California Water and Environmental Modeling Forum

2016 ANNUAL MEETING SESSION ABSTRACTS

With Links to Speaker Presentations

ABSTRACTS[1]

Session 1. DSM2 Development and Applications

1. Delta Salinity Simulation with DSM2-GTM 3.3 MB

Presenter(s): En-Ching Hsu (California Department of Water Resources)
Presenter(s) Email Address(es): En-Ching.Hsu@water.ca.gov
Collaborators: Eli Ateljevich, Nicky Sandhu
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
DWR's Delta Modeling Section is developing a new DSM2 transport module, the General Transport Model (DSM2-GTM). DSM2-GTM employs a fixed (Eulerian) mesh rather than one that moves with flow (Lagrangian). The fixed grid will make it easier for the model to interact with other models, georeferenced data, data assimilation, optimization and visualization, as well as to couple inline to Hydro .The new model is also much more straightforward to extend to new physical processes, with sediment, dissolved oxygen and mercury cycling models in the works. Because of its extensibility, DSM2-GTM is expected to replace DSM2-QUAL model. With the historical delta EC simulation from Jan 1999 to Apr 2012 and the calibrated dispersion coefficients from current DSM2-QUAL, DSM2-GTM shows consistent results compared to DSM2-QUAL and also match historical EC data at key locations fairly well.

2. Challenges and Progress on Extending DSM2 for Mercury and Sediment 2.6 MB

Presenter(s): Jamie Anderson (DWR)
Presenter(s) Email Address(es): Jamie.Anderson@water.ca.gov
Collaborators: En-Ching Hsu, Nicky Sandhu, Tara Smith, Carol DiGiorgio (DWR) and Reed Harris and Dave Hutchison (Reed Harris Environmental Ltd)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The Delta Simulation Model 2 (DSM2) is being extended to include mercury and sediment. The development of a modernized General Transport Model (GTM) for DSM2 provides the foundation for extending the processes that are represented in DSM2. Mercury and sediment are being added to DSM2/GTM in part to support Department regulatory compliance with the Delta Mercury Control Program. One of the goals of this expanded modeling capability is to understand if Delta methylmercury production will increase or decrease with changes in water project operations. The goals and study methodology will be discussed as well as progress and challenges to date.

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

3. Synthesizing Data, Isotope Analyses and DSM2 Nutrient Model Output to Characterize Nutrient Transformations in the Delta 1.9 MB

Presenter(s): Dr. Marianne Guerin (Resource Management Associates)
Presenter(s) Email Address(es): maguerin@rmanet.com
Collaborators: C. Kendall, S. Peek, and M. Young (USGS);
E. Novick, R. Holleman, T. Jabusch, J. Sun, P. Trowbridge, and D. Senn (SFEI)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The Sacramento-San Joaquin Delta receives nutrient loads from wastewater treatment effluent and agricultural runoff and, after these loadings transverse a network of rivers, channels and flooded islands, nutrients are ultimately delivered to San Francisco Bay. This talk outlines selected results from a recent study using the DSM2 nutrient model and various data sources to quantify the relative importance of transformation, uptake/burial, and other nutrient loss processes within the Delta. The analysis focused only on nitrogen, including loads, cycling, and losses or transformations that influence its ultimate fate. The specific goals of this study were to use a combination of data analysis and results of a recalibrated historical DSM2 nutrient model to:

1. Analyze seasonal and spatial variability in nitrogen forms and concentrations, as an indicator of potential transformation within the Delta
2. Quantify the capacity of the Delta to transform nitrogen using a mass balance approach
3. Use additional supporting water quality and isotope data to hypothesize what are the dominant processes controlling nutrient fate (transformation vs. uptake/burial vs. other loss processes).

4. Modeling Salinity in the San Francisco Bay-Delta Estuary using Artificial Neural Networks

Presenter(s): Sujoy B. Roy (Tetra Tech)
Presenter(s) Email Address(es): Sujoy.roy@tetratech.com
Collaborators: Paul Hutton, John Rath, and Limin Chen
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Improved modeling of salinity in the San Francisco Bay-Delta estuary is of benefit for water project operations and long-term planning scenarios. Using a salinity dataset for water years 1922-2012, this work explored different artificial neural network (ANN) model structures to predict salinity levels in the estuary, including data driven approaches and hybrid approaches that integrate neural networks within an existing empirical modeling framework. Model performance was evaluated by considering the quality of fit to observed data (termed replicative and predictive validation) as well as plausibility when compared with *a priori* knowledge of system behavior (termed structural validation). We found that, in general, larger data driven networks provided superior data fits but were less consistent in representing the expected sensitivity response to coastal water level. Smaller networks, provided consistent responses, but had poorer fits overall. Based on this finding, development focused on hybrid ANNs, coupling ANNs with a successful empirical model, and where the model parameters were constrained to provide plausible sensitivity to water level inputs in a Bayesian parameter estimation framework. The resulting hybrid models met both predictive and structural validation goals, with a better ability to represent the observed data than the underlying empirical model, and are recommended for future consideration.

Session 2. Water Availability and Water Rights Modeling for State Water Board Processes

1. 2015 Water Availability Analyses in the Sacramento-San Joaquin, Russian River, and Eel River Watersheds

Presenter(s): Jeff Yeazell (SWRCB)
Presenter(s) Email Address(es): jeff.yeazell@waterboards.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: No
Abstract:
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 2015, 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 unavailability notices in 2015. Later in the year, another analysis was initiated to monitor conditions in each of the affected watersheds to determine when water would be available for direct diversion or diversion to storage.

2. Update on the Drought Water Right Allocation Tool

 **2.9 MB**

Presenter(s): Chad Whittington (UC Davis)
Presenter(s) Email Address(es): ccwhittington@ucdavis.edu
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The Drought Water Rights Allocation Tool (DWRAT) is an integrated set of water right allocation models and databases to suggest water right curtailments during drought. In the 2013-2014 water year, the State Water Resources Control Board issued water right curtailments for the first time since 1976-1977. As California's population rises and its water quality standards become more stringent, water supplies will become even scarcer and curtailments will likely be issued more commonly. Future droughts are increasingly likely to require formal, transparent, and data-based curtailment of water rights. Therefore, a mathematically precise and transparent method of issuing water right curtailments is needed.

DWRAT offers an approach to fully allocate California's limited water supplies by employing mathematical representations of riparian and appropriative water law doctrines across basins with spatially varying supply and demand. DWRAT can aid the State Water Resources Control Board in making effective water right curtailment decisions and better inform water right holders on current and likely curtailment conditions. These methods can be extended to assess water reliability and the probability of curtailment for each right holder. DWRAT is compiled within an Excel workbook, which

includes a user-friendly interface and an open-source solver that allows for straightforward model runs and easily interpretable results. This presentation primarily focuses on applications of DWRAT for the Russian River, but the tool is also being developed for the Eel, Sacramento, and San Joaquin rivers.

3. **Water Supply Effects Modeling Analyzing San Joaquin Tributary Streamflow Requirements as Part of the SWRCB Bay-Delta Pan Update Process** 3.1 MB

Presenter(s): Will Anderson (SWRCB)
Presenter(s) Email Address(es): will.anderson@waterboards.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The State Water Resources Control Board has developed a Water Supply Effects (WSE) spreadsheet model to evaluate the effects of proposed streamflow requirements for the lower San Joaquin, Stanislaus, Tuolumne, and Merced Rivers. The approach utilizes a water balance framework from CALSIM II to represent reservoir inflow, diversion, and return flow nodes. Streamflow requirements are based on a percentage of unimpaired flow in the months February-June, in addition to existing salinity and streamflow requirements at Vernalis, and existing fish flows in the tributaries. Water allocation is based on historical demand levels derived from Agricultural Water Management Plans for the five largest irrigation districts. Reservoir operations and available water are modulated by carryover storage guidelines, minimum diversion allocations, and a refill constraint following major droughts. Alternatives for streamflow implementation are compared to baseline and evaluated for effects on water supply, groundwater, and instream temperature.

4. **Update on SacWAM: A WEAP-based Simulation Tool for Bay-Delta Water Quality Control Planning** 0.6 MB

Presenter(s): Scott Ligare (SWRCB)
Presenter(s) Email Address(es): scott.ligare@waterboards.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The State Water Resources Control Board, Stockholm Environment Institute, and MWH have developed the Sacramento Valley Water Allocation Model (SacWAM) to support alternative operations analyses for the Phase II update of the Bay-Delta Water Quality Control Plan. The model, developed in the WEAP software uses a system of supply preferences and demand priorities to allocate water and operate reservoirs. To simulate “current conditions”, SacWAM has a system of 33 discrete priorities that range in value from 0-99. Alternative operational scenarios can be explored by changing the demand priorities within the model.

Session 3. Incorporating Water Right Based Diversions into CalSim

1. Incorporating Water Right Based Diversions into CalSim – Session Introduction 0.3 MB
Presenter(s): Hongbing Yin (California Department of Water Resources)
Presenter(s) Email Address(es): Hongbing.Yin@water.ca.gov
Collaborators: Liheng Zhong, Richard Chen, Mei Lui (Idy), Guobiao Huang, Jianzhong(Jay) Wang, Hao Xie, Erik Reyes, and Francis Chung (California Department of Water Resources)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
In this session, we would like to report the team effort made by the DWR/BDO staff to incorporate the water rights based diversions into CalSim. In times of consecutive drought years as California has experienced over the last 4-years, the water supply in the state becomes very tight; while the water demand, due in part to a of lack of local or regional water supply and above average temperatures as has been for the last several years, grows. During a prolonged drought, diversions to water users with relatively junior water rights in the Sacramento Valley may need to be curtailed in order to meet the water needs of more senior water rights holders. To emulate such water right based water deliveries, an initial attempt is made to incorporate water rights into a water systems model, CalSim. Two modes of applications are being designed: one in a long-term planning context, and the other in a real-time context. To enable a real-time simulation, it is necessary to project and forecast the land use, stream flows, and water demands for the remainder of the water year. This effort is in its infancy at the moment due to a lack of data and processes. The initial results, however, show that the approach is promising and can be further improved with additional data and model development.

2. Water Rights Mapping into CalSim 1.5 MB
Presenter(s): Liheng Zhong (California Department of Water Resources)
Presenter(s) Email Address(es): Liheng.Zhong@water.ca.gov
Collaborators: Richard Chen and Hongbing Yin (California Department of Water Resources)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
In order to incorporate water rights into the CalSim model, detailed water rights records obtained from the SWRCB database and archives have to be processed and mapped to each individual Demand Unit, the basic spatial modeling unit of CalSim. In this initial attempt, 112 major water rights, which represent approximately 70% of the non-project water rights demand in Sacramento Valley, were selected. These selected major water rights were then analyzed and associated with the demand units of CalSim based on spatial overlay in GIS. Geospatial layers from multiple sources were utilized to facilitate locating water rights, including CalSim Demand Units, water rights points of diversions, water district boundaries, National Hydrography Dataset, Public Land Survey System, etc. Place of Use maps associated with water rights documents were scanned and digitized as necessary. A few examples are presented with details to demonstrate the case-by-case process, in which assumptions and expert judgements are involved.

3. Land Use Projection for CalSim 0.7 MB

Presenter(s): Liheng Zhong (California Department of Water Resources)
Presenter(s) Email Address(es): Liheng.Zhong@water.ca.gov
Collaborators: Hongbing Yin (California Department of Water Resources)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Up-to-date agricultural land use data is essential for the projection of the crop water requirement later in the water year. However, such an up-to-date agricultural land use dataset with spatial distribution does not exist in reality. In order to overcome such a data shortage, land use from multiple sources including in-house data development were utilized to come up with an approximate Sacramento Valley-wide up-to-date land use. Such valley-wide land use can be quickly updated accordingly whenever a new piece of land use information becomes available.

4. CalSim Rim Inflow Projection 1.3 MB

Presenter(s): Guobiao Huang and Jianzhong (Jay) Wang (California Department of Water Resources)
Presenter(s) Email Address(es): Guobiao.Huang@water.ca.gov, Jianzhong.Wang@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
SWAT (Soil Water Assessment Tool), a precipitation-runoff model, was used to simulate stream flows for most rim watersheds of the Central Valley. SWAT, which is a public domain, generic, semi-distributed hydrologic model developed by the U.S. Department of Agriculture, provides a tool for using observed precipitation and air temperature data to estimate runoff generation from a watershed. Twenty-three SWAT models were developed and calibrated to match available unimpaired observed streamflow data at different rim watershed outlets for the whole Central Valley. The SWAT model set up is based on existing land use conditions, land surface elevations, soils, and stream geomorphology. The calibrated daily time step SWAT models can be frequently updated with newly available daily precipitation and air temperature data (e.g. PRISM or DAYMET data). Therefore, from a known initial condition at a given time, future weather projection can be used as SWAT input to generate rim inflow projections for use in CalSim water rights simulations. Since SWAT models have not been fully calibrated for all CalSim rim inflow locations, flow mapping is applied to transfer streamflow projections information at SWAT model outlets to CalSim rim inflow locations.

