salmon. We modeled different reservoir operation options under these flow conditions to evaluate trade-offs of temperature deviations from targets and cold pool accumulation. As part of the project, we interacted with reservoir managers to create scenarios that would help them to make decisions about operations at Shasta. Results indicate that extreme climate conditions coupled with management constraints limit options for managing downstream temperatures and in-reservoir cold pool volumes, but the TCD does enhance the ability to address these targets.

Three-Dimensional Numerical Modeling of Periodicity and Spatial Variability in Secondary Circulation in the Tidal Sacramento River – Aaron Bever (Delta Modeling Associates)

Using the three-dimensional UnTRIM Bay-Delta model we examined the spatial and temporal variability in the secondary circulation near the junctions of the Sacramento River with the Delta Cross Channel and Georgiana Slough. The strength of the secondary circulation was shown to vary strongly on the tidal time scale, and generally increased with increasing flow and broke down near slack water. The location of strong secondary circulation was also shown to vary with the tidal cycle, as locations in the bends near the junctions were either on the up-flow side (strong secondary circulation) or the down-flow side (weak secondary circulation) of the bend dependent on the water flow direction. This temporal and spatial variability caused the along-channel pattern in the secondary circulation to be markedly different on ebb than on flood tide.

Session 17. A Deluge of Drought Modeling

Economic Analysis of the 2014 California Drought on Agriculture. Post-Assessment and Prospects for 2015 – Josué Medellín-Azuara (UC Davis)

Collaborators: Richard Howitt and Duncan MacEwan (ERA Economics); Jay Lund (UC Davis)

California faced in 2014 one of the worst droughts in more than a 100 years of records, at a time when agricultural water use and population are the highest environmental concerns have a prominent role in water management. Groundwater, the once abundant swing resource during drought makes over most surface water losses once again. We present methods and results in conducting an economic assessment of the 2014 drought. Emphasis is placed on the Central Valley, which hosts over 7 million acres of irrigated land and has been more severely affected by drought. Study results highlight the role

of groundwater for coping with drought, the region-wide effects of fallowing on employment and income and the vulnerabilities of the water supply system in agriculture. The early estimates of the drought impacts predicted more than 410 thousand acres of land fallowed in the Central Valley costing \$800 million in crop revenue, \$200 million for dairies and livestock and nearly \$450 million in increased pumping costs to partially offset surface water shortage. Remote sensing using Landsat imagery was employed to compare overall idle land patterns. Estimates coincide for the most part, with some discrepancies in the Sacramento Valley where additional rice fallowing occurred due to water trading and other factors. Research in progress includes an economic assessment of the 2015 drought, and use of energy balance approaches to estimate water consumptive use in high idle land areas.

Hydrology Forecasting using SWAT Hydrologic Models for the 2014 California Drought – Guobiao

Huang (DWR)

Collaborator: Francis Chung (DWR)

During the prolonged drought in Water Year 2014, we made use of the in-house calibrated physically-based SWAT watershed models for the Sacramento River basin, and performed the forecast of simulated daily unimpaired streamflow for remaining of the WY2014 to assist DWR drought operation and planning. Weekly update of model input of climate data was made using the 4km grid PRISM daily data. Historical climate data from 1915 to 2013 were then used for remaining of the WY2014 to make probabilistic forecasts. The modeled streamflow frequency and probability plots were then used to inform current drought situation/position in comparison to historical critical dry years (1976, 1977, 1924, and 1931). It was good added information for drought decision making such as the installation and timing of the delta emergency temporary barriers.

Delta Coordinated Operations Model – Tracy Pettit (DWR)

The DCO, developed in house in 1995, is a spreadsheet model used to model SWP operations on a monthly time-step. It is used in the decision-making process to determine how much water the State Water Project can allocate to its 29 State Water Contractors on an annual basis under various hydrologic exceedences and contractor demands, and includes the contractual and regulatory requirements applicable to the State Water Project. The DCO is updated monthly incorporating existing conditions for the current month and projections for the remainder of the year.

2014 was a challenging year for the State Water Project. The State Water Contractors received its lowest allocation on record at 5% following the driest calendar year (2013) on record. The Department of Water Resources (DWR) jointly with the U.S. Bureau of Reclamation (Reclamation) requested modification to the State Water Resources Control Board's Water Rights Decision 1641. In order to evaluate 2014 operations, the State Water Project (SWP) used the Delta Coordinated Operations (DCO) model. Modifications to the hydrology and demand assumptions were made within the DCO due to the extremely dry conditions. An overview of the DCO and how it was used will be presented.

2014 Drought Forecast Modeling in 1-, 2-, and 3-D – John DeGeorge (RMA)

With very little precipitation in California through December 2013 and January 2014, water supply forecasts included very dire conditions that could warrant placement of temporary barriers in the Sacramento-San Joaquin Delta for salinity control. With support from the State and Federal Water Contractors and the Metropolitan Water District of Southern California, RMA conducted an analysis of potential barrier placement strategies using both a 1-D tidally averaged model and the 2D RMA Bay-

Delta Model for several forecast conditions. Simulations were performed on a very tight time schedule, and in parallel with DSM2 modeling performed by the DWR Delta Modeling Section. Later, RMA performed additional analysis with a 3-D model to further examine potential salinity impacts with extremely low net Delta outflow. This talk will present some of the results of the analysis with focus on the importance of the location and timing of barrier placement. The challenges of modeling extreme conditions in an open collaborative environment will also be discussed.

Session 18. Marriage of Data and Water Quality Model Output Visualization for Stakeholder Involvement and Real-time Decision Support

Advanced Real-time Decision Support and Visualization – Jesper Kjelds (DHI)

Balancing the needs for managing water supply, flood risk and protection, ecosystem management, and water quality in receiving waters underlie many of the challenges in coastal and inland environments. Fundamental to these conversations are the issues of accountability and credibility to stakeholders and the ability to share, disseminate and visualize information more rapidly and dynamically than traditional methods provide. Recent advances in capabilities for real time water management, including flood warning, water supply, and information management have been extended to data visualization and scenario comparison in a series of projects in California and Florida.

We will briefly explore the technical implementation of model integration and data workflows, and the various strategies for connecting and interfacing models, getting more analysis than a typical process model inherently provides, and the various overlay capabilities that make these workflows more efficient. The key steps include:

- Data acquisition and quality control
- Model preparation, automation and optimization
- Provision for real time results mapping and scenario development
- Improved visualization and dissemination of forecast and warnings

Stakeholder involvement and visualization are also fundamental components of advanced decision support systems. Expanding the access to data observations, remote sensing, model results and scenario comparison is a common feature of modern decision support systems. The ability to achieve this objective in a robust manner for any model, and any platform across the client, web and mobile environments is a common requirement. By exposing these capabilities and providing programmatic access to these features, agencies and communities can help to foster involvement, collaborative discussion, and eventual decision-making.

Integration of Real-time Data Management Systems and Runoff Models in Reservoir Operations – Timothy Lee (Kisters International Inc.)

KISTERS North America completed a recent project with TransAlta in Calgary where the RAVEN precipitation and snow runoff model was integrated with Water Information System KISTERS (WISKI) software. Using publicly available GRIB2 forecast data, the end product has an integrated GUI and is a good example of gathering data from multiple sources, processing the data in WISKI, running the model, and analyzing the results back in WISKI. The data is used to help operate a series of cascading

hydroelectric reservoirs and will eventually be an input to the KISTERS Resource Optimization (ResOpt) software which TransAlta also uses.

Silver Creek Watershed – Dynamic Stream Temperature Modeling and Visualization – Stephen Blake (DHI)

The incorporation of water quality data collection with modeling and visualization is an emerging opportunity to advance the analysis and stakeholder engagement process. These capabilities can be built on automated and real time data connections, processing and advanced modeling and analysis linking traditionally separate fields of study. An integrated hydrologic and water quality tool has been developed for the Silver Creek Watershed in south-central Idaho to simulate hydrologic processes, stream temperature and fish life-cycles. The approach is used to analyze anthropogenic impacts to stream temperature and salmonid habitat helping watershed managers demonstrate links between development and water management scenarios and the effect on the stream and watershed thermal regime.

Gauging the impacts on salmonids requires the ability to synthesize intensive data collection and data management techniques with an understanding of processes that control seasonal and spatially varying temperature dynamics. Temperature dynamics are in turn influenced by surface water-groundwater interaction. Hence the need has arisen to consider groundwater, surface water, and water quality as an integrated system, and to provide the ability to encapsulate these techniques within an integrated framework. Data connections of sensors and remote sensing to modeling platforms are enabling rapid improvements in the delivery of environmental modeling and decision support. Improvements in sensor capabilities, cellular telemetry, and remote sensing provide new data streams that are growing in availability, resolution, and overall utility. This affords the means to acquire and process data in real-time, to guide awareness and decision support, and to run models that provide a coherent spatial picture, as well as the ability to predict future conditions and compare scenarios. DHI's MIKE Customised Platform has been implemented to address operational decision support, data dissemination, and visualization of models results and scenario comparisons in a variety of water environments.