5. A CalSim Model for Water Rights Diversion in Sacramento Valley 0.5 MB

Presenter(s): Z.Q. Richard Chen (California Department of Water Resources)
Presenter(s) Email Address(es): ZhiQiang.Chen@water.ca.gov
Collaborators: Liheng Zhong and Hongbing Yin (California Department of Water Resources)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
A CalSim model for water rights diversions in Sacramento Valley (CalSim3WR) is being developed. Water rights diversions can be simulated using projected land uses, rim inflows, and other water rights information as the input to CalSim3WR. A refined version of this model may one day be useful for making curtailment decisions.

Information of individual water rights is incorporated in the model based on a CalSim schematic and the spatial overlay of its locations and CalSim demand unit coverages in GIS. Priority of each water rights applicant is assigned based on seniority when water shortage occurs. Model constraints such as seasonal diversion limit and diversion priority are applied to each demand unit for all relevant water rights. CalSimHydro is used to estimate the upper limit of beneficiary water use at each demand unit based on its existing land use information.

Modeling conceptualization, model structure, initial result, and future development will be presented.

Session 4. Riverine and Alluvial Fan Flood Modeling

1. **Changing Flood Risks in the Central Valley under Climate Change** 7.8 MB

Presenter(s): Armin Munévar, CH2M

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

Collaborators: Tapash Das, CH2M; Michael Anderson, DWR

Permission to Post pdf of Presentation on CWEMF Website: Yes

Abstract:

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

2. **Atmospheric Conditions Associated with Extreme Precipitation and Post-fire Debris Flows on Alluvial Fans - Transverse Ranges, Southern California** 5.5 MB

Presenter(s): Jeremy T. Lancaster, California Geological Survey, Sacramento, CA

Presenter(s) Email Address(es): Jeremy.Lancaster@conservation.ca.gov

Collaborators: Nina Oakley, Western Regional Climate Center - Desert Research Institute, Reno, NV

Permission to Post pdf of Presentation on CWEMF Website: Yes

Abstract:

The Transverse Ranges of southern California are known to experience the sequence of fire and flood, often generating post-fire debris flows (PFDF) that pose a threat to life and property situated on alluvial fans. The combination of steep topography, rock and soil composition, and wildfire, coupled with intense rainfall, can initiate PFDF even in cases of low storm rainfall totals. Established

rainfall triggering thresholds have led to better forecast planning in the near term; however, recognition of atmospheric conditions present at the time of triggering rainfall may enhance our capability to provide advanced warning and inform research on past events.

This study identifies atmospheric conditions during which convective cells are most likely to develop, focused on the cool season (November-April). A compilation of 100 PFDF events, triggered by 19 storms located within the Transverse Ranges of southern California was compared against precipitation, radar, and satellite imagery to confirm or revise debris flow trigger times. A meteorological case study was built for each storm event using the North American Regional Reanalysis (Mesinger et al. 2006) dataset. Each case study was analyzed to determine common atmospheric features and range of values of meteorological variables present at the trigger time of a PFDF. Preliminary results show atmospheric rivers are a dominant feature, observed in 14 of the 19 storm events. This understanding along with other common features observed can be applied to the interpretation of weather forecast model output to improve early warning and reduce forecaster uncertainty for future PFDF occurrence.

3. Alluvial Fan Flood Hazards and Modeling in the Coachella Valley

Presenter(s): Jimmy Pan (NHC) and/or Brady McDaniel (NHC)

Presenter(s) Email Address(es): jpan@nhcweb.com; bmcdaniel@nhcweb.com

Collaborators: Tesfaye Demissie (CVWD); Dan Charlton (CVWD); Mark Johnson (CVWD); Aric Torreyson (Tetra Tech); Brent Wolfe; Andrey Shvidchencko (NHC) and Brent Wolfe (NHC)

Permission to Post pdf of Presentation on CWEMF Website: No

Abstract:

The presentation will focus on alluvial fan projects within the Coachella Valley that were commissioned by the Coachella Valley Water District (CVWD) and completed or reviewed by Northwest Hydraulic Consultants (NHC). The projects are components of CVWD's master planning studies that assess flood hazards and guide development in the Coachella Valley.

The presentation will highlight individual projects and the modeling methods applied, which include HEC-HMS, DHI's MIKE Flood, HEC-RAS 2D and the FEMA FAN program. The projects presented will highlight different environments and methods used to assess alluvial fan flood hazards. Specific project features presented will likely include: 2D Modeling of a system using flow path uncertainty to assess peak discharges and overall hazards; modeling a system that has alluvial fan and riverine flows; assessing levee conditions directly downstream of alluvial fans for certification; and defining fan extents and flood hazards using the FEMA FAN program.

Additionally, a comparison of MIKE Flood and HEC-RAS 2D floodplain extents on the bajada surface downhill of alluvial fans will be presented. The models were run for the same project area and boundary conditions. General observations between the two models for this example project will be presented.

4. **Modeling Subsidence in the Central Valley and Evaluating the Current and Future Impact on Flood Risk** 3.5 MB

Presenter(s): Mary Horvath (CH2M)
Presenter(s) Email Address(es): Mary.Horvath@ch2m.com
Collaborators: David Arrate (DWR); Devinder Dhillon (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The extensive withdrawal of groundwater and resulting compaction of the aquifer-system within the San Joaquin Basin is causing land subsidence. The situation, exacerbated by the current drought conditions, is expected to worsen in the next 50-100 years. Using current measured rates of subsidence, the California Department of Water Resources (DWR) has projected the subsidence that is likely to occur by mid-century within the upper San Joaquin Basin. The depths of this projected subsidence vary from approximately 6 feet at the Chowchilla Bifurcation structure to up to 17 feet in areas near the Sand Slough diversion, decreasing northward to near zero at the confluence of the San Joaquin and Tuolumne Rivers. Impacts of this variable subsidence will be changes to the Eastside Bypass capacity and adjustments of the flow delivery patterns within the San Joaquin River system. As part of the San Joaquin Basin Wide Feasibility Study and 2017 Central Valley Flood Protection Plan update, DWR has examined capacity impacts of the projected subsidence using Central Valley Evaluation and Delineation (CVFED) and Central Valley Hydrology Study (CVHS) tools. The CVFED hydraulic models were modified to reflect projected subsidence and run with flows taken from CVHS that replicate 1) flood conditions and 2) events that match the design capacity of the Eastside Bypass. The resulting water surface elevation profiles and floodplain inundation depths were then compared to baseline conditions. Impacts of subsidence include decreased capacity in Eastside Bypass and adjacent additional floodplain inundation in both flood conditions and more frequent design events.

5. **2D Modeling for the San Joaquin Basin-Wide Feasibility Study to Evaluate Multi-Benefit Projects** 1.3 MB

Presenter(s): Devinder S. Dhillon, P.E.
Presenter(s) Email Address(es): Devinder.Dhillon@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
California Department of Water Resources (DWR) is currently developing two State-led Basin-Wide Feasibility Studies (BWFS), one in the Sacramento River Basin and one in the San Joaquin River Basin. The BWFS will evaluate approaches to reduce flood risk in the Central Valley while providing multi-benefits, including ecosystem restoration opportunities. The BWFS will inform the 2017 update of the Central Valley Flood Protection Plan (CVFPP).

To evaluate multi-benefit projects, a new two-dimensional (2D) hydraulic model software, HEC-RAS, with 2D flow areas, has been applied to the San Joaquin BWFS. The first application of HEC-RAS 2D was to develop flow-inundation relationships to facilitate formulation of ecosystem restoration concepts in the San Joaquin River Basin through identifying the alternative with maximum inundation, and thus maximizing the proposed ecosystem benefits. The second application was to develop inundation maps for the Stockton area. The simulated inundation maps were used to evaluate flood hazards, flooding of critical facilities and other benefits such as avoided loss of transportation and power.

Session 7. CalSim and CalLite Model Applications

1. CalSim and CalLite Model Updates

Presenter(s): Raymond Hoang(DWR), Nur Taraky (DWR)
Presenter(s) Email Address(es): Raymond.Hoang@water.ca.gov, Nur.Taraky@water.ca.gov
Collaborators: Nazrul Islam (DWR), Chris Quan (DWR), Karandev Singh (DWR), MBK Engineers, CH2M
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
This presentation is overview of model updates for CalSim/CalLite and will consist of three sub-sections.

CalLite Updates: Two modules are being added to CalLite to enhance its modeling and post-processing capabilities. (1) CalLite Power Module post-processes the data from CalLite simulation to predict energy, capacity, revenue, and cost of power plants throughout CVP and SWP. (2) CalLite Tulare Basin Module implements a full water balance including return flows, reuse, and groundwater representation of Tulare Lake Basin in CalLite model and GUI.

CalSim Updates: DWR has released the 2015 Delivery Capability Report (DCR) and updated its companion CalSim II study. The 2015 DCR study is an updated version of the 2013 DRR CalSim II study. Updates include changes to the WSI-DI curve generation method, EBMUD allocation, Dynamic FRSA Rice Decomposition and updates from U.S. Bureau of Reclamation.

CalSim/CalLite Post-Processing Tool: A standalone CalSim/CalLite post-processing tool is in development. The objective is to create a standard post-processing platform on which CalSim/CalLite study results can be viewed and analyzed. This tool is expected to include 70%-80% of the post-processing features that are used on a regular basis. The target audience for this tool ranges from policymakers to model developers. As such, it must feature a wide spectrum of functionalities, supported by an intuitive GUI and workflow structure.

2. What's Controlling Delta Outflow? 1.2 MB

Presenter(s): Karandev Singh (DWR)
Presenter(s) Email Address(es): Karandev.Singh@water.ca.gov
Collaborators: Raymond Hoang (DWR) and Nazrul Islam (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
As a result of spatial and temporal variance in water supply and demand in the State of California, environmental, agricultural, and urban users are regularly competing for water. This struggle magnifies during times of extreme scarcity like the ongoing drought. Among several factors, Delta Outflow is a controversial topic and depending on the interest, outflow to the Pacific Ocean is either seen as a waste or as a necessity. The Bay Delta Office was asked to determine the percentage of Delta Outflows used for protecting fish and wildlife versus for maintaining agricultural and municipal water quality. Common methodologies used by DWR and SWRCB were explored and it was found that the results varied based on the approach used to determine the factors controlling Delta Outflow.

3. **Decision Scaling with CalLite to Identify Climate Change Vulnerabilities to the State Water Project (Update of Work Performed to Date)** 1.1 MB

Presenter(s): Andrew Schwarz (DWR)
Presenter(s) Email Address(es): Andrew.Schwarz@water.ca.gov
Collaborators: Matt Correa (DWR), Patrick Ray (University of Massachusetts-Amherst) and Sungwook Wi (University of Massachusetts-Amherst)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The California Department of Water Resources – Climate Change Program in cooperation with the University of Massachusetts-Amherst Hydrosystems Research Group are using CalLite and the Decision Scaling approach to explore the State Water Project's operational vulnerabilities to climate change. Decision Scaling links bottom-up vulnerability assessment with multiple sources of climate information. The Decision Scaling approach is particularly well suited to exploration of California's unique internal and external variability and can provide decision relevant metrics of change. CalLite's ability to rapidly simulate water system response to an array of hydrologic changes allows for the exploration of a wide range of internal/natural variability and external variability/imposed climate shifts (long-term changes in precipitation and temperature).

This presentation will provide an update of the work that has been completed to date including initial results showing SWP performance across a wide range of internal variability and climate changes. A detailed look at performance during various types of droughts (ranging in severity and duration) will also be presented.

4. **Cost Allocation/Flow Tracker** 0.6 MB

Presenter(s): Nancy Parker (Reclamation)
Presenter(s) Email Address(es): nparker@usbr.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Hydrology analysis for the CVP Cost Allocation Study is complete. Modeling approaches and results include a CalSim2 representation of CVP delivery capability, post-processing to reflect severe drought allocation decisions, and calculation of single purpose facility sizes. A Flow Tracker was used to identify some aspects of system wide operations for input to the sizing model. All analysis methodology and results will be presented.

5. CalSim 3.0 and the San Joaquin: Has the Model Changed? 1.8 MB
Presenter(s): David O'Connor & Jim Shannon (U.S. Bureau of Reclamation)
Presenter(s) Email Address(es): doconnor@usbr.gov , jshannon@usbr.gov
Collaborators: Kenneth Wright, Michael Wright, Travis Yonts, & Nancy Parker (U.S. Bureau of Reclamation); Andy Draper (MWH Global)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
This presentation summarizes work completed on CalSim 3.0 for the San Joaquin river basin since the last annual meeting. A combined Sacramento/San Joaquin CalSim 3.0 model now successfully simulates water years 1922 - 2009. Completed work has included historical data collection, migration to WRESL Plus, general QA/QC, and updates to east-side tributary operations. In progress work includes cycle reformulation, removal of the Sacramento/San Joaquin groundwater boundary condition, and calibration of San Joaquin Valley agricultural water deliveries.

Session 8. Shifting Baselines in the Bay-Delta Watershed and Estuary

1. Development of Hydrologic Time Series for 1850-1920 1.8 MB
Presenter(s): John Rath
Presenter(s) Email Address(es): john.rath@tetratech.com
Collaborators: Paul Hutton, Jesse Roach, Carrie Munill, and Sujoy Roy
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The goal of this study was the development of a consistent precipitation and streamflow time series for the Sacramento and San Joaquin Valleys, for the period of 1850-1920. Over this period, streamflow observations are limited prior to the 1880's and precipitation data are sparse for 1850-1890.

Observational data for both flow and precipitation are more commonplace beginning in the mid-1890's. We therefore used a suite of estimation approaches to develop the spatial precipitation and runoff time series, and fill in the gaps in the early part of the record. In addition to the limited amount of historical precipitation data, we also incorporated reconstructed annual precipitation data from tree ring studies to develop spatial estimates of monthly precipitation across the Sacramento and San Joaquin Valley and the surrounding watersheds. Runoff-precipitation relationships for the surrounding watersheds were developed from recent data, and employed to estimate monthly runoff in the early part of the record. This data set allows the evaluation of valley flows and Delta outflow through other hydrologic models to understand the transition from pre-1850 natural conditions to the better-characterized post-1920 period.

2. Changing Delta Inflows – a Historical Analytical Perspective 1 MB
Presenter(s): Andy Draper (MWH)
Presenter(s) Email Address(es): andy.draper@mwhglobal.com
Collaborators: Paul Hutton (MWD)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Human activities during the 20th and early 21st centuries have dramatically affected inflows to and outflows from the Sacramento-San Joaquin Delta. Upstream storage regulation has changed the monthly pattern of river and channel flows. Diversions for irrigation and municipal and industrial purposes have depleted surface waters. Changes in land use have affected the amount of consumptive use and timing of surface runoff. Groundwater pumping has impacted groundwater elevations and groundwater inflows to streams and rivers.

The Historical Level of Development Study provides a set of model results for understanding both how and why stream flows in the Sacramento and San Joaquin valleys have changed over the last 110 years. By using a fixed level of development approach, the influence of hydrology is separated from anthropogenic actions. A total of 'fixed level of development' model studies were created. Water facilities, land-use, water supply contracts, and regulatory requirements are held constant over the period of simulation. The historical climate trace from October 1921 to September 2009 is used to represent the possible range of water supply conditions. The earliest, 1900 LOD, includes early flood control measures, drainage of wetlands, and the onset of irrigated agricultural development. The most recent, 2010 LOD, incudes the Central Valley Project and State Water Project operated in accordance with State Water Board regulations and recent biological opinions. Spreadsheet-based reservoir operations models and the CVP-SWP system operations model, CalSim II, were used to develop inputs to C2VSim, an integrated surface water groundwater model of the Central Valley.

3. Delta and Central Valley Watershed Flows: Trends and Attribution 1922-2009 3 MB
Presenter(s): Sujoy Roy
Presenter(s) Email Address(es): sujoy.roy@tetratech.com
Collaborators: Paul Hutton and John Rath
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Delta outflow and its component flows, as characterized through monthly observations over water years 1922-2009, were evaluated for trends over this period, and for two sub-periods representing conditions prior to and following the completion of the major water projects in the basin (1922 to 1967 and 1968-2009). Trends were evaluated using the non-parametric Mann-Kendall test, and provide insight into significant changes that occurred over the past nine decades, at the annual and monthly level. For example, the pre-Project period saw significant increases in late summer and fall (August–November) Delta outflows. In the post-Project period, these trends were largely reversed, with net Delta outflows trending downward in September–November. Similar analyses were performed for each contributing flow component of the Delta outflow. The attribution analysis for Sacramento Valley and net Delta outflow consisted of two elements: (1) development of a monthly water balance using observed data, and (2) use of models (C2VSIM and CalSim) to evaluate flows for the 1922-2009 climatology at various levels of development. The water balance considered surface water flows, precipitation, imports into the Central Valley, groundwater-surface water exchange in the rivers, and groundwater and surface water withdrawals for municipal and irrigation use. These

water balances were used to understand the drivers of change underlying the flow trends on an annual and monthly basis. The modeling approach allowed for a separation of the effects of climatic drivers and development levels, and provided additional insight into the relative change in flows over the course of the 20th century.

4. Connecting Past to Present and Watersheds to Ocean: Modeling 165 Years of Incremental Changes to Flows into the San Francisco Bay Delta System  **1.6 MB**

Presenter(s): Lissa MacVean (University of California-Berkeley, Civil and Environmental Engineering)
Presenter(s) Email Address(es): lmacvean@berkeley.edu
Collaborators: Sally Thompson (University of California-Berkeley, Civil and Environmental Engineering), Paul Hutton (Metropolitan Water District), Murugesu Sivapalan (University of Illinois at Urbana-Champaign, Civil and Environmental Engineering)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
California's Sacramento-San Joaquin Delta sits at the intersection of vast agricultural and population centers, and supplies fresh water for the diverse and often competing needs of ecosystems, farmers, and millions of Californians. Managing and allocating this resource is a complex feat of economics, politics, and engineering, made increasingly formidable by the ongoing drought. The objective of this research is to augment the scientific foundation of management decisions by addressing the question of how flows into the Delta have evolved in response to human intervention since 1850. In particular, quantifying the dynamic components of water usage through vegetative uptake and evapotranspiration, groundwater recharge, flood conveyance, and water exports at incremental levels of development is a key ambition. This approach emphasizes the built environment, which is subject to the local regulatory framework, rather than climate change, which is generally considered immovable without united global effort. This work encompasses the creation of a hydrologic model representing the watersheds of the San Francisco Bay-Delta system, and quantifies the impacts of changes in land use and the gradual construction of levees, reservoirs, and diversion infrastructure. The model is run using the same climatological forcing at each level of development, thus elucidating the effects of local anthropogenic activity on the Delta and the inflows to the San Francisco Bay estuary. Our results provide a timeline of change, giving decision-makers a scientifically established baseline to aid in the sustainable management of the Bay-Delta system.

Session 10. Managing Groundwater According to SGMA – Developing Approaches

1. Evaluating the Effects of Over Pumping and Drought on Water Supply Well Pumping Costs

Presenter(s): Brad J. Arnold
Presenter(s) Email Address(es): barnold@ucdavis.edu
Collaborators: Robert M. Gailey (UC Davis Center for Watershed Sciences)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Significant decreases in groundwater elevations are generally caused by pumping more from groundwater basins than they can sustainably supply. This overdraft can be especially pronounced during drought and dry conditions when supplemental surface water is unavailable. Economic impacts from over pumping and drought include increased water supply costs and lost revenues from inability to fulfill demands. Decreased groundwater elevations also limit well pump operating capacity and increases pumping costs. Pumps are selected and installed in wells based upon desired production rate, standing groundwater elevation, and hydraulic performance of the well. As groundwater elevations decrease from overdraft, operating points on head-capacity curves shift towards lower production rates, pump efficiencies decrease, and operating times to produce similar volumes of water increase.

Potential impacts of groundwater elevation decreases on well pumping costs were evaluated for a study area located in California's Central Valley (greater vicinity of Tulare, Ca). Water demand characteristics were assessed for a 216 square mile area of combined agricultural and urban demands. A range of pump specifications (i.e. head-capacity and efficiency curves) were developed for representative pumping systems. Changes in cost over time were evaluated by considering ranges in lift requirements based on the standing groundwater elevations at different points in time, for a representative range of assumed well capacities. Estimated trends in pumping costs were developed by calculating lift cost based on standard calculations. This presentation summarizes

2. Effects of Ending Long-Term Overdraft on California's Water Supply System **1.2 MB**

Presenter(s): Mustafa Dogan
Presenter(s) Email Address(es): msdogan@ucdavis.edu
Collaborators: Karandev Singh, Josué Medellin-Azuara and Jay Lund
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Effects of ending long-term groundwater overdraft in the Central Valley are evaluated with several management cases using CALVIN. Four hypothetical "no overdraft" scenarios, besides base operations with overdraft, are evaluated under projected 2050 water demands using 82-year monthly historical hydrology .The cases include effects of Delta outflow and Delta exports from a "no overdraft" policy. The least cost overdraft that minimizes groundwater pumping and scarcity costs is calculated for the 82-year period. Furthermore, Delta exports from Delta-Mendota Canal and California Aqueduct are prohibited with a no overdraft policy. Prohibiting Delta exports results in severe water scarcities south of the Delta. More Delta exports, increased groundwater banking, and water trades are useful adaptations when long-term overdraft is ended.

3. Using Cross-Sectional Models to Develop Measurable Objectives for Saltwater Intrusion

Presenter(s): Sean Culkin (HydroMetrics Water Resources Inc.)
Presenter(s) Email Address(es): sean@hydrometricswri.com
Collaborators: Cameron Tana and Derrik Williams (HydroMetrics Water Resources Inc.)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Abstract:
The Sustainable Groundwater Management Act defines saltwater intrusion as an undesirable result that must be avoided to achieve basin sustainability. Groundwater Sustainability Plans need to define measurable objectives that prevent undesirable results such as saltwater intrusion. A water quality standard for salt concentrations is certainly necessary as a measurable objective, but measurable objectives based on groundwater elevations can also facilitate management of the basin to prevent saltwater intrusion for two main reasons:

1. If the saltwater/freshwater interface is offshore, water quality may not indicate risk of saltwater intrusion resulting from depressed groundwater levels until the interface comes onshore. Measurable objectives based on groundwater elevations can be designed to prevent intrusion over the long term.
2. If a groundwater model is used to manage a basin, modeling the density dependent flow of the saltwater/freshwater interface can be numerically intensive and may produce errant results without a fine vertical model grid. By developing measurable objectives based on groundwater elevations, basinwide models do not need to model density dependent flow and groundwater elevation results from the basinwide models can be used for comparison to measurable objectives when evaluating groundwater management alternatives.

Measurable objectives based on groundwater elevations can be developed using density dependent cross-sectional models. The use of these models accounts for basin-specific geology as opposed to using more generalized approaches like the Ghyben-Herzberg relationship. Cross-sectional models were developed for the critically overdrafted Santa Cruz Mid-County Basin and the adjudicated Seaside Basin on the central coast of California. The cross-sectional models extend offshore to identify onshore groundwater elevations that allow the interface to equilibrate at a known location offshore, regardless of the interface's current position. This approach is a time independent approach that has the advantage of not requiring time series model inputs. Model layers were extended offshore based on understood geology and the aquifer parameters were varied based on a Monte Carlo approach. Results from the Monte Carlo approach were used to assess the probability that a protective groundwater elevation will prevent saltwater intrusion. Based on these probabilities, measurable objectives for groundwater levels were established for coastal locations. These measurable objectives can be compared to groundwater elevation data to assess whether the basin will avoid the undesirable result of saltwater intrusion over the long term. Groundwater flow model results can also be compared to the measurable objectives to evaluate groundwater management alternatives.

4. Hydro-Economic Considerations for Sustainable Groundwater Management
Presenter(s): Robert M. Gailey
Presenter(s) Email Address(es): rmgailey@ucdavis.edu
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: No
Abstract:
In addition to hydrology, elements critical for the sustainable management of groundwater include aspects of economics, engineering, finance, law and politics. Economic analysis will play a significant role and can be combined with hydrogeologic analysis to create useful management formulations. Important considerations with regard to groundwater are: 1) that it exists as a common-pool resource with open access, 2) the magnitude of pumping and scarcity costs, 3) demands (individual, aggregate and hardening), 4) the potential value of markets in counteracting the negative effects of regulation and 6) pumping taxes. This presentation addresses these points within the general context of California's Sustainable Groundwater Management Act.

Session 11. A Kaleidoscope of Modeling

1. MODFLOW-OWHM Version 2 Features and Updates **Read-Only PowerPoint (.pptx; 8.5 MB)**
Presenter(s): Scott E. Boyce (USGS, California Water Science Center)
Presenter(s) Email Address(es): seboyce@usgs.gov
Collaborators: Randall T. Hanson (USGS, California Water Science Center)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The One-Water Hydrologic Flow Model (MF-OWHM) is a MODFLOW-based integrated hydrologic flow model that is the most complete version of the MODFLOW family of hydrologic simulators needed for the analysis of a broad range of conjunctive-use issues. MF-OWHM fully links the movement and use of groundwater, surface water, and imported water for consumption by agriculture and natural vegetation on the landscape, and for potable and other uses within a supply-and-demand framework. MF-OWHM is based on the Farm Process for MODFLOW-2005 combined with Local Grid Refinement, Streamflow Routing, Surface-water Routing Process, Seawater Intrusion, Riparian Evapotranspiration, and the Newton-Raphson solver. MF-OWHM also includes linkages for deformation-, flow-, and head-dependent flows; additional observation and parameter options for higher-order calibrations; and redesigned code for facilitation of self-updating models and faster simulation run times.

The next version of MF-OWHM, currently under development, will include a new surface-water operations module that simulates dynamic reservoir operations, the conduit flow process for karst aquifers and leaky pipe networks, a new subsidence and aquifer compaction package, and additional features and enhancements to enable more integration and cross communication between traditional MODFLOW packages.

By retaining and tracking the water within the hydrosphere, MF-OWHM accounts for "all of the water everywhere and all of the time." This philosophy provides more confidence in the water accounting by the scientific community and provides the public a foundation needed to address wider classes of problems such as evaluation of conjunctive-use alternatives and sustainability analysis, including potential adaptation and mitigation strategies, and best management practices.