We will show an applied approach to data acquisition and processing, scenario development and planning, model development and post-processing, and visualization and dissemination of results. These capabilities are applied in example projects focused on stream temperature modeling, with impacts from agricultural withdrawals climate change and riparian restoration. Integrated models are used to represent surface and groundwater dynamics, constituent transport, and agent based modeling to represent impacts on salmonid habitat and sustainability.

Real-time Decision Support and Visualization for Salinity Management in the San Joaquin River – WARMF Online – Nigel Quinn (Berkeley National Laboratory/Reclamation), Amye Osti and Nathan Hemenway (34 North, Inc.)

Collaborative, real time water quality management is best facilitated when all stakeholders have a forum and toolset for aggregating and accessing the data and information used to inform management decisions and operations. These data include reports, GIS data, DEMs, telemetered data (real time, discrete and historic), model inputs and results, graphs, visualizations and much more. The SJR real time management program has developed a comprehensive online resource to support collaborative efforts to provide a salt assimilative capacity forecasting model and supplemental decision support tools to improve salinity management in the lower San Joaquin River. The online decision support platform

combines WARMF model output visualizations alongside customizable data dashboards with the supplemental data visualizations for understanding the bigger picture. The tools provide collaborators with timely information and a transparent process for estimating their salt load contributions to the River in relation to other dischargers in the Basin. The collaborative forum creates opportunity to coordinate west-side Basin salt loading schedules with reservoir releases of high quality flows from the East-side of the Basin. The talk will provide information on the long-term goals of the project, demonstrate accomplishments to date and details of the various GIS-based visualization techniques being deployed on a publicly accessible web server to support real-time salinity management.

The SJR real time salinity management program in developed is a four-way collaboration between the US Bureau of Reclamation, Systech Water Resources, 34-North Inc. and Berkeley National Laboratory.

Session 19. Poster Session

Impact of Aquifer Desaturation on River Seepage – Hubert Morel-Seytoux (Hydroprose)

There are two parts to this investigation.

(1) A simple, analytically derived, criterion is presented to determine the initiation of the loss of saturated hydraulic connection at the interface between a river bottom and the aquifer below. Desaturation below a clogging layer happens usually due to a significant lowering of the water table in the vicinity of the river (recharge area). Most groundwater models use incorrect criteria for this estimation of incipient desaturation and of the associated resulting flow exchange. Does it have a strong importance in practice?

(2) A simple procedure is developed to estimate the recharge rate to the aquifer under transient conditions of the supply rate to the recharge area. The capillary barrier phenomenon at the interface between a clogging layer and the aquifer below has a very strong effect on the amount of recharge taking place, particularly when the ponded depth in the recharge area is small (and maintained small). How large must the ponded depth be so that the capillary barrier effect can be neglected? Most saturated-unsaturated numerical models do not account for the capillary barrier effect at the interface between highly contrasted soil layers.

Quasi-decadal Oscillation in the CMIP5 and CMIP3 Climate Model Simulations: California Case – Jay Wang (DWR)

Collaborators: Hongbing Yin, Erik Reyes, and Francis Chung (DWR)

The ongoing three drought years in California are reminding us of two other historical long drought periods: 1987-1992 and 1928-1934. This kind of interannual variability is corresponding to the dominating 7-15 yr quasi-decadal oscillation (QDO) in precipitation and streamflow in California. When using global climate model projections to assess the climate change impact on water resources planning in California, it is natural to ask if global climate models are able to reproduce the observed interannual variability like 7-15 yr quasi-decadal oscillation.

Further spectral analysis to tree ring chronicles and historical precipitation records proves the existence of 14 yr quasi-decadal oscillation in California in modern climate. But while implementing spectral

analysis to all the CMIP5 and CMIP3 global climate model historical simulations using wavelet analysis approach, it was found that only CESM1-WACCM, have statistically significant 14 quasi-decadal oscillations in California.

Modeling the Establishment of Riparian Habitat Vegetation with Applications to Populus Fremonti on the Sacramento River, California – Michael Tansey (Reclamation)

Collaborator: Chuck Young (SEI)

The existence of healthy riparian forests in the Sacramento, San Joaquin and other tributaries of the Bay-Delta is important for successfully managing the estuary for both human and ecosystem benefits. These riparian forests provide important ecological services including stream bank stabilization, shade, nutrient inputs, and physical habitat for terrestrial and aquatic species. The survival and renewal of riparian forests requires the periodic establishment of cottonwood and other riparian vegetation seedlings in near-river sediments in order to replace trees lost to natural mortality and other causes. Determining under what conditions riparian vegetation seedlings will survive is an important consideration in managing river flows for both human and ecological objectives.

To address this need, a hydro-biological conceptual model describing the growth and survival of riparian vegetation from germination through the first year of seedling growth was developed. This Riparian Habitat Establishment Model (RHEM) was developed by integrating the conceptual model into the well-known HYDRUS-2D numerical model. RHEM dynamically simulates seedling root and shoot growth and plant survival as the combined effects of sediment texture, meteorological conditions, and water table depth. Using the RHEM model, an analysis based on water table controlled cottonwood (*Populus Fremonti*) growth experiments revealed that the seedlings do not experience significant water stress until a critical water table depth is reached. This depth depends on sediment texture with finer textured sediments having greater critical depths. Additional analyses showed that, for the conditions simulated in this study, sediment texture has a larger effect on seedling survival than meteorological conditions. The RHEM model was also used to derive and evaluate a simple cottonwood seedling density and survival model which was applied to observed seedling growth and survival conditions on the Sacramento River, CA. The density model was able to successfully replicate the decline in seedling density observed as river stage declined.

Five Years of Change: The Hidden Story of the Sacramento River at Georgiana Slough – Shawn Mayr (DWR)

Collaborators: Amy Zuber and Scott Flory (DWR)

The saga continues with our annual multibeam bathymetric data sets at Georgiana Slough. Highly detailed bathymetric measurements have been made of this important intersection since 2010. What might changes in the topography mean to hydrodynamics, and fish migration?

Color Your Delta – Shawn Mayr (DWR)

Colored pencils and crayons will be provided with this interactive poster to share locations of good fishing areas, lunch spots, and unexplained phenomena. We can also show locations of bathymetric datasets to share and a wish list of data needs. Existing data extents in our library will be shown as well as a (live?) link to our updated online bathymetry catalog map.

Using Measured Bottom X2 to Estimate Effective Delta Outflow and Electrical Conductivity during Water Year 2014 – Anne Huber (ICF)

Collaborator: Russ Brown (ICF)

Daily average bottom EC measured in the western Delta during water year 2014 was used to interpolate the daily average X2 where bottom EC was 3,830 $\mu\text{S}/\text{cm}$ (2 ppt). This measured X2 position varied with the variation in the daily mean tide (spring-neap tidal cycle) by a distance generally between ± 3 km. This tidal variation in X2 can be estimated as a function of daily mean tide (minus the 2-week average tide). Effective Delta outflow was estimated from the measured X2 values by first removing the tidal effect from the measured X2 values and then back-calculating effective outflow from the steady-outflow form of the daily X2-log outflow equation. The magnitude of the resulting effective outflow was generally between the effective outflow calculated from the DAYFLOW estimates of daily outflow and the effective outflow calculated from USGS tidally-filtered daily outflow based on flow measurements at Rio Vista, Jersey Point, Threemile Slough, and Dutch Slough. If tidal effects are retained in the measured X2 values, the back-calculation of effective outflow includes the flow-equivalent effect of the tidal variation, representing the “equivalent” outflow. This “equivalent” outflow was used in G-model negative exponential formulas to produce estimates of daily average surface EC. These estimates showed good agreement with daily average surface EC measurements at multiple locations, including good agreement with the variations due to the spring-neap tidal cycle.

Mapping Decadal Change of Rice Field Extent and Phenology in the Sacramento Valley using Landsat Imagery – Liheng Zhong (DWR)

As the largest water consumer in the Sacramento Valley, rice plantation is one of the most significant sources of variability in water management and planning. Historical changes have been observed in the extent and growing season of rice due to annual variation of weather and water availability, the use of early-mature varieties, etc. It is essential to precisely detect rice growing extent and phenology to improve the hydrological simulation using models like CalSim 3.0. In this project, several years since 1989 were selected based on the availability of high-quality Landsat images. Rice fields were identified based on the unique temporal profiles of vegetation indices derived from series of segmented images. Validation using field survey data and other land use maps shows a promising accuracy for further change analysis. The start and the end of the growing season and other phenological metrics were extracted from object-level temporal profiles of vegetation index by a curve-fitting method. Historical change and spatial distribution of rice growing period were compared to site observations and district-level water delivery data.

Trailing Non-Aqueous Phase Liquids (NAPL) in the Groundwater: Modeling and Application – Pavithra Prakash (Indian Institute of Technology)

Collaborator: Indumathi Nambi (Indian Institute of Technology)

The distribution of NAPL in multiple forms and configurations is a likely phenomenon in a layered heterogeneous subsurface system due to variations in capillary pressure in each of its layer. The unique feature of a NAPL contaminated heterogeneous subsurface system is the spatio-temporal variation in fluids and porous media properties. The variable porous media properties includes reversible permeability fields, changing flow hydrodynamics such as flow bypassing and preferential flow, while variable fluid property includes changing NAPL saturation. An improvised contaminant transport model was formulated to account for the spatio-temporal while predicting concentration profile in downstream end of the NAPL source. The key features in the model were the inclusion of new relative

permeability correlations; NAPL-water mass transfer correlations, and a non-Gaussian dispersion equation. The robustness of the predictive model was assessed through comparative analysis of the predicted concentration with experimentally observed concentrations.