2. Evaluating Erosion at a Dam Spillway – a 3D Model of Free Surface Jet Flow 3.8 MB

Presenter(s): Will L'Hommedieu (cbec, inc. eco engineering)
Presenter(s) Email Address(es): w.lhommedieu@cbecoeng.com
Collaborators: Sam Diaz (cbec, inc. eco engineering)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract: Information on scour downstream of "flip-bucket" and "ski jump" spillways is critical for determining dam safety and appropriate protection measures. Traditional analyses of scour downstream of these spillways use empirical equations to estimate vertical scour from free-surface jet impingement. This study addresses erosion from an impinging free-surface jet due to formation of strong lateral eddies and breaking waves. cbec was contracted to model and provide recommendations on erosion protection measures for the Black Butte Dam re-regulation basin, where significant bank erosion has occurred downstream of a "flip-bucket" spillway. The hydraulics at and downstream of the dam spillway were simulated using a three-dimensional hydrodynamic model (FLOW-3D). Bed shear and riprap size were calculated from model output data using multiple methods, including spatially-distributed and empirical equations. It was observed that bed shear and required riprap size were less for wave action than due to eddies, but also that the areas affected primarily by wave erosion or eddies were largely independent. Required riprap size was found to be highly sensitive to irregularities in the bed where flow converged, leading to isolated regions of increased bed shear. These findings highlight the importance of choosing flow data that are representative of bulk flow conditions for sizing required riprap size, as well as the importance of appropriate bank design to avoid isolated areas of elevated shear. This study demonstrates the utility of a three-dimensional free-surface flow model to estimate scour forces in highly turbulent flows where lateral flows are of concern.

3. Flow Management Tool

Presenter(s): Rob Simpson – Citizens Water Plan
Presenter(s) Email Address(es): citizenswaterplan@gmail.com
Collaborators: Steve Haze- San Joaquin Valley Leadership Forum, The Sierra Club, Barbara Daly- North Delta Cares, Gregg Coppes- CA Senate Candidate 3rd district
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:

(1) The aquatic environment within Bay Delta and the low salinity zone is complex and endangered. Competing interest groups are currently engaged in an epic political battle over who gets the biggest piece of the pie. This battle has been ragging generations.
(2) At the other end of the aqueduct, in the Southern half of the Central Valley, agriculture consumes 80% of all CVP and SWP exports. Draining the historic Tulare Lake is the largest, yet to be mitigated, environmental disaster in U.S. history. This was one of the last habitats that the California Grizzly was known to frequent. Native species went extinct, migrations along the Pacific Flyway were impacted and we lost the "heat sink" and climate moderation associated with a 25 million acre foot freshwater lake.
(3) The "Flow Management Tool" is a simple Excel based empirical model which shows how the current strategy of storage in the North and summer conveyance is failing to address the needs of the Delta and the Southwest U.S. The model uses 60 years of DAYFLOW data to find short and long term averages in Delta inputs and outputs and compares these results to other factors like fish species indexes groundwater depletion. The model results indicate that a change to more wet period pumping and Storage in the South will provide better results for all interested parties.

4. Updating EBMUD's Water Supply Planning Model to Meet Future Challenges 5 MB

Presenter(s): Gary Palhegyi, P.E., D.WRE. (EBMUD)
Presenter(s) Email Address: gpalhegy@ebmud.com
Collaborators: Ben Bray, Ph.D., P.E. (EBMUD)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
For decades, EBMUD has relied on a FORTRAN computer model of its raw water supply system for evaluating system reliability and performance under varying configurations and supply scenarios. In 2012, EBMUD began the process of identifying and evaluating potential software alternatives; upon which RiverWare was ultimately selected to replace the older FORTRAN model. Although a number of reasons can be sited for making this change, a primary reason is to bring EBMUD up-to-date in terms of modern software capabilities. Such as increasing flexibility in testing changes in operating policy, improving system resolution, improving time step resolution, and enhancing input/output processing.

EBMUD has re-built the Mokelumne River water supply planning model in RiverWare. RiverWare is a generalized modeling tool that enables users to build and evaluate complex water supply system operations. The software allows for the expression of operating policy in an easy and flexible manner. Although the model is designed for long-term planning, one goal for EBMUD was to establish a better representation of actual operations. Of the more challenging elements is the need to forecast in April the future storage conditions in September. Forecasting is required for setting rationing goals, triggering supplemental supply options, cold water pool support and for defining environmental flows.

In this presentation, EBMUD will summarize model development, calibration, and testing, and illustrate results with examples.

5. Fully Coupled 1-D Mobile-bed River Sediment Transport Model (Unsteady Flow and Non-equilibrium Sediment Transport with Looped Network System) 9.5 MB

Presenter(s): Sungho Lee / Ph D, PE/ CVFPB (Central Valley Flood Protection Board), DWR
Presenter(s) Email Address(es): Sungho.Lee@water.ca.gov
Collaborators: -
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
A fully coupled one-dimensional mobile-bed river sediment transport model for the condition of unsteady flow and non-equilibrium sediment transport with looped network system is created to apply natural rivers. The governing equations are as follows: continuity, motion, conservation of material in suspension, conservation of bed-material, sediment transport formula and roughness equation. The above equations are solved simultaneously using the Preissmann implicit scheme. Manning roughness coefficient with the bed form (ripple and dune) considered by van Rijn method is calculated at each time step.

Applying this fully coupled sediment transport model to Belley reservoir of Rhone river in France, total trap efficiency (=0.4) gives reasonably good result comparing with the measurement (=0.49). This model will be used to support the Basin wide and Regional flood planning study and to predict erosion of river bed, sediment deposit and trap efficiency with suspended load and bed load in channels and natural rivers.

Session 12. Coastal and Delta Flood Modeling

1. Operational and Future Flood Forecasting for San Francisco Bay and the Outer Coast

Presenter(s): Liv Herdman (USGS)
Presenter(s) Email Address(es): lherdman@usgs.gov
Collaborators: Patrick Barnard (USGS), Rob Cifelli (NWS), Li Erikson (USGS), Lynn Johnson (NWS), Jungho Kim (NWS), Andrea O'Neill (USGS)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The USGS-developed Coastal Storm Modeling System (CoSMoS) makes detailed predictions of coastal flooding by integrating tidal forcing, seasonal water level anomalies, surge, offshore-wave conditions, locally generated wind waves, and tributary discharges. In the Our Coast Our Future (OCOF) project, flooding predictions were made for the North Central California Coast and San Francisco Bay for a suite of scenarios that cover sea level rise (SLR) ranging from 0 to 5 meters and coastal storms with daily to 100-yr return periods. These coastal flooding predictions are available via interactive maps from OCOF and are useful tools to help coastal planners and emergency responders understand, visualize, and anticipate local impacts from SLR and storms in the San Francisco Bay region. This scenario-driven expertise is now being used to develop a state-of-the-art operational flood forecast model for the San Francisco Bay area, supported by the CA Department of Water Resources, which will predict watershed and ocean-based flooding up to 72 hours in advance of an approaching storm. For this application, we utilize Delft3D-FM, a hydrodynamic model based on a flexible mesh grid. Surge and in-Bay generated wind waves are created from the wind and pressure fields of a National Weather Service (NWS) forecast model, and tributary discharges are from the Research Distributed Hydrologic Model (RDHM), developed by the NWS Office of Hydrologic Development. The flooding extent is determined by overlaying the resulting water levels onto a 2-m digital elevation model of the study area which best resolves the extensive levee and tidal marsh systems in the region. Here we present initial pilot results of hindcast winter storms and demonstrate the feasibility of predicting flooding on an operational time scale that incorporates both atmospheric and hydrologic forcings.

2. California Coastal Flood Modeling and Effects of Sea Level Rise: Relating Future Conditions Coastal Flood Hazards to Existing Conditions FEMA Maps

Presenter(s): Bob Battalio, ESA
Presenter(s) Email Address(es): bbattalio@esassoc.com
Collaborators: Peter Bromirski, Scripps; Dan Cayan, Scripps; Marisa Villarreal, OST; Aaron McGregor, USACE; Ryan Meyer, OST; Lauma Willis, DWR; Maria Lorenzo-Lee, DWR
Permission to Post pdf of Presentation on CWEMF Website: YES
Abstract:
Future projections of coastal water levels and wave runup for 5 sites along the California coast will be presented and compared to projected flood hazards in existing FEMA flood maps. A methodology relating existing and future flood limits for planning purposes will also be presented.

The work is a component of a NOAA-funded project to develop products for local communities that link sea-level-rise and coastal flood management. The project was led by the Department of Water Resources (DWR), the Ocean Science Trust, and Scripps Institution of Oceanography (SIO). The presentation will focus on work by ESA under contract to DWR and Ocean Science Trust, with

emphasis on future conditions modeling by SIO, comparison to historic data, and methods to map future "V Zones" where wave action leads to the most severe coastal impacts.

A "Focus Group and Needs Assessment" effort determined that guidance relating future conditions for coastal hazards to existing FEMA maps would benefit local and regional planners. A Technical Methods Manual (TMM) was drafted to accomplish this purpose. It relates FEMA methodology to SIO methodology for future conditions, and provides guidance on how to adjust existing conditions hazards for sea level rise.

3. SCHISM: 2D and 3D Flood Modeling Approaches for the Bay-Delta

Presenter(s): Eli Ateljevich
Presenter(s) Email Address(es): Eli.Ateljevich@water.ca.gov
Collaborators: Department of Water Resources
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
This presentation describes our approach and recent progress modifying Bay-Delta SCHISM for modeling the Bay-Delta in 2D and 3D. Bay-Delta SCHISM has been extensively used in a tidal regime, particularly in low-medium flow scenarios. The extension to very high flow regimes is motivated by diverse requirements ranging from temperature impacts in the Bay to levee threats on the Sacramento and San Joaquin Rivers and projects on Yolo Bypass. Interim results in 2D and 3D for 2006 and 1997 hindcasts will be presented, with some discussion of how dimensionality, scale, and inclusion/exclusion of circulation processes affect the sorts of results this project can achieve.

4. Development of Stage-Frequency Curves in the Sacramento - San Joaquin Bay Delta

Presenter(s): Romain Maendly
Presenter(s) Email Address(es): Romain.maendly@water.ca.gov
Collaborators: California Department of Water Resources
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The California Department of Water Resources will soon release its Basin-Wide Feasibility Study (BWFS). The BWFS, which includes the Sacramento and San Joaquin river basins and to some extent the Sacramento - San Joaquin Bay Delta (Delta), will help to inform the 2017 Central Valley Flood Protection Plan (CVFPP) to improve the overall flood management of the system.

An important component of the study is the development of stage-frequency curves for existing and future conditions which includes climate change and sea level rise. Developing Delta stage frequency curves that are consistent with the development of the upstream stage frequency curves is complex. One needs to account for the Sacramento and San Joaquin Rivers at the upstream Delta boundary and the effect of tides and tidal surge from the advancing storm fronts coming from the Pacific Ocean. To aid in this endeavor, assumptions and methodology using a set of tools have been used. Key assumptions are for example: the determination to use in-channel vs. at-latitude regulated flow frequency curves, the phase of the surge tide with the peak flow hydrographs and the tidal boundary conditions setting with and without sea level rise. The tools used are Central Valley Hydrologic Study (CVHS), Central Valley Floodplain Evaluation and Delineation (CVFED) hydraulic model and the RMA 2-D Bay Delta model.

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

5. Delta Emergency Response Tool: Recent Developments and Operational Forecasting
Presenter(s): Jeremy Hill (DWR), John DeGeorge (RMA), Shankar Parvathinathan (MBK)
Presenter(s) Email Address(es): Jeremy.Hill@water.ca.gov; jfdegeorge@rmanet.com; shankar@mbkengineers.com
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The Delta Emergency Response Tool (Delta-ERT) has been developed for the California Department of Water Resources (DWR) to quickly analyze the potential impacts from levee damage in the Sacramento-San Joaquin Delta and determine the most effective response strategy. The Delta-ERT utilizes the Emergency Repair and Recovery (ERR) and Water Analysis Module (WAM) computational engine originally developed for the Delta Risk Management Strategy (DRMS). The ERR estimates repair scheduling, resource requirements, and cost associated with levee repairs. WAM couples a 1-D tidally-averaged hydrodynamic and water quality simulation with water operations decision logic for evaluating impacts of levee failures on water exports. The initial version of the Delta-ERT was developed in 2013 to provide a user interface to perform reconnaissance level forecasting using the ERR and WAM models with future hydrology drawn from representative CalSim data. In 2015, DWR funded enhancements to the Delta-ERT to improve the flexibility of the software for more realistic forecasting. New controls were added to manage reservoir releases, operate for water quality, and install temporary barriers. The most significant enhancement was to support simulations based on operational forecast data as opposed to drawing from the CalSim hydrology. Boundary conditions for the operational forecast simulation can be assembled from observed data, short term daily forecast data prepared for DSM2 runs, and long term monthly forecast data from DWR and/or USBR. The operational forecasting simulation can incrementally adjust the forecasted reservoir releases to meet Delta water quality standards using the G-Model relationship for antecedent flows and salinity.