Predicting Effect of Reservoir Expansion with Three-Dimensional Modeling: Case Study of Los Vaqueros Reservoir – Gang Zhao (Flow Science)

Collaborators: Benjamin Martin, Li Ding, and E. John List (Flow Science)

The use of three-dimensional (3D) models to simulate the hydrodynamics and water quality of reservoirs and lakes can be a powerful tool to aid in the development of management strategies. Models can be used proactively to predict how reservoirs will react to changes, either physical or operational. 3-D modeling aided in the management decisions of the Los Vaqueros Reservoir (LVR), managed by Contra Costa Water District (CCWD), during a recent expansion via dam raise. A well calibrated and validated hydrodynamic and water quality model was used to evaluate the adequacy of the existing oxygenation system for the expanded reservoir and the potential water quality effects. Available data from LVR was analyzed and used to construct a 3D computational fluid dynamics (CFD) model of the reservoir. Two predictive scenarios were run: 1) Drawdown, where LVR storage was ~ half the original volume during construction, and 2) Expanded Reservoir, where LVR storage reached the full 160TAF capacity. Predictions were used to support design decisions for the oxygenation system and evaluate potential changes in water quality within the reservoir.

Cloud Cover Variability and its Relation to Springtime Snowmelt and Runoff – Edwin Sumargo (UC San Diego)

Collaborator: Daniel Cayan (UC San Diego)

The uncertainties in water supply forecast are largely produced by the variability in solar insolation, which in turn is modulated by cloud cover. Here we investigate the space/time variability of cloud and incoming radiation and its influence on snow and streamflow. We employ NASA/NOAA Geostationary Operational Environmental Satellite (GOES 9-11 and 15) albedo product spanning from 1996 to 2012 during the daytime (8-16 PST) over the westernmost U.S. (25-50 °N, 113-130 °W) with 4-km spatial and 30-minute temporal resolutions. Pixels with elevations below 800m are masked to avoid contaminations from coastal marine and low stratus clouds. A translation of cloud albedo (α_{cloud}) to incoming surface radiation yields results that are well correlated with a scattered set of time series from surface radiometers in Sierra Nevada locations. To describe prominent patterns and temporal variability of α_{cloud} over the western U.S., we conduct a Rotated Empirical Orthogonal Function/Principal Component (REOF/PC) analysis. The 5 leading REOF modes account for ~65% of the total variance of α_{cloud} . The leading mode (~19%) covers portions of the Sierra Nevada and the Cascades and has a high variance during the springtime, suggesting its pertinence during the snowmelt season. During spring and early summer, correlation maps reveal sizeable PC/ α_{cloud} influence on snowmelt/runoff ($R^2 > 30\%$), with anomalously high α_{cloud} producing lower snowmelt/runoff and vice versa. Correlations indicate a strong change in the response to incoming radiation of snowmelt and streamflow over the seasonal transition from winter-to-spring-to-summer. Dry years and wet years exhibit considerable difference in cloud amount and pattern, with lower overall springtime cloudiness in drier years, which leads to higher surface radiation available for snowmelt.

Planning for Sustainable Management of Groundwater Resources – Ahmad Abrishamchi (Sharif University)

Groundwater as a major source of water in arid and semiarid regions is the key source for development in many developing countries. Therefore, sustainable management of groundwater resources is vital for sustainable development. Nevertheless, groundwater is not managed sustainably so far and groundwater depletion and contamination is increasing in Iran. Groundwater sustainability should be defined in an integrated hydrological, agronomic, social, economic, and environmental system. So in order to be sustainable, groundwater systems should be designed and managed to be effective, efficient and robust- balancing changes in demands and supplies over time and space and to ensure that there are no negative long-term irreversible or cumulative impacts on ecosystems.

In Iran, due to its climatic conditions and limitations of dry farming, groundwater management has an essential role in food production. Over the years, the increasing population and therefore the greater demand for water has resulted in over-exploitation of groundwater resources in almost the whole country of Iran. Groundwater depletion has caused many problems such as land subsidence, reduction in base flow of the rivers, destruction of wetlands, increasing the cost of pumping, decreasing drainage capacity of the aquifer, and salt water intrusion in coastal areas. Studies show that in Iran only 10 percent of the groundwater basins are still in equilibrium state; the rest are over-exploited and facing ever increasing depletion. Khorasan Province in north east of Iran where groundwater is the main source of water supply is in a critical condition. Uncontrolled withdrawal of groundwater resources has caused continuous water table decline. All these problems show the importance and necessity of planning for sustainable groundwater management in this province.

Planning for sustainable management of groundwater resources is a complex task due to its long-term nature faced with many uncertainties and the need for coordinated use of surface and groundwater and water allocation between competitive uses and users. WEAP software will be used for simulation of the system of sources and uses. This software has the ability to connect to MODFLOW groundwater model and thus provide an integrated model of surface and groundwater resources and uses. Several management scenarios will be examined to determine sustainable groundwater discharge using the integrated model and the concept of “capture”. Having determined the sustainable aquifer discharge in each scenario, Game Theory will be used to determine the optimal groundwater resources allocation to different consumers. To consider the effect of uncertainty and participation of stakeholders in the sustainable management of groundwater resources, Bayesian Belief Network (BBN) will be used. Hugin software will be used for the development of BBN network structure based on the conceptual model of the study area. A conceptual model of the region determines various components of the system and their interrelationships. Available information and data and the results of the integrated model of water resources and uses will provide the input data to the network.

Real-time Forecasting of Salt Assimilative Capacity in the San Joaquin River – Reginald Dones (Reclamation)

Collaborators: Nigel Quinn, Michael Mosley, and Laura Condon (Reclamation)

Real-time forecasting of salt assimilative capacity in the San Joaquin River is a key component of Basin-scale real-time salinity management. The WARMF-SJR model has been under development for more than a decade. The new WARMF Manager module has been designed to automate easy importation of web-accessible real-time flow and electrical conductivity data and the substitution of model-derived watershed forecasts with data obtained from interaction with local stakeholders. The poster shows the

capability of the current WARMF-SJR model and examines forecast "skill" by comparing model forecasts to observed data at key monitoring sites.

2D Modeling of the Salinas River to Facilitate Consensus Based Flood Protection and Conservation – Paul Frank (Newfields)

The Salinas Valley is one of the world's most productive agricultural areas with some farming occurring within the 5-year floodplain of the River. In decades past, private landowners removed vegetation from the riverbed in an attempt to increase flood conveyance but in recent years such activities have not been accepted by regulatory agencies. Additionally, the flood-reducing benefits of vegetation removal had not been quantified. After several years of being unable to remove vegetation from the channel, competing interests of farmers, environmentalists, regulators, and other stakeholders reached a boiling point.

In 2013 The Nature Conservancy (TNC) invested in a program to improve the physical understanding of the River's hydraulics and geomorphology, build consensus amongst stakeholders, and engage regulators to develop a solution to the problem. At the core of this program, NewFields created a 2D hydraulic model of approximately 25 miles of the Salinas River that helped explain flooding mechanisms within the complex private levee system along the River. Based on the new understanding of river hydraulics and flooding this model provided, NewFields and others designed a geomorphically-based vegetation clearing approach that minimized impacts on sensitive riparian habitat. In 2014, TNC spearheaded an effort to work with landowners in a pilot reach of approximately 12 miles that successfully permitted and implemented this geomorphically-based approach. In 2015 TNC as well as the Monterey County Water Resources Agency, the Central Coast Grower-Shipper Association and the Salinas River Channel Coalition, are working towards implementing similar programs throughout the approximately 100 river miles of the Salinas in Monterey County, including expansion of the 2D model.

Climates Change. That's What They Do – Om Prakash (West Consultants) Collaborator: David Curtis (West Consultants)

Climates change. That's what they do. It is a natural and dynamic process. With all of the discussion about anthropogenic (i.e. man-made) climate change, it is easy to overlook just how variable our natural climate is. California's climate is uniquely variable. It can and does vary by significant amounts within one human lifetime and well within the design lifetime of our water infrastructure. Sometimes this fact gets lost in the noise of climate change debate. Part of the reason is our relatively short meteorologic and hydrologic records. The few long records available provide some interesting insights.

This presentation explores and presents findings regarding rapid variation of "climate averages" in central and northern California using long term rainfall records and tree ring measurements. The results suggest that not only is stationarity dead, it likely wasn't really alive in the first place. We simply assumed it was.

Flood Warning with HEC-RTS (Real Time Simulation) – Kayson Shurtz (West Consultants) Collaborator: Jeff Harris (West Consultants)

The US Army Corps of Engineers has developed the Corps Water Management System (CWMS) for managing forecasts for Corps of Engineers reservoirs. For security reasons, this is proprietary software for use by the Corps of Engineers on. However, many agencies have expressed interest in being able to

use the capabilities of CWMS for managing their own forecasts. The US Army Corps of Engineers, Hydrologic Engineering Center responded to this need by providing these capabilities in the HEC-RTS software. WEST Consultants is working with San Diego County and applying HEC-RTS to the San Diego River. This poster will show the flow of HEC-RTS and how it is being applied to the San Diego River.