Session 13. Integrated Water Resources Modeling

1. Using CVFED Hydraulic Models to Inform the C2VSim Groundwater-Surface Water Model
Presenter(s): Holly Canada (David Ford Consulting Engineers, Inc.)
Presenter(s) Email Address(es): hcanada@ford-consulting.com
Collaborators: Tariq Kadir (DWR), Can Dogrul (DWR), Guobiao Huang (DWR), Tom Molls (David Ford Consulting Engineers, Inc.), Ric McCallan (David Ford Consulting Engineers, Inc.), William Sicke (David Ford Consulting Engineers, Inc.), Ali Taghavi (RMC), and Mesut Cayar (RMC).
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The California Central Valley Groundwater-Surface Water Simulation (C2VSim) model is an integrated hydrologic model that the California Department of Water Resources (DWR) developed specifically for Central Valley water management planning. C2VSim simulates water movement through the interconnected land surface, surface water, and groundwater flow systems in the area defined by the alluvial Central Valley aquifer. DWR is developing the C2VSim fine grid model as an update to the

existing C2VSim coarse grid model. We applied information from the latest version of DWR's Central Valley Floodplain Evaluation and Delineation (CVFED) Program TO34 HEC-RAS models to develop depth-flow rating curves at C2VSim stream nodes within the CVFED model extents. CVFED hydraulic models enabled improvements to water surface elevation estimates within the stream network of the C2VSim hydrologic model.

2. Recent Enhancements to the SACFEM Groundwater Flow Model of the Sacramento Valley

Presenter(s): Heather Perry, CH2M, Redding, California
Presenter(s) Email Address(es): Heather.Perry@ch2m.com
Collaborators: Peter Lawson/CH2M, Lisa Porta/CH2M, Walter Bourez/MBK Engineers, Lee Bergfeld/MBK Engineers, and Patrick Ho/MBK Engineers.
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The Sacramento Valley Finite Element Groundwater Flow Model (SACFEM) is a three-dimensional numerical model originally developed in the mid-2000's, that simulates transient groundwater flow within the Sacramento Valley Groundwater Basin. SACFEM was developed using a combination of the Micro-FEM finite-element groundwater modeling platform to simulate groundwater flow along with DWR's Internal Demand Calculator (IDC) to simulate the processes associated with irrigated agricultural in the valley. Current applications of the model incorporate monthly output from a detailed surface water budgeting module (IDC) as well as pumping rates and schedules to forecast potential groundwater and surface water impacts associated with conjunctive water management projects in the Sacramento Valley. The SACFEM model has been used to assess potential groundwater and surface water impacts associated with a variety of projects including: Drought Water Bank Development (which evaluated the potential to "store" excess water in the aquifer system for use during drought periods), the Lower Tuscan Conjunctive Water Management Evaluation, the Proposition 50 Groundwater Production projects (focused on development of environmental documents for the installation of new production wells to augment in-basin supplies for individual water districts during drought periods), various single year groundwater substitution water transfers, and the USBR Long-Term Water Transfer EIS/EIR program (which evaluated groundwater substitution water transfers for multiple water districts over a period of 10-years).

This presentation will focus on improvements/updates to the model (now known as SACFEM2013) based on the findings of an independent Peer Review conducted for the USBR. Significant improvements to the model include: expansion of the simulation period through water year 2010, incorporation of transient stream stages, incorporation of flood bypasses including transient inundation areas and water depths, refinements to the IDC water budget module, expansion of the calibration target distribution (spatially and vertically), and model recalibration. Complete documentation of SACFEM2013, as well as directions for model application, can be found in the Sacramento Valley Finite Element Groundwater Flow Model User's Manual (CH2M HILL and MBK Engineers, 2015).

3. HydroEconomic Modeling of Groundwater Sustainability, A Pilot Study 2.2 MB
Presenter(s): Mesut Cayar (RMC)
Presenter(s) Email Address(es): mcayar@rmcwater.com
Collaborators: Ali Taghavi (RMC), David Mitchell (M.Cubed), Duncan MacEwan (ERA Economics), Steve Hatchet (CH2M)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
This study looked at the impacts to the physical groundwater resource and the socio-economic impacts to the agricultural sector and the broader regional economy with and without sustainable groundwater management by integrating DWR's California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) with its Statewide Agricultural Production Model (SWAP). The study region encompassed the Kings and Tulare Lake groundwater subbasins within Fresno, Kings, and Tulare Counties.

The hydrologic modeling results showed the Kings and Tulare Lake subbasins are not presently on a path of sustainable groundwater management. A reduction in groundwater pumping in the range of 15-20% from current amounts is needed to stabilize average groundwater elevation in the study region. Modeling results also highlighted the complex, interdependent nature of groundwater usage, recharge, and flow between subbasins. For example, in order to stabilize groundwater elevations within the study region, it is necessary to assume that neighboring basins are being similarly managed. Otherwise, the gains from sustainable management in the study region would be ceded to the western bordering subbasins due to groundwater migration. This has important implications for the establishment and governance of Groundwater Sustainability Agencies (GSAs). In terms of the economic costs of transitioning to sustainable groundwater management, the modeling indicates that farm-level production losses would be more or less offset by avoided costs of pumping and well investment, and the value of having additional groundwater reserves in dry years.

4. Features and Planned Updates in the Integrated Water Flow Model (IWFM) in Support of Sustainable Groundwater Management Act (SGMA) 4 MB
Presenter(s): Emin Can Dogrul (DWR)
Presenter(s) Email Address(es): Can.Dogrul@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
IWFM is a generic integrated hydrologic flow model that is well-suited to be used as a planning tool in support of SGMA. The fully-coupled surface and subsurface flow simulation, its land surface and root zone simulation component (a.k.a. IDC) that can accurately represent agricultural and urban water demands as well as water management, the automatic water supply adjustment feature to meet the predicted water demands, and the extensive water budget outputs are only some of the features that make IWFM an effective modeling and planning tool for SGMA. In addition, over the last year, DWR staff has started the development of post-processing tools to make IWFM applications and their results more accessible to water managers and non-modeler users. This presentation will outline some of the features of IWFM that are most useful for and the upcoming developments in support of SGMA.

Session 15. Advances in Integrated Modeling

1. **Long-term Decline in Ungaged Inflows and the Beginning of Net Seepage Losses in the Lower San Joaquin River** 2 MB

Presenter(s): Joel Herr
Presenter(s) Email Address(es): joel@systechwater.com
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The lower San Joaquin River between its gages near Stevinson and at Vernalis has historically been a "gaining" river with more outflow from the river than inflow from its tributaries. Additional inflows come from agricultural drains and exfiltration of shallow groundwater. These ungaged inputs can be calculated as river outflow minus the sum of all gaged tributary inflows, with a positive value indicating a gaining river and negative a losing river. Measured inflows from the San Joaquin River near Stevinson, Salt Slough, Mud Slough, Merced River, Orestimba Creek, Del Puerto Creek, Tuolumne River, and Stanislaus River were summed to get total daily inflows to the lower San Joaquin River back to 1985 and then compared with measured flow in the San Joaquin River at Vernalis. This data analysis reveals a long term trend of decreasing ungaged inflows which have become negative indicating water is now being lost from the river to groundwater. While diversion losses occur in the irrigation season, the long-term trend in ungaged inflows is similar for both the irrigation and non-irrigation season. The annual decrease in ungaged inflows from 2001-2016 was approximately 40-50 cubic feet per second. If this trend is verified and continues it could have profound ecological and economic consequences for the region as sections of the river start running dry. An integrated effort of the surface water and groundwater modeling community will play a critical role in learning the mechanisms of seepage losses, communicating with stakeholders and decision makers, and developing potential solutions.

2. **Interaction of Surface Water and Groundwater under Highly Dynamic Conditions** 8 MB

Presenter(s): Michael Gabora (DHI)
Presenter(s) Email Address(es): mmg@dhigroup.com
Collaborators: Bertram Monninkhoff (DHI), Steve Blake (DHI)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Integrated watershed models are becoming more important than ever before due to climate change and consequent more frequent storm water and drought events. It is evident that such models should be able to describe both flooding and low water conditions. Furthermore, environmental issues (contaminants, saltwater intrusion or accumulation as well as biological processes like algae bloom) will have to be addressed as a consequence of changing hydrological conditions. With the coupling interface between FEFLOW and MIKE11 these processes can be simulated in one single system, representing dynamic interactions between the surface channel network and groundwater systems. This system has been applied in many projects of which three will be presented at the conference. In the first project, the effect of artificial check dams (managed aquifer recharge) on saltwater intrusion was analyzed for the water supply system of the southern Indian metropolitan area of Chennai. In the second project, the system was used to facilitate the balancing of interests between the different stakeholders (such as farmers, different government authorities, and conservation groups) with respect to the operation of an extensive system of hundreds of drainage

canals and numerous pumping stations and weirs in an ecologically important area along the Odra river in Germany. In the last example, the advantage of the coupled approach will be presented by means of a flood study, in which the operation of an extensive flood polder area was optimized to reduce the flood risk along the lower Elbe river.

3. **Developing Water Quality Objectives for Salinity Diversions to Agriculture using Steady-state and Transient Models** 5 MB

Presenter(s): Nigel W.T. Quinn (Berkeley National Laboratory/ USBR)
Presenter(s) Email Address(es): nwquinn@lbl.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The relationships between agricultural applied water salinity, leaching fraction, and soil salinity are complex. A general understanding is needed to provide decision support to stakeholders and regulators therefore to set river salinity objectives such that farmers have sufficient leaching water volume available while protecting salt sensitive crops from yield impacts. A steady-state hydrosalinity spreadsheet model, based on algorithms developed by the FAO in the 1970's, provided early decision support tool to engage stakeholders – providing easy-to-understand outputs and requiring a minimum of data inputs. A transient hydrosalinity model and graphical user interface based on the Colorado State university Irrigation Drainage (CSUID) model code has been developed that incorporates the earlier transient model and allows basic information exchange between the two models. This has allowed stakeholders and regulators a means of transitioning between simple and more complex models while retaining an overall understanding of the hydrological and salinity dynamics of the Basin. This paper reviews the design and application of the two models and modeling approaches and discusses the challenges of simultaneously estimating appropriate leaching fractions for salt sensitive crops grown on salinity impaired soils in the western San Joaquin Basin of California and providing suggested salinity limits to irrigation supply water to afford full protection from potential salinity-induced yield decline. Future use of this decision support system is discussed in the context of drought conditions and salt loading regulation in the San Joaquin Basin.

4. **Integrated Modeling of Surface and Groundwater Quality: Using EC to Calibrate Hydrology between ET and Deep Percolation to Groundwater** 1.2 MB

Presenter(s): Joel Herr
Presenter(s) Email Address(es): joel@systechwater.com
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The unconfined groundwater aquifer of the San Joaquin Valley is threatened by gradual depletion and accumulation of salinity. Modeling the interactions between surface water and groundwater is an important component of managing the long-term quantity and quality of groundwater. Modeling of surface water – groundwater interactions requires calibration of hydrologic parameters to accurately represent evapotranspiration and deep percolation. An important tool for hydrologic calibration is integration with continuously measured salinity data and water quality modeling to perform mass balance calculations. The amount of water and salinity applied to a land area can be calculated from precipitation, precipitation quality, irrigation rates, and irrigation source water quality. Concurrent surface water flow and salinity data allow for the calculation of water volume

and salinity mass leaving a given area to surface water. Evapotranspiration removes much of the water applied to the land and concentrates the remaining salt. Under a long-term equilibrium condition, the remaining flow and salinity percolates to the unconfined aquifer. The process of concurrent hydrology and salinity calibration is demonstrated using the Watershed Analysis Risk Management Framework (WARMF) model on a section of the San Joaquin River watershed. The WARMF model maintains water volume balance and constituent mass balance to calculate runoff, shallow groundwater exfiltration to surface water, and deep percolation to the groundwater aquifer. Model parameters were adjusted to balance flow and salt load leaving the watershed and calculate flow and salt load percolating to the aquifer.

Session 16. Environmental Flows Modeling Under Climate Extremes

1. **Recommendations for a Modeling Framework to Answer Nutrient Management Questions in the Sacramento-San Joaquin Delta** 2 MB

Presenter(s): Mike Deas
Presenter(s) Email Address(es): Mike.Deas@watercourseinc.com
Collaborators: P.R. Trowbridge, E. Ateljevich, E. Danner, J. Domagalski, C. Enright, W. Fleenor, C. Foe, M. Guerin, D. Senn, and L. Thompson
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Management actions to address nutrients in the Delta could cost billions of dollars to implement in the coming decades depending on decisions that will come before the Central Valley Regional Water Quality Control Board (Water Board). The complexity of the Delta ecosystem and the range of questions to be addressed demand that numerical, processed-based water quality modeling be part of Delta management efforts. In light of this fact, the Water Board convened the Modeling Science Workgroup in 2015, to provide a white paper on the development and use of water quality models as one component of the Water Board's Nutrient Research Plan.

The Charge to the Modeling Science Workgroup was to provide advice to the Water Board on:

- The types of models would be needed to answer the nutrient management questions raised by stakeholders,
- Organizational arrangements to support and maximize the benefits of models, and
- Cost estimates for the modeling task and how such work might be phased over time.

The Modeling Workgroup completed its charge in March 2016. The key findings from the white paper will be presented.