Linking Operations, Watershed, and Water Quality Models to Support Third-Party Nutrient TMDL Review and Revision for the Truckee River, Nevada – John Wolfe (LimnoTech)

Collaborators: Laura Weintraub and Dave Dilks (LimnoTech)

Dissolved oxygen (DO) concentrations in the Truckee River had historically violated water quality standards due to nutrients that foster growth of periphyton, i.e. attached algae, especially at low flow and in shallow water. A 1994 TMDL developed by the Nevada DEP set maximum nitrogen and phosphorus loads to comply with standards for DO, and communities built state-of-the-art treatment facilities to meet those limits, while non-point sources were left unchanged.

Faced with population growth since 1994, along with an expected increase in summer river flows in response to the Truckee River Operating Agreement, the Cities of Reno and Sparks, Washoe County, and the Truckee Meadows Water Authority wanted to revisit the TMDL. They engaged LimnoTech to develop a more refined representation of the system, including improved representation of nonpoint-source loadings, nutrient speciation, and the effects of periphyton on water quality. The parties have conducted a series of monitoring events to support calibration and confirmation of a linked suite of models, consisting of the Truckee River Operations Model, a WARMF (Watershed Analysis Risk Management Framework) model of the watershed, and an upgraded HSPF water quality model of the Truckee River. Based on results from this integrative model of the watershed, new water quality standards for phosphorus have been proposed as a necessary precursor to a revised nutrient TMDL. The enhanced model is also helping to support understanding of scientific issues, communication, and decision-making by multiple stakeholders with diverse interests.

Coarse Resolution Planning Tools for Prioritizing Central Valley Improvement Act Fisheries Activities – Rodney Wittler (Reclamation)

Collaborators: Jim Peterson (USGS); David Mooney (Reclamation); Cesar Blanco and Julie Zimmerman (USFWS)

Central Valley Project Improvement Act (CVPIA) Fisheries Program used a structured decision making (SDM) approach to develop a framework to allowed decision-makers to identify Program objectives and guide planning of broad scale fisheries activities. Participants in the process included representatives from various Federal and California State resource management agencies. The participants used a rapid prototyping approach to identify and quantify Program objectives and develop dynamic coarse resolution decision models to evaluate the relative benefit of candidate CVPIA Fisheries actions. The structure of the models was determined by the participants and acknowledged subject matter experts and represented their beliefs regarding the dynamics of the managed system. When two or more experts could not agree, alternative representations of system dynamics were developed. The models were parameterized using a combination of expert judgment and empirical data. Model performance was evaluated using stochastic simulation of alternative Program actions and via sensitivity analyses. The models were able to capture the coarse dynamics of the system and estimated escapement of fall run Chinook salmon reasonably well. Sensitivity analysis provided insight into the important or influential unknowns and assumptions that can be targeted for monitoring in an adaptive management

framework. The entire process was completed in one year. The Program is currently developing a transparent decision making process that will revise and incorporate these models.

Use of UAVs in the Design, Construction Observation, and Post-Project Monitoring of Rehabilitation Projects – Jesse Barker (cbec eco-engineering)

Collaborators: Chris Bowles and Chris Hammersmark (cbec eco-engineering); John Hannon (Reclamation)

The accessibility of unmanned aerial vehicles (UAVs or Drones) to the general public has grown in recent years, and with it has the opportunity to apply these relatively inexpensive, yet sophisticated devices in natural resource management. One application is the use of UAVs to collect low altitude aerial imagery for river rehabilitation projects. The aerial images can be used: to develop site maps and topographic data; to inform hydraulic modeling and design; to track progress on land and within aquatic areas, and to perform post-project physical and biological monitoring. To demonstrate the potential for this type of technology, a recently design and constructed salmonid rehabilitation project consisting of gravel augmentation and side channel creation within the Nimbus Basin, along the Lower American River in Fair Oaks, CA is used. Aerial imagery was collected before, during and after construction. Imagery was used to develop topographic datasets and digital elevations models (DEMs) that were geo-referenced using RTK-GPS surveyed points. The DEM, as modified with additional bathymetric survey data, was used for hydraulic modeling to inform the rehabilitation design. During construction, the site was monitored regularly with the UAV to ensure proper construction techniques were being implemented as well as track overall progress. The site was surveyed after construction to document the as-built topographic conditions. In addition, post-project imagery was used to document the utilization of the constructed site by spawning salmonids.

Session 21. California Water Rights Analyses and Modeling

2014 Water Right Curtailment Analyses in the Sacramento-San Joaquin, Russian River, and Eel River Watersheds – Brian Coats (SWRCB)

The right to divert surface water in California is based on the type of right being claimed and the priority date. Water right permits specify the season of use, purpose of use and place of use for the quantity of water authorized under the permit or license. In times of drought and limited supply, the most recent (“junior”) right holder must be the first to discontinue use. Even more senior water right holders, such as some riparian and pre-1914 water right holders may also receive a notice to stop diverting water if their diversions are downstream of reservoirs releasing stored water and there is no natural flow available for diversion.

In 2014, due to severe drought conditions, water availability analyses were performed to determine allocations to water right holders in the Sacramento-San Joaquin, Russian River, and Eel River watersheds. State Water Board staff evaluated both tributary and basin-wide variations prior to issuing water right curtailments in May and June of 2014. Later in the year, a post-curtailment analysis was initiated to monitor conditions in each of the affected watersheds to determine if and when to lift curtailments. The State Water Board lifted water right curtailments in November 2014.

Drought Water Rights Allocation Tool (DWRAT) - Ben Lord (UC Davis)

The 2014 drought has focused and renewed discussion about how California curtails water rights when water availability is insufficient. Prior to the 2013-14 water year, the most recent curtailment effort dates back almost 40 years to 1976-77. Since then, many changes and advances have occurred in water use, policies, and technology. New complicating issues include the growth of environmental and water quality requirements. Given the likely growing frequency of the need for water right curtailments and the centrality of curtailments to overall drought management, the State Water Resources Control Board needs a comprehensive, quantitative water rights curtailment program. Preliminary phases of such a program have already been developed and applied in the Eel and Russian River basins, including a Drought Water Right Allocation Tool (DWRAT) that estimates ideal curtailments given data sets on water rights and water availability. Extending this program to other basins, including the Sacramento-San Joaquin Delta watershed, will require decisions on water rights and water availability quantification and resolution of several ambiguous or conflicting policies. Supporting the development of DWRAT as the basis for water rights curtailment decisions will provide a long-term approach that brings structure, quantification, and transparency to a complex and difficult administrative process.

WRIMS-based Sacramento Valley Water Right Model – Liheng Zhong and Richard Chen (DWR)

A WRIMS-based model is being developed in order to incorporate water right information for water allocation under drought conditions and to support decision-making of water management in the Sacramento Valley. Detailed and timely information on individual water rights is essential to estimate water demand and consumption, especially under drought conditions. However, such information is rarely fully implemented by simulation models due to the complexity of the water right system. As an early attempt in this study, detailed water right records were obtained from SWRCB database with major water rights identified based on actual diversions during previous years, which account for over 90% of the total diversion for consumptive use in the Sacramento Valley. These major water rights were analyzed and were associated with the demand units of CalSim 3.0 based on spatial overlay in GIS.

In this model, information of individual water rights are explicitly incorporated in the model based on the detailed CalSim 3.0 schematic. Model constraints such as seasonal diversion limit and diversion priority are applied to each demand unit by reviewing all relevant water rights. Water right categories including riparian, pre-1914, and post-1914 appropriative water rights are treated differently according to existing regulations. Riparian and pre-1914 water right holders are assumed to divert the amount of reasonable beneficiary use from natural flow prior to project construction with equal priority. CalSimHydro is used to estimate the upper limit of beneficiary water use at each demand unit based on its existing land use information. Among post-1914 water rights the priority of each water right applicant is assigned based on seniority when water shortage occurs. Then the total diversion to each demand unit under water right is estimated. Modeling conceptualization, model structure, and preliminary findings of the study will be presented.

Session 22. Modeling an Unstructured Environment: Recent Developments and Applications of Multi-Dimensional Bay-Delta Models

Open Software, Open Source, Open Data, and Open Models: San Francisco Community Model Initiative – Edwin Elias (Deltares USA Inc.)

The San Francisco Bay-Delta system is complex in its physical and environmental dynamics. Modeling tools that integrate hydrodynamics and water quality dynamics are essential to unravel the governing processes on various spatial and temporal scales and assess potential developments due to climate change and adapting management strategies. There is a need for open access, publicly available, integrated modelling platforms to facilitate and enhance interdisciplinary and interagency scientific communication, collaboration, and understanding.

Sediment Transport Modeling in a San Francisco Bay Salt Marsh – Yun Zhang (Stanford University) Collaborators: Oliver Fringer, Ivy Huang, Derek Fong, and Stephen Monismith (Stanford University)

We apply the 3D SUNTANS model to a salt marsh in San Pablo Bay to study sediment transport. Subgrid bathymetry is incorporated into the SUNTANS model to study the system with a hierarchy of 3D, 2D, and 1D discretizations to understand tradeoffs between model complexity and accuracy. Effects of marsh drag and culverts are also studied to understand how they affect sediment transport. Results show that the culverts act to retain sediment in the system, while marsh drag acts to restrict the flow to the main channels and encourage landward sediment transport due to the tides. Comparison of the 3D, 2D, and 1D models shows that the 1D model predicts flow and stage reasonably well, although the 2D model is needed to predict sediment transport as accurately as the 3D model.

SCHISM Salinity Modeling 2013-2014 and Recent Developments – Eli Ateljevich (DWR)

The talk will begin with a few slides describing recent model developments, workshops and the recent independent release of the Virginia Institute of Marine Science (VIMS) version of SELFE as SCHISM. Then we will focus on our own DWR modeling in 2013-2014 including some relatively new introspection concerning mechanisms of salinity transport in the corridor of the Sacramento above the confluence region. We describe recent calibration decisions we've made in this region and how they were influenced by salinity observations near the peak of intrusion in 2014.

Salinity, Waves, Sediment, and X2: Recent Applications Using the UnTRIM Bay-Delta Model – Michael MacWilliams (Delta Modeling Associates) Collaborator: Aaron Bever (Delta Modeling Associates)

The UnTRIM Bay-Delta model is a three-dimensional hydrodynamic and salinity model of San Francisco Bay and the Sacramento-San Joaquin Delta, which extends from the Pacific Ocean through the entire Sacramento-San Joaquin Delta. The UnTRIM Bay-Delta model has been coupled with the Simulating WAVes Nearshore (SWAN) wave model and the SediMorph morphological model and used in studies of San Francisco Bay and the Sacramento-San Joaquin Delta for California DWR, USBR, USGS, US EPA, and the US Army Corps of Engineers. The model calibration and validation conducted as part of these studies demonstrate that the UnTRIM Bay-Delta model is accurately predicting flow, stage, and salinity, wind waves, and sediment transport in San Francisco Bay and the Sacramento-San Joaquin Delta under a wide range of hydrologic conditions. This presentation will give an overview of some of the recent

applications of the UnTRIM Bay-Delta model, which include simulation of sediment transport in the Sacramento-San Joaquin Delta, some recent high resolution model applications in South San Francisco Bay, and a 34 year three-dimensional hydrodynamic and salinity simulation completed for the US EPA.

Session 24. California Water Plan Update 2013: Key Contents

California Water Plan Update 2013: Investing in Innovation and Infrastructure – Paul Massera (DWR)

For almost 60 years, the California Water Plan has served as the long-term strategic plan for informing and guiding the sound management and development of water resources in our state. With updates every five years, it remains the single most complete and relevant body of knowledge about statewide water resources. Update 2013 reaffirms the State's commitment to integrated water management. It recognizes and reflects these basic facts about today's water situation:

- Water is California's Life Blood.
- California's Complex Water Resources System is in Crisis.
- A Diverse Portfolio Approach is Required to Address the Challenges.
- The Solution Requires Integration, Alignment, and Investment.
- We All Have a Role to Play in Securing Our Future.

Consistent with State law, the 2013 update of the California Water Plan lays out recommendations, rather than mandates. Based on decades of scientific data and analyses, nearly 40 State agency plans, and the voices of hundreds of stakeholders, it is a tool to guide investment priorities and legislative action to ensure resilient and sustainable water resources. Update 2013 applies at statewide, regional, and local scales, and serves to advise a diverse audience, including elected officials, planners and resource managers, tribal governments, academia, and the general public.

California Water Plan Update 2013 Water Portfolios, WYs 2001-2010 – Jennifer Kofoid (DWR)

The water portfolios are an essential component of the California Water Plan. "The primary reason for the water portfolio tables and flow diagrams is to provide an accounting of all water that enters and leaves the state and how it is used and exchanged between the regions for each water year. This is important to all water planning activities". –excerpt from *California Water Plan Update 2013*

The water portfolios provide an abundance of water supply and use information. Update 2013 presents annual water portfolio data in Volumes 1, 3, and 5 at varying levels of detail and at different spatial scales, including statewide and California's 10 hydrologic regions. The presentation will provide an overview of Update 2013's water portfolio content for water years 2001-2010, including where and how to access the technical content.

California Water Plan Update 2013 Future Scenarios: Results and Analysis – Mohammad Rayej (DWR)

Planning scenarios were developed for California Water Plan Update 2013 to illustrate how key uncertainties such as future population growth, land use patterns, and climate affect future water demands. Future urban and agricultural water demands were computed for 10 hydrologic regions of the State under nine growth scenarios as well as under twelve Climate Action Team (CAT) future climate

scenarios and a thirteenth scenario representing a repeat of historical climate (1962-2006). Future water demands were calculated utilizing the Water Evaluation and Planning (WEAP) modeling framework that simulates catchment hydrology under various climate and land use scenarios. Results show that future urban water demands under the three growth scenarios are heavily influenced by the assumptions related to future population growth and to a lesser extent by future climate. Future agricultural water demands, however, are observed to be heavily influenced by both assumptions about future climate and urbanization of agricultural lands.

Enhanced Groundwater Contents for California Water Plan Update 2013 – Abdul Khan and Mark Nordberg (DWR)

California's Groundwater Update 2013: A Compilation of Enhanced Content for California Water Plan Update 2013 compiles and analyzes readily-available groundwater information to characterize California's groundwater basins, aquifers, and well infrastructure. It also presents data and analysis related to groundwater monitoring efforts, aquifer conditions in response to extraction, groundwater management practices, and conjunctive management programs. Statewide and regional findings, data gaps, and recommendations to improve groundwater management are also included. It expands and enhances baseline groundwater information on a regional scale, identifies challenges associated with sustainable groundwater management, and helps guide implementation of diverse resource management strategies. The set of data, information, and analysis developed can help local and regional groundwater managers, as well as individual well owners, better understand California's hidden and commonly misunderstood resource.

Session 25. Meet the Students and More

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

Location: *Sierra 1*

The HOBBS Project Update – Josué Medellín-Azuara (UC Davis)

Collaborators: Quinn Hart, Jay Lund, Samuel Sandoval, Alvar Escriba-Bou, Rui Hui, Mustafa Dogan, Karandev Singh, and Nicholas Santos (UC Davis)

The HOBBS project offers a bottom-up approach and a venue for modelers in California and elsewhere to create an open, organized and documented quantitative representation of the an intertwined water system. This presentation provides an update of the HOBBS project including visualization and editing tool for the California's water supply system, geocoded elements such as storage and conveyance and service areas and metadata capabilities. User interface, database schema and details on the platform employed and future development in the following months will be presented.

California Water Management with Upgraded Hydropower and Reservoir Operations Representation with CALVIN – Mustafa Dogan (UC Davis)

Collaborators: Karandev Singh, Josué Medellín-Azuara, and Jay Lund (UC Davis); Joshua Viers (UC Merced)

Management of water resources is essential in California since it is a place where water is scarce. Allocation of limited resources, therefore, needs careful planning. Computer models have been useful tools to help optimally manage water and to study different management scenarios and alternatives.

CALVIN, an economic-engineering optimization model for California's entire intertied water system, is used to exercise California water management. CALVIN has been recently updated to have better representation of hydropower and reservoir operations, as well as urban and agricultural demand areas and wildlife refuges. Water resources models generally use average energy prices. This can underestimate revenue of energy production. With updated hydropower representation of low-elevation hydropower plants in CALVIN, the effect of releasing water during peak hours are tried to be captured. In addition, the effect of a warm-dry climate scenario on California water supply management is studied, and results are compared with the historical case.

Optimal Conjunctive Use of Surface Water and Groundwater Resources: A Tale of Two Cities in the Delta – Robert Gailey (UC Davis)

The results of a planning study that considers coordinating municipal use of surface water and groundwater are presented. Operations research, or optimization, methods were used to streamline the exploration of conjunctive use options. Seasonal groundwater pumping schedules were developed considering well production capacities, pumping interferences from wells in a neighboring city, and facility management policies. Another constraint on pumping was the potential to draw waters of undesirable quality (naturally occurring high TDS and VOC contamination) into the wellfield. A limited supply of surface water was available to supplement groundwater production in meeting the total demand. The tradeoff between quantity and quality was also addressed by examining the effects of various groundwater quality protection policies on total production capability. It was found that the magnitude of this tradeoff could be reduced through selection of a seasonal allocation of surface water use that was appropriate for the particular set of circumstances in this study.

Optimal Flood Hedging Pre-releases for a Single Reservoir – Rui Hui (UC Davis)

Hedging for flood reservoir operations involves making releases in advance of a storm to make additional storage capacity available in the reservoir, as a way of reducing the probability of more severe flooding. Such pre-releases can involve the likely loss of water supply value and might also involve too large pre-releases to create small floods or increase downstream levee failures under some conditions. This study explores some theoretical conditions for flood hedging to be optimal. A necessary condition for flood hedging in all cases is that damages from flood releases are convex. The convexity in flood damages can arise from convex increasing probabilities of levee failure with flow, convex flood damage functions, or uncertainty in intermediate downstream inflows. Small storms, which are handled relatively easily, and extremely large storms, which overwhelm flood management systems, do not encourage flood hedging operations. The likelihood of intermediate storms that are large but not overwhelming, where the additional flood storage capacity from pre-releases is likely to reduce overall flood damage, drives the optimality of flood hedging pre-releases operations.