2. **Multi-Benefit Analysis for Flood Bypass Capacity Optimization** 1.7 MB

Presenter(s): Alessia Siclari (UC Davis)
Presenter(s) Email Address(es): asiclari@ucdavis.edu
Collaborators: Rui Hui, Jay R. Lund (UC Davis)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Uses of flood bypasses, when possible, lead to advances in flood management. Unlike structural flood control systems, bypasses are designed to deliver excessive flood water, inundating

floodplains. Therefore, bypasses also provide benefits in environmental restoration, groundwater recharge, and recreation. The optimization model in this study uses a benefit-cost analysis to address the best solution for flood bypass capacity expansion. Benefit of flood risk reduction is evaluated with a probability analysis, while the other benefits are approximated linearly to bypass capacity. Costs considered are from levee setback, weir expansion and land purchase.

3. Modeling Juvenile Fish Passage at Shasta Lake

Presenter(s): Laurel Saito, University of Nevada Reno
Presenter(s) Email Address(es): lsaito@cabnr.unr.edu
Collaborators: Katherine Clancey, University of Nevada Reno; Connie Svoboda, US Bureau of Reclamation
Permission to Post pdf of Presentation on CWEMF Website: No
Abstract:
To address recovery of Chinook salmon and steelhead on the Sacramento River, an interagency committee has been considering reintroduction of adult fish to tributaries upstream of Shasta Dam. Such reintroduction would require downstream passage of juvenile fish past Shasta Dam, and the committee is evaluating several options. One option is to collect fish at the head-of-reservoir (where riverine conditions become more reservoir-like) and transport them around the dam. To assist with evaluation of this option, we used a two-dimensional CE-QUAL-W2 model of Shasta Lake to assess where and when conditions (i.e., water temperatures) were favorable on the McCloud River to collect juvenile fish. We simulated dry, median, and wet year conditions with the model and assessed water temperatures and velocities during estimated periods of juvenile fish migration. We also modeled anchored and floating temperature curtains to see if simulated temperature conditions improved over without curtain conditions. Model results indicated that simulated water temperatures were favorable for juvenile spring-run Chinook salmon and steelhead migration under all hydrologic scenarios, and simulated conditions for winter-run and late fall-run Chinook salmon could be improved with the use of temperature curtains, especially a long floating curtain. Use of the curtains assisted with reducing or eliminating harmful water temperatures. Model results suggest that temporary placement of temperature curtains may also be effective at improving conditions on the McCloud River above Shasta Dam.

4. Central Valley Refuge Management under Non-stationary Climatic and Management Conditions  **3.8 MB**

Presenter(s): Karandev Singh
Presenter(s) Email Address(es): Karandev.Singh@water.ca.gov
Collaborators: Mustafa Dogan, Jay Lund, Josh Viers, Rachel Esralew and Josué Medellin-Azuara.
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Global warming and regional hydro-climatic alterations are likely to further limit state's ability to manage water, reduce total volume of available water and intensify competition for surface water. Historically, reduction in surface water supplies is substituted with groundwater pumping. Long-term overdraft and Sustainable Groundwater Management Act (SGMA) provisions will, however, limit future pumping opportunities. This research examines impacts from a warm-dry climate, peripheral tunnels, groundwater overdraft regulations, and competing environmental flow demands on water deliveries to CVPIA refuges. The study is conducted within a statewide framework using CALVIN – a

hydro-economic optimization model of State of California – to capture the physical, environmental and policy constraints in the existing water management system. Sixteen scenarios are analyzed to capture and quantify the hydrologic and economic implications of climatic and management uncertainties on refuge deliveries including (1) climate vulnerability: historical and warm-dry climates; (2) Delta regulations: high and existing Delta Outflows; (3) infrastructure: with and without isolated facility or peripheral tunnels; and (4) groundwater management: with and without long-term overdraft. A separate Spreadsheet Tool is also developed to explore the benefits and implications of inter-refuge trading and optimizing refuge land-use management practices.

5. Using Machine Learning to Statistically Model Natural Flow: The Sacramento River Watershed under Dry Conditions 0.7 MB

Presenter(s): Bonnie Magnuson-Skeels
Presenter(s) Email Address(es): brmagnuson@ucdavis.edu
Collaborators: Jay R. Lund, Robert J. Hijmans, and Theodore E. Grantham
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Machine-learning techniques were applied to climatic, geologic, and geographic data to statistically model natural flow in dry years. The model is tailored to predict for drier conditions in order for its predictions to be used as inputs for the Sacramento River version of the Drought Water Rights Allocation Model (DWRAT), a water rights curtailment model developed at the University of California, Davis. The flow model builds on a general-purpose statistical natural flow model developed by the US Geological Survey designed to be able to predict natural flows at the national and regional scale. The advantage of such models is that they can be used when building a traditional mechanistic natural flow model is too expensive or time-consuming. Applying multiple machine-learning algorithms, using different techniques to select features and reduce dimensionality, and restricting training data to drier years resulted in models that, when used to predict known dry water year flows and evaluated on multiple test metrics, consistently tested as better than or equivalent to the corresponding general-purpose models, and in certain cases, they performed far better. This is a significant improvement toward predicting natural flows in dry years and could help DWRAT make improved curtailment decisions. Additionally, this research provides a Python framework for developing models and testing different machine learning techniques in a pipelined approach.

Session 17. Sustainable Groundwater Management

1. The Sustainable Groundwater Management Act, a Year Later 2.5 MB

Presenter(s): Rich Juricich (DWR) and Sam Boland-Brien (SWRCB)
Presenter(s) Email Address(es): rich.juricich@water.ca.gov, Samuel.Bolland-Brien@waterboards.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
A year after SGMA was passed much of the framework for implementing this new legislation has been started. New regulations for local agencies to propose groundwater basin boundary changes have been adopted. Draft regulations for groundwater sustainability plans are out for public review. And the hard work by local agencies to form groundwater sustainability agencies is underway. This presentation will highlight the activities by the Department of Water Resources and the State Water Resources Control Board for this new legislation including linkages to analytical tools and data.

2. Measurable Objectives for SGMA
Presenter(s): Juliet Christian-Smith (Union of Concerned Scientists)
Presenter(s) Email Address(es): jchristiansmith@ucsusa.org
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: No
Abstract:
Groundwater is a critical resource for California. It provides a crucial buffer against drought and the growing impacts of global warming, especially the diminishing mountain snowpack that has historically been a crucial component of California's water supply. Over the last century, however, groundwater in California has been largely unregulated. This has led to severe declines in groundwater levels in many places, particularly California's Central Valley.

In 2014, California's severe and ongoing drought helped spur the passage of the Sustainable Groundwater Management Act, the first-ever statewide effort to comprehensively measure and manage groundwater. One of the act's key provisions is that local groundwater sustainability agencies (GSAs) must develop Groundwater Sustainability Plans (GSPs) by 2020. As part of this, GSAs must set "measurable objectives" in their plans to achieve "the sustainability goal for the basin." Yet the legislation does not specifically define measurable objectives or how they should be set or evaluated over time. Rather, the legislation directs GSAs to set measurable objectives that will avoid what the act refers to as "undesirable results" (such as the chronic lowering of groundwater levels). This report provides a review of the state of knowledge and practice related to setting measurable objectives for groundwater management and indicates that effective measurable objectives do the following: Define clear baselines, set quantitative thresholds; develop protective triggers, incorporate regular measurement and monitoring, account for uncertainty, and adapt to changing conditions and knowledge.

3. Tackling Technical and Policy Aspects of SGMA in Butte County **5.1 MB**
Presenter(s): Christina R. Buck (Butte County Department of Water and Resource Conservation)
Presenter(s) Email Address(es): cbuck@buttecounty.net
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: YES
Abstract:
The Butte County Department of Water and Resource Conservation (DW&RC) has been actively engaged with implementation of the Sustainable Groundwater Management Act (SGMA) on two fronts, addressing both technical and policy considerations. At the state level, the County participates in the dialogue with the Department of Water Resources on the development of regulations influencing policy and technical issues. Locally, the DW&RC is actively engaging in local conversations with other Groundwater Sustainability Agencies and stakeholders in the four groundwater subbasins within Butte County. A collaborative dialogue on governance is being conducted through the Butte County GSA Assessment. Moreover, technical considerations are becoming critically important as demonstrated by the relevance to SGMA of the update of the Inventory and Analysis Report, groundwater model update, and development of the Interbasin Groundwater Flow Evaluation project in the Northern Sacramento Valley. This presentation will describe these and other efforts the County has been involved in prior to and since passage of SGMA to continue building a foundation for sustainable groundwater management.

4. **Historic, Current, and Future Availability of Surface Water for Agricultural Groundwater Banking in the Central Valley, California**

Presenter(s): Helen Dahlke (UC Davis)
Presenter(s) Email Address(es): hdahlke@ucdavis.edu
Collaborators: Tiffany Kocis (UC Davis)
Permission to Post pdf of Presentation on CWEMF Website: No
Abstract:
Groundwater banking, the intentional recharge of groundwater from surface water for storage and recovery, is an important conjunctive use strategy for water management in California. Understanding the availability of excess streamflow (e.g., the magnitude, frequency, timing, and duration of winter flood flows) is fundamental to assessing the feasibility of local-scale implementation of groundwater banking. In this study, we estimate the current availability and forecast the future availability of winter (Nov to Apr) flood flows based on current and historic daily streamflow records for 93 stream gauges on tributaries to and streams within the Central Valley, California. For each gauge, we consider flows above a stationary 90th percentile as potential source for groundwater banking. Results based on available historic streamflow records and a common time period representing post-impairment (e.g. after reservoir construction) conditions of most streams show that both the Sacramento and the San Joaquin River have on average 7 MAF (1970-2014) and 2.2 MAF (1989-2014) of flood flows occurring between November and April in a given year when flows exceed the 90th percentile. Comparison of these flood flows to the Coordinated Operation Agreement Delta Status reveals excess Delta conditions for all days with flows above the 90th percentile. A trend analysis shows that for 25% (11%) of the gauges the November-April flow volumes above the 90th percentile are significantly decreasing (increasing).

Session 18. San Joaquin River Restoration Program 2D Hydraulic Modeling Applications

1. **Two-dimensional Water Temperature Modeling of In-channel and Hydraulically Connected Off-channel Zones in Reach 1A of the San Joaquin River** 1.4 MB

Presenter(s): Daniel Dombroski (Bureau of Reclamation)
Presenter(s) Email Address(es): ddombroski@usbr.gov
Collaborators: Blair Greimann, Yong Lai (Bureau of Reclamation)
Permission to Post pdf of Presentation on CWEMF Website: YES
Abstract:
The San Joaquin River Restoration Program (SJRRP) Office of Reclamation has requested the Technical Service Center (TSC) analyze water temperature dynamics in Reach 1A of the San Joaquin River. A desired outcome of the SJRRP is to restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish. Reach 1A of the San Joaquin River just downstream of Friant Dam has been identified for potential spawning habitat. Appropriate water temperature is critical for survival of fish as they move through the system. Water temperature is affected by flow characteristics and local meteorology; the presence of large hydraulically connected off-channel pools in Reach 1A potentially complicates the local thermal dynamics, impedes fish passage, and provides refuge for predatory species. A module in development at the TSC for computing two-dimensional water temperature dynamics was adapted

for application to Reach 1A of the San Joaquin River. The water temperature module is coupled to the SRH-2D computational software package, which contains a two-dimensional flow and mobile bed sediment transport solver. The two-dimensional temperature model was generally successful in simulating the gross spatial and temporal thermal dynamics within the system and may be useful for informing habitat suitability and management decisions. Results are presented for a range of hypothetical restoration hydrographs consistent with weather-driven water year types.

2. Preliminary Estimates of Chinook Salmon Spawning Habitat within Reach 1A of the San Joaquin River 2.1 MB

Presenter(s): Blair Greimann (Bureau of Reclamation)
Presenter(s) Email Address(es): bgreimann@usbr.gov
Collaborators: Elaina Gordon (Bureau of Reclamation)
Permission to Post pdf of Presentation on CWEMF Website: YES
Abstract:
The availability of spawning habitat within the San Joaquin River downstream of Friant Dam (Reach 1A) is crucial for successful reintroduction of Chinook salmon. Multiple studies are complete or underway including evaluations of water quality within the hyporheic zone (DO, water temperature, fine sediment accumulation), egg survival, meso-habitat, bed material size and mobility, scour and deposition, and channel morphology changes associated with alteration to the flow regime.

This study uses literature accepted criteria to delineate potential spawning locations within Reach1A of the San Joaquin River from Friant Dam to Highway 99 based upon suitable hydraulics, bed material, and surface water temperature. These potential areas are then analyzed for patterns of correlation between physical variables, and verified using mapped spawning redds within the reach in 2013 and 2014. In addition, a statistical evaluation was performed to determine the preference of salmon to spawn in redds within hydraulically suitable areas, within dominant substrate types, and within meso-habitat categories. Results of this effort provide supportive evidence for delineating spawning habitat using hydraulic information gained from two-dimensional modeling and from substrate characterization. Results also suggest that surface water temperature may not limit spawning for Fall-run Chinook in most years, but may limit spring-run Chinook spawning to between the first 5 to 10 miles downstream from Friant Dam. Data gained from the study provide a preliminary estimate of the quantity of spawning habitat available within Reach 1A based upon suitable hydraulics and substrate.

3. Channel Morphology Design of the Mendota Pool Bypass 5.8 MB

Presenter(s): Rebecca Kallio, Hydraulic Engineer, US Bureau of Reclamation, Technical Service Center
Presenter(s) Email Address(es): rkallio@usbr.gov
Collaborators: Blair Greimann and Scott O'Meara (US Bureau of Reclamation, Technical Service Center)
Permission to Post pdf of Presentation on CWEMF Website: YES
Abstract:
Reclamation's Technical Service Center (TSC) developed conceptual level designs for the future Mendota Pool Bypass on the San Joaquin River (SJR). The Mendota Pool Bypass channel design objectives included fish passage criteria, development of rearing habitat, conveyance of at least 4,500 cubic feet per second, maintenance of current flood capacities, and development of a stable stream profile that minimizes long-term sediment imbalances within the project area. Hydraulic and

sediment modeling established channel dimensions to promote channel complexity, and provide a stable stream profile and entrance and exit conditions.

The vegetation design within the bypass was to meet both short and long-term goals. In the short-term, the vegetation goals were suppression of invasive plants, quick revegetation to provide sediment stability, functional riparian habitat, management of flows through the bypass to promote establishment and growth of native riparian vegetation, and woody species to encourage channel and floodplain complexity. Long-term vegetation goals for the bypass design were to have a contiguous expanse of multi-tiered native vegetation, natural riparian recruitment where sediment is deposited, natural recruitment and additional large woody debris to the channel and floodplain, and a well-established and sustainable ecosystem. An irrigation system was designed to ensure vegetation establishment with in the project reach. The irrigation design sought to ease maintenance, promote high water efficiency, and promote root training to tap into groundwater system and become self-sufficient.

4. Informing Channel Stability Considering Added Cohesion Due to Roots using BSTEM 1.5 MB

Presenter(s): Emily Thomas (USBR)
Presenter(s) Email Address(es): ethomas@usbr.gov
Collaborators: Blair Greimann (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The San Joaquin River Restoration Program's preferred alternative to pass salmon and other native fish around the existing Mendota Dam is a one mile bypass channel that will allow fish to move upstream and downstream through a nature-like fishway. This channel will be constructed in an area currently in agriculture, and will require significant revegetation for biological function, invasive species control, and channel stabilization. To estimate erosion and soil stability in the designed channel with planned vegetation, analyses were conducted using RipRoot (Pollen and Simon, 2005), a component of the Bank Stability and Toe Erosion Model (BSTEM). Added cohesion due to vegetation was estimated for the three species mixes proposed in the bypass channel design over the first ten years after planting. The combined critical shear stress for the soil and vegetation was compared to applied shear stresses at flows through the bypass channel ranging from 250 cfs to 4,500 cfs, calculated using Reclamation's SRH-2D hydraulic model. Using these results, we predicted the total resistance to erosion of the soil and vegetation, and estimated the time required for vegetation to establish prior to resisting erosion by a series of flows. This analysis suggests that four years of vegetation establishment in the bypass channel will be necessary to resist erosion by the maximum design flow of 4,500 cfs, which informs the revegetation timing and sequencing of the Mendota Pool Bypass project.

Session 20. Poster Session

1. Optimal Drinking Water Provision 0.24 MB

Presenter(s): Lauren E. Adams (University of California, Davis)
Presenter(s) Email Address(es): leadams@ucdavis.edu
Collaborators: Jay Lund (Dept of Civil & Environmental Engineering, University of California, Davis, CA)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Over pumping from groundwater basins can significantly decrease groundwater elevations. In some cases, the combination of decreased groundwater elevation and existing well depth limits well production capacity as wells run dry. Water supply wells are constructed to different depths depending upon a variety of factors that include production rate and water quality requirements, local hydrogeology, and projections of future conditions and supply needs. Deeper wells also have been constructed over time as conditions and construction methods have evolved. As a result, the depths of existing water supply wells vary over fairly wide ranges. Overall, shallower wells are more susceptible to impact from decreased groundwater elevations. The potential impact of groundwater elevation decreases on well production capacity was evaluated for a study area located in a combined agricultural/urban area of California's Central Valley (greater vicinity of Tulare, CA). Well completion reports for a 216 square mile area (T19S to T21S by R24E to R25E) were obtained from the California Department of Water Resources (CADWR). Well constructions were characterized through statistical analysis of the elevations for the tops and bottoms of screened intervals. Cumulative distribution functions (CDFs) of the well construction data were developed for different spatial grouping resolutions (i.e., section and townshiprange levels). Groundwater elevation time series were obtained from the CADWR Water Data Library at spatial resolutions comparable to the well construction groupings. Changes in capacity over time were evaluated by identifying the intersections of the construction elevation CDFs with the standing groundwater elevations at different points in time. (A representative range of specific capacities for the wells was assumed.) Estimated trends in lost capacity were developed by determining the fraction of wells over time that had standing water levels below 1) the top of the screened interval and 2) the bottom of the screened interval. This presentation summarizes initial findings of the study.

2. An Innovative Cellular Automata Method for Reliability-based Hydropower Operation of Reservoirs 0.38 MB

Presenter(s): Mohammad Azizipour (University of California, Davis)
Presenter(s) Email Address(es): mazizipour@ucdavis.edu
Collaborators: Sam Sandoval Solis (University of California, Davis)
M.H. Afshar (School of Civil Engineering, Iran University of Science and Technology)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Optimal use of water from an available reservoir system is an important issue in water resources management. Many attempts have been made by researchers to achieve best possible performance of reservoir systems. Various optimization techniques have been used for optimal hydropower operation of reservoirs represented by a set of releases or storages. The main goal in hydropower operation of reservoir is maximizing energy production and as a result, maximizing net benefit.

In this study, an Adaptive Relaxed Cellular Automata (ARCA) method is developed for finding optimal hydropower operation policy of single reservoirs with maximum reliability. In the present method, constraints of the chance-constrained optimization problem are classified as operational constraints and reliability constraint, and dealt differently. Since the proper value of the penalty parameter to be used for the reliability constraints is not known a priori, an adaptive method is, therefore, proposed to find the proper value. For this, the problem is first solved for the optimal operation using a zero value of the penalty parameter. The value of the penalty parameter is then increased depending on the reliability of the optimal operation obtained. Increasing the value of penalty parameter leads to increase in the reliability of optimal. The iterative process is repeated until no change in the penalty parameter is possible.

The proposed model is used for optimal operation of a hydropower dam in the State of California. The operation is considered over short, medium and long term periods to demonstrate the efficiency and effectiveness of proposed method for hydropower reservoir operation problems of different scales.

3. Recommendations for a Modeling Framework to Answer Nutrient Management Questions in the Sacramento-San Joaquin Delta 1 MB

Presenter(s): Michael L. Deas (Watercourse Engineering, Inc.)
Presenter(s) Email Address(es): mike.deas@watercourseinc.com
Collaborators: n/a
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Management actions to address nutrients in the Delta could cost billions of dollars to implement in the coming decades depending on decisions that will come before the Central Valley Regional Water Quality Control Board (Water Board). The complexity of the Delta ecosystem and the range of questions to be addressed demand that numerical, processed-based water quality modeling be part of Delta management efforts. In light of this fact, the Water Board convened the Modeling Science Workgroup in 2015, to provide a white paper on the development and use of water quality models as one component of the Water Board's Nutrient Research Plan. The Charge to the Modeling Science Workgroup was to provide advice to the Water Board on:

- The types of models would be needed to answer the nutrient management questions raised by stakeholders,
- Organizational arrangements to support and maximize the benefits of models, and
- Cost estimates for the modeling task and how such work might be phased over time.

Citation: Trowbridge, P.R., M. Deas, E. Ateljevich, E. Danner, J. Domagalski, C. Enright, W. Fleenor, C. Foe, M. Guerin, D. Senn, and L. Thompson. 2016. Recommendations for a Modeling Framework to Answer Nutrient Management Questions in the Sacramento-San Joaquin Delta. Modeling Science Workgroup White Paper prepared for the Central Valley Regional Water Quality Control Board (V). March.

4. **FREEWAT, a HORIZON 2020 Project to Build Open Source Tools for Water Management: A European Perspective** 1.9 MB

Presenter(s): Laura Foglia
Presenter(s) Email Address(es): lfoglia@ucdavis.edu
Collaborators: Iacopo Borsi(TEA SISTEMI, Pisa, Italy), Violeta Velasco Mansilla (UPC Barcelona, Spain), Steffen Mehl (California State University, Chico), Rudy Rossetto (Scuola Superiore Sant'Anna, Pisa, Italy)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
FREEWAT is a HORIZON 2020 EU-project. FREEWAT's main result will be an open source and public domain GIS integrated modelling environment for simulation of water quantity and quality in surface water and groundwater with an integrated water management and planning module. FREEWAT aims at promoting water resource management by simplifying the application of Water Framework Directive and related Directives. Specific objectives of FREEWAT are: coordinate previous EU and national funded research to integrate existing software modules for water management in a single environment into the GIS based FREEWAT and support the FREEWAT application in an innovative participatory approach gathering technical staff and relevant stakeholders (policy and decision makers) in designing scenarios for application of water policies. The open source characteristic of the platform creates an initiative "ad includendum", as further institutions or developers may contribute to development.

The main expected impacts of FREEWAT are to help produce scientifically and technically sound decisions and policy making based on innovative data analysis tools and to support a participatory approach through all phases of a project, from scenario generation to the final stage of discussion. Activities are carried out on two lines: (i) integration of modules to fulfill the end-users requirements, including tools for producing feasibility and management plans; (ii) a set of activities to fix bugs and to provide a well-integrated interface for the different tools implemented. Through creating a common environment among water research/professionals, policy makers, and implementers, FREEWAT's main impact will be on enhancing a science- and participatory approach and evidence-based decision making in water resource management, hence producing relevant and appropriate outcomes for policy implementation.

5. **Understanding Reservoir Temperature Dynamics with Distributed Temperature Sensing and Modeling at Shasta Lake, California** 1.1 MB

Presenter(s): Rachel Hallnan (University of Nevada Reno)
Presenter(s) Email Address(es):
Collaborators: Laurel Saito (University of Nevada Reno),Scott Tyler (University of Nevada Reno), Eric Danner (NOAA Fisheries)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Stress on California's salmon fisheries as a result of recent drought drives a need for increased temperature management in California's Sacramento River. Cool temperatures downstream of Shasta Dam are required for Chinook salmon spawning and rearing. To acquire a more complete understanding of the thermal resources available to water managers, distributed temperature sensing (DTS) technology was used at Shasta Lake in a pilot deployment from August 2015 to the present. DTS measures the backscattered Raman photons along a standard telecommunication optical fiber. The backscattered photons can be related to temperature, and provide high resolution

data along the entire length of the fiber optic cable. At Shasta Lake, the fiber optic cable extends vertically just upstream of the dam from the surface of the reservoir to the bottom in order to capture the reservoir's thermal structure through time. Data collected by the DTS since August, 2015 shows the progression from summer stratification to isothermal conditions in late November. Future work aims to use the high resolution data provided by the DTS to build a computational fluid dynamics model of the reservoir directly upstream of the dam to examine changes in reservoir dynamics as a result of dam release operations. Ultimately, the goal is to use the in a predictive mode to help inform reservoir operations for effective temperature release for salmon spawning and rearing downstream.

6. Evaluating the Effects of Over Pumping and Drought on Water Supply Well Capacity

Presenter(s): Angela J. Kwon (University of California, Davis)
Presenter(s) Email Address(es): ajekwon@ucdavis.edu
Collaborators: Robert M. Gailey (University of California, Davis, CA) and Joshua H. Cho (University of California, Davis, CA)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Over pumping from groundwater basins can significantly decrease groundwater elevations. The combination of decreased groundwater elevation and existing well depth can limit well production capacity as wells run dry. Water supply wells are constructed to different depths depending upon a variety of factors that result in a wide range of water supply well depths. Overall, shallower wells are more susceptible to impact from decreased groundwater elevations. The potential impact of groundwater elevation decreases on well production capacity was evaluated for a study area located in a combined agricultural/urban area of Tulare in California's Central Valley. Well completion reports for an 81 square mile area were obtained from the California Department of Water Resources (DWR). Well constructions were characterized through statistical analysis of the elevations for the tops and bottoms of screened intervals. Cumulative distribution functions (CDFs) of the well construction data were developed for different spatial grouping resolutions. Groundwater elevation time series were obtained from the DWR Water Data Library at spatial resolutions comparable to the well construction groupings. Changes in capacity over time were evaluated by identifying the intersections of the construction elevation CDFs with the standing groundwater elevations at different points in time. Estimated trends in lost capacity were developed by determining the fraction of wells that had standing water levels below 1) the top of the screened interval and 2) the bottom of the screened interval. This presentation summarizes initial findings of the study.