Impact of Climate Change on Ecosystem Management in the Central Valley of California – Karandev Singh (UC Davis)

Collaborators: Mustafa Dogan, Josué Medellín-Azuara, and Jay Lund (UC Davis); Rachel Esralew (USFWS); Joshua Viers (UC Merced)

Water is non-optimally distributed across time and space in California. Vast engineering networks were constructed in 1940s and 1960s to move water from places of abundance to places of scarcity; however, at a cost to the State's aquatic ecosystems and freshwater dependent species in terms of reduced environmental flows. The water supply network heavily depends on sociopolitical and economic

constraints that often limit efficiency and discourage equity. Global warming and regional hydroclimatic alteration are likely to exacerbate the water scarcity problem. This research examines the impact of a warm-dry climate scenario, changes in water infrastructure and competing environmental flow demands on water deliveries to eleven National Wildlife Refuges (NWRs) in California's Central Valley. Alternate water management schemes are evaluated to enhance resiliency of NWRs to face uncertainties in water supplies. The study is conducted within a statewide framework to capture the physical, environmental and policy constraints present in the existing water management system. This is achieved by employing CALVIN, a hydro-economic optimization model of the State of California. Historical and a warm-dry form of climate change are explored. Region of Hydrologic Influence (RHI) is determined for each refuge which includes inflows from topographically generated surface water runoff and water delivered through engineered conveyances. Lastly, the NWRs are integrated into the statewide CALVIN model. Several simulation runs are set-up to examine the hydrologic, economic, and ecological consequences of alternative management schemes and climatic scenarios on the NWR water deliveries. Results highlight vulnerabilities in the water supply system, especially competing demand for water earmarked for environmental use and the potential of water markets, water banking and other water management tools to cope with water scarce conditions.

PEST WORKSHOP

John Doherty (Watermark Numeric Computing)

Calibration, Uncertainty Analysis and Model-Based Decision-Making

Many important decisions are made using a "calibrated environmental model"; this may be a groundwater model, surface water model, or a model which integrates both systems. Expensive contracts are signed for the production, review, and use of such models. Implied in many of these contracts, and in the proposals that win these contracts, is that good models are complex models, that better models are even more complex models, and that a model's ability to replicate historical system behaviour ensures its ability to predict future system behaviour. Is this indeed the right recipe for model-based decision-making? If not, then how should models be best developed and deployed to inform decisions and resolve conflicts?

This workshop has two purposes. First it explains and demonstrates the capabilities of the PEST suite of software in model calibration and in calibration-constrained uncertainty analysis. In a basic and easily-understood way, it introduces the theory behind PEST and demonstrates application of this theory, with numerous examples from the real world.

The discussion is then broadened to explore issues that calibration and uncertainty analysis expose. In particular, it investigates how an environmental model can provide receptacles for the two types of information on which decisions pertaining to environmental management are necessarily based, namely expert knowledge and the historical behaviour of that system. The issues of appropriate complexity and the need for "good calibration" are discussed. Particular attention is focussed on the fact that even the most complex model is a grossly imperfect replicator of real-world environmental system behaviour. Conclusions are drawn which question some long-established beliefs of what constitutes "a good model". Suggestions are made of what should be asked of an environmental model when used to support the making of important management decisions.

ANNUAL MEETING PARTICIPANTS

No.	Last	First	Organization	Email Address
1	Abrishamchi	Ahmad	Sharif University	abrisham@sharif.edu
2	Abrishamchi	Ali	Department of Water Resources	Ali.Abrishamchi@water.ca.gov
3	Alexander	Nadya	UC Davis	nadya426@yahoo.com
4	Altare	Craig	MWH	Craig.Altare@mwhglobal.com
5	Anderson	Jamie	Department of Water Resources	jamie.anderson@water.ca.gov
6	Andrews	Stephen	Resource Management Associates	steve@rmanet.com
7	Archer	Mike	MBK Engineers	archer@mbkengineers.com
8	Archibald	Elaine	CWEMF	elaine.archibald@comcast.net
9	Asinas	Emmanuel	Department of Water Resources	emmanuel.asinas@water.ca.gov
10	Ateljevich	Eli	Department of Water Resources	eli.ateljevich@water.ca.gov
11	Barker	Jesse	cbec eco-engineering	j.barker@cbecoeng.com
12	Bartolomeo	Eleanor	State Water Resources Control Board	Ebartolomeo@waterboards.ca.gov
13	Bell	Andy	UC Davis	ambell@ucdavis.edu
14	Bell	Marco	Merced Irrigation District	mbell@mercedid.org
15	Bergfeld	Lee	MBK Engineers	bergfeld@mbkengineers.com
16	Bettencourt	Mark	Department of Water Resources	mark.bettencourt@water.ca.gov
17	Bever	Aaron	Delta Modeling Associates	aaron@deltamodeling.com
18	Bindra	Amy	Department of Water Resources	amarjot.bindra@water.ca.gov
19	Blake	Stephen	DHI US Water Resources	shb@dhigroup.com
20	Bourez	Walter	MBK Engineers	bourez@mbkengineers.com
21	Bray	Benjamin	East Bay Municipal Utility District	bbray@ebmud.com
22	Brian	Joyce	SEI	brian.joyce@sei-us.org
23	Brush	Charles	Department of Water Resources	charles.brush@water.ca.gov
24	Buck	Christina	Butte County Dept. of Water and Resource Conservation	cbuck@buttecounty.net
25	Canada	Holly	David Ford Consulting Engineers	hcanada@ford-consulting.com
26	Cayar	Mesut	RMC Water & Environment	mcayar@rmcwater.com
27	Charles	Young	SEI	cyoung@sei-us.org
28	Chen	Richard	Department of Water Resources	Zhiqiang.Chen@water.ca.gov
29	Chilmakuri	Chandra	CH2M Hill	cchilmak@ch2m.com
30	Chou	Heidi	CH2M Hill	heidi.chou@ch2m.com
31	Chowdhury	Shyamal	Wood Rodgers	schowdhury@woodrodgers.com
32	Chu	Andy	Department of Water Resources	andychu@water.ca.gov
33	Chung	Francis	Department of Water Resources	francis.chung@water.ca.gov
34	Clancey	Katherine	University of Nevada Reno	katherine.clancey@gmail.com
35	Coats	Brian	State Water Resources Control Board	Brian.Coats@waterboards.ca.gov
36	Culkin	Sean	Hydrometrics	sean.culkin@gmail.com
37	Curtis	David	West Consultants	dcurtis@westconsultants.com

No.	Last	First	Organization	Email Address
38	Daniel	Wendell	The Nature Conservancy	dwendell@TNC.ORG
39	Das	Tapash	CH2M Hill	tapash.das@CH2M.com
40	Deas	Mike	Watercourse Engineering	mike.deas@watercourseinc.com
41	DeGeorge	John	Resource Management Associates	jfdegeorge@rmanet.com
42	DiGiorgio	Carol	Department of Water Resources	carol.digiorgio@water.ca.gov
43	Dogan	Mustafa	UC Davis	msdogan@ucdavis.edu
44	Dogrul	Emin	Department of Water Resources	can.dogrul@water.ca.gov
45	Doherty	John	Watermark Numerical Computing	johndoherty@ozemail.com.au
46	Dones	Reginald	U.S. Bureau of Reclamation	rdones@usbr.gov
47	Donigian	Anthony	Aqua Terra Consultants	donigian@aquaterra.com
48	Draper	Andy	MWH	Andrew.J.Draper@us.mwhglobal.com
49	Easton	Daniel	MBK Engineers	easton@mbkengineers.com
50	Edwards	James	Department of Water Resources	James.Edwards@water.ca.gov
51	Ekdahl	Erik	State Water Resources Control Board	Erik.Ekdahl@waterboards.ca.gov
52	Elias	Edwin	Deltares USA, Inc.	Edwin.Elias@Deltares-usa.us
53	Faunt	Claudia	U.S. Geological Survey	cfaunt@usgs.gov
54	Fischer	Frances		fischerfjf@aol.com
55	FitzHugh	Tom	U.S. Bureau of Reclamation	tfitzhugh@usbr.gov
56	Fleenor	William	UC Davis	wefleenor@ucdavis.edu
57	Ford	David	David Ford Consulting Engineers	
58	Frank	Paul	NewFields Consulting	pfrank@newfields.com
59	Gailey	Robert	UC Davis	rngailey@ucdavis.edu
60	Giorgi	Bryant	Department of Water Resources	Bryant.Giorgi@water.ca.gov
61	Guerin	Marianne	Resource Management Associates	maguerin@rmanet.com
62	Haile-Selassie	Samson	Department of Water Resources	samson.haile-selassie@water.ca.gov
63	Hanson	Randy	U.S. Geological Survey	rthanson@usgs.gov
64	Harris	Jeff	West Consultants	jharris@westconsultants.com
65	Harrison	Katrina	U.S. Bureau of Reclamation	kharrison@usbr.gov
66	Harter	Thomas	UC Davis	tharter@ucdavis.edu
67	Hatch	Tyler	CH2M Hill	tyler.hatch@ch2m.com
68	Hemenway	Nathan	34-North	nathan@34north.com
69	Heywood	Brian	CDM Smith	heywoodbj@cdmsmith.com
70	Hillaire	Todd	Department of Water Resources	todd.hillaire@water.ca.gov
71	Hoang	Raymond	Department of Water Resources	Raymond.Hoang@water.ca.gov
72	Hsu	En-Ching	Department of Water Resources	En-Ching.Hsu@water.ca.gov
73	Huang	Guobiao	Department of Water Resources	guobiao.huang@water.ca.gov
74	Huber	Anne	ICF International	Ahuber@jsanet.com
75	Hui	Rui	UC Davis	rhui@ucdavis.edu
76	Huston	Dave	Department of Water Resources	dave.huston@water.ca.gov
77	Hutton	Paul	Metropolitan Water District of Southern California	phutton@mwdh2o.com

No.	Last	First	Organization	Email Address
78	Huxley	Chris	Department of Water Resources	chuxley@woodrogers.com
79	Islam	Nazrul	Department of Water Resources	Nazrul.Islam@water.ca.gov
80	Jayasundara	Nimal	Department of Water Resources	nimal.jayasundara@water.ca.gov
81	Joyce	Brian	SEI	brian.joyce@sei-us.org
82	Juricich	Richard	Department of Water Resources	rich.juricich@water.ca.gov
83	Kabir	Jobaid	U.S. Bureau of Reclamation	jkabir@usbr.gov
84	Kadir	Tariq	Department of Water Resources	tariq.kadir@water.ca.gov
85	Kao	Kevin	Department of Water Resources	kuo-cheng.kao@water.ca.gov
86	Khan	Abdul	Department of Water Resources	Abdul.Khan@water.ca.gov
87	Kjelds	Jesper	DHI US Water Resources	jtk@dhigroup.com
88	Kofoid	Jennifer	Department of Water Resources	Jennifer.Kofoid@water.ca.gov
89	Leaf	Rob	CH2M Hill	rob.leaf@ch2m.com
90	Lee	Sungho	Department of Water Resources	lees@water.ca.gov
91	Lee	Timothy	Kisters International Inc.	Timothy.Lee@kisters.net
92	Li	Wayne	Wood Rodgers	wli@woodrogers.com
93	Liang	Lan	Department of Water Resources	lan.liang@water.ca.gov
94	Liang	Yiguo	Department of Water Resources	yliang@water.ca.gov
95	Lindberg	Brian	Arcadis U.S.	brian.lindberg@arcadis-us.com
96	Liu	Yuan	Contra Costa Water District	yliu@ccwater.com
97	Lord	Ben	UC Davis	bglord@ucdavis.edu
98	Lu	James	U.S. Bureau of Reclamation	jlu@usbr.gov
99	Lui	Mei (Idy)	Department of Water Resources	mei.lui@water.ca.gov
100	Lund	Jay	UC Davis	jrlund@ucdavis.edu
101	MacWilliams	Michael	Delta Modeling Associates	michael@deltamodeling.com
102	Maendly	Romain	Department of Water Resources	romain.maendly@water.ca.gov
103	Malakpet	Chakri	CH2M Hill	chakradhar.malakpet@ch2m.com
104	Maples	Stephen	UC Davis	smap@ucdavis.edu
105	Marcinkevage	Cathy	National Oceanic and Atmospheric Administration	cathy.marcinkevage@noaa.gov
106	Massera	Paul	Department of Water Resources	paul.massera@water.ca.gov
107	Mayr	Shawn	Department of Water Resources	shawn.mayr@water.ca.gov
108	McCord	Stephen	McCord Environmental	sam@mccenv.com
109	Medellin-Azuara	Josue	UC Davis	jmedellin@ucdavis.edu
110	Mehl	Steffan	Chico State University	smehl@csuchico.edu
111	Miller	Aaron	Department of Water Resources	Aaron.Miller@water.ca.gov
112	Morel-Seytoux	Hubert	Hydroprose	hydroprose@sonic.net
113	Munevar	Armin	CH2M Hill	armin.munevar@CH2M.com
114	Nam	Kijin	Department of Water Resources	kijin.nam@water.ca.gov
115	Nichol	George		george.nichol@comcast.net
116	Nickel	Arlan	U.S. Bureau of Reclamation	anickel@usbr.gov

No.	Last	First	Organization	Email Address
117	Nishikawa	Tracy	U.S. Geological Survey	tnishikawa@usgs.gov
118	Nordberg	Mark	Department of Water Resources	Mark.Nordberg@water.ca.gov
119	O'Connor	David	U.S. Bureau of Reclamation	doconnor@usbr.gov
120	Osti	Amye	34-North	amy@34north.com
121	Parker	Nancy	U.S. Bureau of Reclamation	nparker@usbr.gov
122	Parvathinathan	Shankar	MWH	shankar.parvathinathan@mwhglobal.com
123	Pettit	Tracy	Department of Water Resources	Tracy.Pettit@water.ca.gov
124	Phillips	Steve	U.S. Geological Survey	sphillip@usgs.gov
125	Pingel	Nathan	David Ford Consulting Engineers	Pingel@ford-consulting.com
126	Porta	Lisa	CH2M Hill	lporta@ch2m.com
127	Prakash	Pavithra	Indian Institute of Technology	pavi.iitm@gmail.com
128	Quan	Chris	Department of Water Resources	chris.quan@water.ca.gov
129	Quinn	Nigel	Berkeley National Laboratory/Reclamation	nwquinn@lbl.gov
130	Rachiele	Richard	Resource Management Associates	richard@rmanet.com
131	Rajbhandari	Hari	Department of Water Resources	hari.rajbhandari@water.ca.gov
132	Rayej	Mohammad	Department of Water Resources	Mohammad.Rayej@water.ca.gov
133	Reyes	Erik	Department of Water Resources	erik.reyes@water.ca.gov
134	Safran	Sam	San Francisco Estuary Institute	sams@sfei.org
135	Saito	Laurel	University of Nevada Reno	lsaito@cabnr.unr.edu
136	Sandhu	Nicky	Department of Water Resources	prabhjot.sandhu@water.ca.gov
137	Satkowski	Richard	State Water Resources Control Board	rsatkowski@waterboards.ca.gov
138	Scavone-Tansey	Marcia	Department of Water Resources	marcia.scavone-tansey@water.ca.gov
139	Schafer-Kramer	Jane	Department of Water Resources	jane.schafer-kramer@water.ca.gov
140	Schwarz	Andrew	Department of Water Resources	Andrew.Schwarz@water.ca.gov
141	Seneviratne	Sanjaya	Department of Water Resources	sanjaya.seneviratne@water.ca.gov
142	Sereno	Deanna	Contra Costa Water District	dsereno@ccwater.com
143	Shahcheraghi	Reza	Department of Water Resources	rezas@water.ca.gov
144	Shih	Lucinda	Contra Costa Water District	lshih@ccwater.com
145	Singh	Karandev	UC Davis	singh.karandev@gmail.com
146	Slaweki	Tad	LimnoTech	tad@limno.com
147	Smith	Don	Resource Management Associates	don@rmanet.com
148	Smith	Peter	Peter Smith	pesmith07@comcast.net
149	Smith	Tara	Department of Water Resources	tara.smith@water.ca.gov
150	Sumargo	Edwin	UC San Diego	esumargo@ucsd.edu
151	Sumer	Derya	CH2M Hill	dsumer@ch2m.com
152	Swift	Ted	Department of Water Resources	ted.swift@water.ca.gov
153	Tagavi	Ali	RMC Water & Environment	Ataghavi@rmcwater.com
154	Tana	Cameron	Hydrometrics	Cameron@HydroMetricsWRI.com
155	Tanaka	Stacy	Watercourse Engineering	stacy.tanaka@watercourseinc.com

No.	Last	First	Organization	Email Address
156	Tansey	Michael	U.S. Bureau of Reclamation	mtansey@usbr.gov
157	Thomas	Emily	U.S. Bureau of Reclamation	ethomas@usbr.gov
158	Thomas	Jeremy	CH2M Hill	jeremy.thomas@ch2m.com
159	Thompkins	Mark	NewFields Consulting	mtopmpkins@newfields.com
160	Thompson	David	R.O. Anderson Engineering	drdbthompson@gmail.com
161	Thompson	Lisa	Regional San	thompsonlis@sacsewer.com
162	Tomkovic	Lily	UC Davis	LilyTomkovic@gmail.com
163	Trahan	Alex	Arcadis U.S.	alex.trahan@arcadis-us.com
164	Traum	Jon	U.S. Geological Survey	jtraum@usgs.gov
165	Triana	Enrique	MWH	enrique.triana@mwhglobal.com
166	Tu	Ming-Yen	Department of Water Resources	ming-yen.tu@water.ca.gov
167	Van Lienden	Brian	CH2M Hill	bvanlien@CH2M.com
168	Wang	Chuching	Metropolitan Water District of Southern California	cwang@mwdh2o.com
169	Wang	Jay	Department of Water Resources	jianzhong.wang@water.ca.gov
170	Wang	Xiaochun	Department of Water Resources	Xiaochun.Wang@water.ca.gov
171	Wendell	David	The Nature Conservancy	dwendell@TNC.ORG
172	White	Kristin	U.S. Bureau of Reclamation	knwhite@usbr.gov
173	Winslow	Kyle	CH2M Hill	kyle.winslow@ch2m.com
174	Wittler	Rodney	U.S. Bureau of Reclamation	rjwittler@usbr.gov
175	Wolfe	John	LimnoTech	jwolfe@limno.com
176	Woolfenden	Linda	U.S. Geological Survey	lwoolfenden@usgs.gov
177	Work	Paul	U.S. Geological Survey	pwork@usgs.gov
178	Xie	Hao	Department of Water Resources	hao.xie@water.ca.gov
179	Yamanaka	Dan	Department of Water Resources	Dan.Yamanaka@water.ca.gov
180	Yarmout	Ghina	Weston Solutions	ghinay@gmail.com
181	Yin	Hongbing	Department of Water Resources	hongbing.yin@water.ca.gov
182	Yonts	Travis	U.S. Bureau of Reclamation	tyonts@usbr.gov
183	Young	Charles	SEI	cyoung@sei-us.org
184	Yu	Min	Department of Water Resources	min.yu@water.ca.gov
185	Zhang	Yun	Stanford University	zhangyun.zhy@gmail.com
186	Zhao	Gang	Flow Science	gzhao@flowscience.com
187	Zhao	Haihong	Arcadis U.S.	haihong.zhao@arcadis-us.com
188	Zhong	Liheng	Department of Water Resources	Liheng.Zhong@water.ca.gov
189	Zuber	Amy	Department of Water Resources	amy.zuber@water.ca.gov



CALIFORNIA WATER AND ENVIRONMENTAL MODELING FORUM

STRATEGIC PLAN 2015-2018

ADOPTED MARCH X, 2015

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INTRODUCTION

The California Water and Environmental Modeling Forum (CWEMF) was formed in 1994. CWEMF is a statewide, nonprofit, non-partisan organization of scientists, engineers, and other professionals who work on the modeling efforts related to California water issues. This strategic plan sets the direction of CWEMF and guides its operations for the next several years.

CWEMF is a volunteer organization with a part-time Executive Director. The Steering Committee serves as the body that oversees all aspects of CWEMF's activities, and reports to the full membership at the Annual Meeting. CWEMF has two forms of membership, organizational and individual. CWEMF's organizational members currently consist of agencies and consulting firms who pay dues as an entity, meaning that their employees are members of CWEMF. Other people join as individual members.

CWEMF has historically organized and hosted an Annual Meeting, administered impartial peer reviews of models, and organized workshops. These are considered to be the core activities of the organization.

MISSION

CWEMF is a non-profit, non-partisan organization whose mission is to increase the usefulness of models and technical analysis tools for evaluating California's water-related problems and to provide a collaborative forum for advancing knowledge on water issues.

GOALS

CWEMF has identified five goals to guide its future activities.

1. Provide educational opportunities through technical conferences, workshops, and documents
2. Administer impartial peer reviews of water and environmental models
3. Support interdisciplinary and collaborative water and environmental modeling initiatives
4. Maintain a strong financial base
5. Maintain relevance

Each of these goals and strategies to achieve them are described in detail below.

1. Provide Educational Opportunities through Technical Conferences, Workshops, and Documents

CWEMF strives to promote the professional development of scientists, engineers, and others involved in modeling within the water community. This is primarily achieved through the Annual Meeting and workshops.

Strategy 1.1 - Conduct and improve the Annual Meeting

The Annual Meeting is the core educational activity of CWEMF. CWEMF will maintain the practice of developing new relevant sessions, topics, and content. CWEMF will also investigate new features that may further increase attendance and may broaden the attendance and topics presented at the Annual Meetings. Potential new features could include training workshops, hot topics discussions, an expanded poster session, a vendor exhibition, increased and improved student participation, and publishing proceedings of the Annual Meeting on the CWEMF website.

Strategy 1.2 – Host workshops

One of CWEMF's core activities is to organize, plan, and execute educational workshops on models, modeling topics, and key issues in California water. The workshops are generally well-attended, receive positive reviews from attendees, and frequently attract new members. CWEMF strives to ensure that the workshops and materials prepared for the workshops are of high quality. The Vice-Convenor maintains the list of potential workshop topics and works with others to develop new topics for the modeling community. The goal is to host at least one workshop per quarter.

To broaden workshop topics, CWEMF will consider bringing experts together in a workshop format to solve problems on issues consistent with CWEMF's mission. To the extent possible, these workshops will be cost-neutral. As needed, subcommittees of the Steering Committee could be formed to oversee these workshops.

2. Administer Impartial Peer Reviews of Water and Environmental Models

An additional core activity is to administer peer reviews of models in accordance with procedures established by the Steering Committee. The purposes of CWEMF peer reviews are to document strengths and weaknesses of models and their documentation, suggest improvements, assess the suitability for intended applications, and advance the state of the art of models.

3. Support Interdisciplinary and Collaborative Water and Environmental Modeling Initiatives

CWEMF developed "*A Strategic Analysis Framework for Managing Water in California*" in 2005, calling for the state to develop a coherent set of databases and models with broad-based support. In 2013 the Delta Stewardship Council's Delta Science Plan called for development of "a framework for collaborative community modeling to enhance interdisciplinary modeling, accelerate new understanding, avoid duplication of efforts, and support diverse modeling approaches." CWEMF assisted the Delta Science Program in these efforts in 2014, as little progress has been made on the goals of the "Strategic Analysis Framework" since 2005.

Strategy 3.1 - Support efforts to improve existing models and develop new models to answer future more complex questions

CWEMF is in a unique position to assist in identifying modeling needs and using this information to address increasingly complex questions through improved models, data collection, and overall system characterization. The Steering Committee has determined that CWEMF will expand its activities by conducting special projects. This could be done by CWEMF members, by collaborating with other organizations, or by contracting with a consultant. CWEMF may financially support some projects but may need to obtain outside funding to support larger projects. The Steering Committee will regularly develop a list of top priority projects and be prepared to initiate projects when funding and volunteers to lead the effort have been obtained.

Strategy 3.2 – Support the development of conceptual models.

CWEMF may assist groups in the development of conceptual models, including interdisciplinary models. It is preferable to develop conceptual models prior to the initiation of any modeling initiatives. These conceptual models can be used to assist in identifying the data needed to be collected to support the modeling effort.

4. Maintain a Strong Financial Base

CWEMF will maintain a strong financial base to carry out the mission and core functions of the organization.

Strategy 4.1 – Establish and monitor an annual budget

The Treasurer establishes a budget for each fiscal year, and a budget is adopted by the Steering Committee at a meeting preceding the start of the fiscal year. The Treasurer provides a report at each Steering Committee meeting comparing income and expenses to the budget. The budget items are reviewed annually to ensure compatibility with the Mission Statement and that it reflects changing needs and priorities.

Strategy 4.2 – Maintain a diverse funding base

CWEMF is currently funded primarily by membership dues and revenue from the Annual Meeting. Possible funding sources include increasing the number of organizational members, revenue from workshops, grant funding, and funding from organizations that request peer reviews of models or otherwise need CWEMF's services. The Steering Committee may also explore additional funding options.

Strategy 4.3 – Maintain integrity and transparency of CWEMF's accounting records

The CWEMF Executive Director and Treasurer maintain independent accountings of CWEMF's finances, which are reconciled prior to each Steering Committee meeting. CWEMF will procure an external audit of the accounting records whenever an Executive Director or Treasurer announces he/she is resigning to ensure that CWEMF is in compliance with state and federal regulations, that the new Executive Director

or Treasurer takes over with a clean set of accounting records, and that there are sufficient controls to prevent fraudulent use of CWEMF's funds.

5. Maintain Relevance

CWEMF strives to be recognized as an impartial forum on topics regarding modeling methodology and technical analysis tools. In addition, CWEMF strives to broaden its membership, expand the number of CWEMF members who actively participate in CWEMF's activities, and increase outreach.

Strategy 5.1 – Maintain a strong, representative membership

CWEMF will recruit members who are involved in modeling activities by demonstrating the value of becoming a member.

Strategy 5.2 – Increase participation

CWEMF will strive to increase volunteer participation in areas where the need for assistance is identified. The Steering Committee will explore options for increasing volunteer participation by CWEMF members.

Strategy 5.3 – Evaluate CWEMF's activities

To maintain relevance of current activities and to continuously evaluate potential future activities, CWEMF will identify, through outreach to membership and the modeling community, activities that support CWEMF's mission and goals. The Steering Committee will appoint subcommittees to evaluate the identified activities and recommend implementation strategies.

Strategy 5.4 – Increase visibility

CWEMF will increase its visibility to reach a broad audience and advance its mission. The Steering Committee will explore activities such as partnering with other organizations and increasing communication with the CWEMF membership.

ACTION PLAN

This Strategic Plan provides the framework for achieving CWEMF's mission and goals. The Steering Committee will develop an annual Action Plan to implement the strategies described in this Strategic Plan.