7. **A Reach-Scale Hydrogeomorphic Classification of California for Environmental Flows Applications** 2.3 MB

Presenter(s): Belize A. Lane (University of California, Davis)
Presenter(s) Email Address(es): baalane@ucdavis.edu
Collaborators: S. Sandoval-Solis (University of California, Davis), H.E. Dahlke (University of California, Davis), and G.B. Pasternack (Dept. of Land, Air and Water Resources, University of California, Davis, CA)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Physical processes associated with particular streamflow patterns and geomorphic settings (e.g., slope, confinement) have major implications for river ecological functions. Understanding these processes is complicated in California by extreme hydrologic variability and extensive hydrologic alteration. Improved understanding of natural streamflow patterns and their ecological functions in various geomorphic settings is needed to develop effective environmental flow targets for the state. Our study addresses the need for a comprehensive environmental water management framework through the development of a spatially explicit hydrologic classification of California. We calculated 67 hydrologic metrics from 20 years of continuous daily discharge data for 91 unimpaired gauge stations, which were entered into a k-means cluster analysis to classify flow regimes into seven major classes. We then used a recursive partitioning algorithm to predict flow class based on a suite of topographic, climatic, and geologic variables using available geospatial data. Overall classification success was 87%, and the model was used to predict flow classes at the reach scale for the entire state. This methodology identified seven natural flow classes representing distinct flow sources, hydrologic characteristics, and catchment controls over rainfall-runoff response. We further investigated the reach-scale geomorphic variability of individual hydrologic classes within the Sacramento Basin to develop a nested hydro-geomorphic classification of river reaches based on cross-sectional and longitudinal morphology and sediment composition. This study provides a process-based framework upon which hydro-geomorphic setting – ecological function relationships can subsequently be established towards the development of reach-scale environmental flow targets for California with minimal resource and data requirements.

8. **Defining MODFLOW's River Coefficient for Calculation of Seepage in Large Regional Studies**

Presenter(s): Hubert J. Morel-Seytoux (Hydroprose International Consulting)
Presenter(s) Email Address(es): hydroprose@sonic.net
Collaborators: n/a
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
In large regional studies when the water table aquifer is treated as a single calculation layer the stream-aquifer boundary condition is assumed of the third type (Cauchy, General Head). In MODFLOW (and generally in most commercial groundwater codes) no procedure is provided to estimate the associated "river coefficient" (if historical data are available, it is calibrated). Using (mostly) analytical techniques a coefficient accounting for the presence of a clogging layer in the streambed, aquifer anisotropy, degree of penetration of the river, etc., was derived. With that coefficient it is possible to calculate the seepage with an accuracy equivalent to the use of an extremely refined grid size in vertical and horizontal directions (several thousand cells) with no change in the code and an extremely reduced computational burden. This work was done in cooperation with several individuals: Cinzia Miracapillo, Calvin Miller, Steffen Mehl and Can Dogrul.

9. Water Prism, a Decision Support System for Examining Strategies to Address Water, Energy, Food, and Ecosystem Security Challenges 0.5 MB

Presenter: Tad Slawecki (LimnoTech)
Presenter Email Address: tad@limno.com
Collaborators: Laura Weintraub (LimnoTech), Bob Goldstein (EPRI), Dr. Hua Tao (LimnoTech), Todd Redder (LimnoTech)
Permission to Post pdf of Presentation on CWEMF Website: Yes (a version of the interactive poster will be provided)
Abstract:
Developed with the sponsorship of the Electric Power Research Institute (EPRI), Water Prism supports the evaluation and design of sustainable water use strategies in watersheds/catchments and basins. It provides a watershed-scale assessment of water demands from various water use sectors in the context of available supply, and includes both surface water and groundwater systems. Water Prism interfaces with an underlying hydrologic model to establish water reference conditions (natural streamflow without influence of withdrawals or discharges). Availability and demands are projected for a 50-year planning horizon for all points within a watershed, with demands characterized by sector (electric power, municipal, industrial, and agricultural).

Results are visualized as a 'prism' graphic with each sector's demand depicted as a discrete color band within a spectrum as referenced against 'dry' and 'wet' available water conditions. After assessing the level of risk under “business as usual” conditions, water management scenarios can be evaluated to explore the benefits of nonpotable or in-plant reuse for industry, alternative cooling of power plants, low water crops and water efficient irrigation for agriculture, and reuse and improved water efficiency for municipal use. The tool, which is designed to promote collaborative scenario development and evaluation of results, also accounts for ecological demands and management objectives for reservoirs while computing the aggregated benefits of community water sharing strategies as both reduced demand and net savings.

10. Climate Change Impact Study with CMIP5 and Comparison with CMIP3 1.4 MB

Presenter(s): Jay (Jianzhong)Wang (California Department of Water Resources)
Presenter(s) Email Address(es): wangj@water.ca.gov
Collaborators: Hongbing Ying (California Department of Water Resources), Erik Reyes (California Department of Water Resources) and Francis Chung (California Department of Water Resources)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
One of significant uncertainties in climate change impact study is the selection of climate model projection including the choosing of greenhouse gas emission scenarios. With the new generation of climate model projection, CMIP5, coming into use, CCTAG selected 11 climate models and two RCPs (rcp4.5 and rcp8.5) for California. Previous DWR climate change study was based on 6 CMIP3 climate models and two emission scenarios (SRES A2 and B1) which were selected by CAT. It is an unanswered question that how the selection of these climate model projections and emission scenarios affect the assessment of climate change impact on future water supply of California CVP/SWP project. This work will run the water planning model CalSim in DWR with 44 CMIP5 and 12 CMIP3 climate model projections to investigate the sensitivity of climate model impact study on future water supply in the CVP/SWP region to the section of climate model projection. It was found that in 2060 CMIP5 projects the wetting trend in Northern California while CMIP3 projects the drying trend in the entire California on the average. And CMIP5 projects about half-degree more warming

than CMIP3. As a result, Sacramento River rim inflow increases by 8% for CMIP5 and reduces by 3% for CMIP3. In spite of this difference in rim inflow, north of Delta carryover storage will be reduced both under CMIP5 (13%) and under CMIP3 (20%) in 2060. And south Delta export will be reduced both for CMIP5 (8%) and for CMIP3 (15%).

11. A Review of Grid-based Datasets for Hydrological Modeling  **1.3 MB**

Presenter(s): Luciana Cunha
Presenter(s) Email Address: lcunha@westconsultants.com
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Advances in remote sensing, data merging, and land surface modeling techniques have created a new era in water resources modeling. Now, a large range of observed and modelled datasets are available which can potentially simplify the implementation of hydrological models and reduce uncertainties. It is the responsibility of the modeler to determine which datasets are the most appropriate for each project which will usually depend on project goals, region, governing hydrological and climatological processes, temporal and spatial scales, dataset and model expected uncertainty, and available computational resources. This poster presents a review of freely available grid-based datasets with the goal of providing guidance in model implementation. We list available datasets for each hydrological variable, including precipitation, snow, evapotranspiration, soil moisture, surface water storage, and discharge. The main characteristics of each dataset, including their spatial and temporal resolution, source (modelled or observed), period of availability, and limitations, are also provided. We exemplify how different projects might require different datasets by presenting two case studies which focus on (1) the implementation of an operational flood forecast system, (2) and on the long term evaluation of hydrological losses.

12. Site Specific Probable Maximum Precipitation (PMP)

Presenter(s): Jeff Harris
Presenter(s) Email Address: jharris@westconsultants.com
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The National Oceanic and Atmospheric Administrations (NOAA) is association with the US Army Corps of Engineers (USACE) published several Hydrometeorological Reports (HMR) which present guidance on the development of the PMP throughout the United States. However, many of these documents were published in the 1980's or earlier. Subsequent to the publication of these documents, large rainfall events have occurred in many regions of the US. When a new Probable Maximum Flood is computed for a reservoir in one of these areas it is necessary to include these new events and determine if the PMP developed from the HMR guidance needs to be updated. This poster will step through the development of updating the PMP for a specific area.

13. Quantifying Floodplain Inundation Patterns in Space and Time
Presenter(s): Alison A. Whipple (University of California, Davis)
Presenter(s) Email Address(es): aawhipple@ucdavis.edu
Collaborators: W.E. Fleenor (Civil & Environmental Engineering, University of California, Davis, CA)
J.H. Viers (School of Engineering, University of California, Merced, CA)
Permission to Post pdf of Presentation on CWEMF Website:
Abstract:
Spatially and temporally variable conditions important for floodplain ecosystem process and function are a product of land-water interaction, where different flood types comprising a river's flood regime inundate heterogeneous floodplain topography. Natural flood regimes to which species adapted have been altered across the globe by water management, land use change, and climate change. Improving understanding of spatiotemporal floodplain inundation patterns, or hydrospatial conditions, and how restoration actions (either of flows or landscape) affect these patterns is needed to better support ecosystem integrity. For this research, the flood regime and its associated hydrospatial conditions are quantified for a floodplain restoration site of the lower Cosumnes River, California. Selected floods from the historical record representing previously-established flood types are applied within a 2D hydrodynamic model of the floodplain site. A range of metrics, including depth and duration, are quantified and compared in space and time from the model output. This research establishes new methods for evaluating spatiotemporal characteristics of floodplain inundation, which provide needed information to manage floodplains for greater ecosystem function.

14. Implementation of the Truckee River Operating Agreement with the RiverWare Modeling Platform **0.9 MB**
Presenter(s):James Lu (Bureau of Reclamation)
Presenter(s) Email Address(es): jlu@usbr.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Implementing the Truckee River Operating Agreement (TROA) in the Lahontan Basin prompted a transition from pre-TROA to TROA operation. Thanks to the foresight and careful planning of the Federal and local regulators and stakeholders, the transition happened without incident. The implementation highlights a RiverWare operations model in the Federal Water Master's Office with a toolset that enables flexibility of water exchanges and trades within the Truckee and Carson River Basins which TROA dictates.

With the aid of the RiverWare operations model, the Federal Lahontan Basin Area Office is able to estimate, at the start of the growing season, the amount of water available for use in the coming season. The water availability information is then discussed with the stakeholders for their input. Based on this information, growers in the Newlands Project are able to formulate a planting strategy for the season. Adjustment to the available water for diversion is subsequently made with the ongoing water and weather forecasts. The RiverWare modeling platform was tested and proved to be a versatile tool for simulating complex water management policies and strategies.

15. Bay-Delta Water Quality Control Plan Update – Fish Benefit Analysis
Presenter(s): Timothy Nelson (SWRCB)
Presenter(s) Email Address(es): Timothy.Nelson@Waterboards.ca.gov
Collaborators: Dan Worth (SWRCB), Will Anderson (SWRCB), Les Grober (SWRCB)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The State Water Resource Control Board (SWRCB) is in the process of updating the 2006 Bay-Delta Water Quality Control Plan. This effort includes establishing flow objectives during the February through June period and a program of implementation for the reasonable protection of fish and wildlife beneficial uses in the Lower San Joaquin River (LSJR) watershed, including the three eastside, salmon-bearing tributaries (the Stanislaus, Tuolumne, and Merced Rivers). These rivers serve as important spawning and rearing grounds for native fish species, including Chinook salmon and steelhead. However, water development over the past several decades, has negatively impacted fish and wildlife beneficial uses and has contributed to the declines in the abundance of native fishes. Human operations have drastically changed the natural flow regime in the spring and early summer seasons, which is an important time for juvenile salmonid development and migration. Scientific evidence indicates that a more natural flow regime is needed to reasonably protect fish and wildlife beneficial uses in the LSJR watershed. Modeling results show that establishing instream flow requirements based on a percent of unimpaired flow in each of the three tributaries for the February through June period will provide improved temperature and floodplain habitat conditions during a time period that is essential to native fishes. Improving flow conditions and related temperature and floodplain regimes to which native fish species are adapted, is expected to provide many juvenile salmonids with additional space, time, and food resources which are necessary for required growth, development, and survival.

16. Optimal Selection and Placement of Green Infrastructure and Tracking Progress for Urban Watersheds 2.1 MB
Presenter(s): Jing Wu
Presenter(s) Email Address(es): jingw@sfei.org
Collaborators: Pete Kauhanen, Lester McKee, Jennifer Hunt, Tony Hale
Permission to Post pdf of Presentation on CWEMF Website: Indicate Yes
Abstract:
Reducing stormwater runoff and contaminant loads in urban environment is complex and relies on costly engineering. Increasingly, Green Infrastructure (GI) is emerging as a multi-benefit solution that can address both stormwater quality and quantity concerns, but challenges remain as how to identify where opportunity sites exist for GI retrofits and what constitutes the most cost-effective management strategy for achieving desired management goals.

To help address these challenges, a planning level tool - GreenPlan-IT, was developed that was centered on watershed modeling and optimization technique. SWMM was used to establish baseline conditions and quantify anticipated runoff and pollutant load reduction from GI sites. An evolutionary optimization technique (NSGA-II) was applied to identify optimal combinations of GI among many options identified through a GIS site locator tool that minimize the total cost of management while achieve water quality and quantity goals. As municipalities begin to implement GI in phase, a Tracker will be used to record the effectiveness of GIs on ground estimated through SWMM and track progress. Together, these four tools can ensure GI features are properly located, tracked, and credited.

The GreenPlan-IT was applied to City of San Jose to support a cost-benefit evaluation of stormwater runoff control, and is currently being applied to four cities in San Francisco Bay area to support their GI planning effort. The GreenPlan-IT can be used to comply with NPDES stormwater permit requirements and address load reduction needs identified in TMDLs. The toolkit has broad applicability and could be used by stormwater agencies across the nation.

Session 21. Climate Change Adaptation – Strategies and Insights from the Sacramento-San Joaquin Basins Study

1. Climate Change Impact Study with CMIP5 and Comparison with CMIP3 1.8 MB

Presenter(s): Jay (Jianzhong)Wang
Presenter(s) Email Address(es): wangj@water.ca.gov
Collaborators: Hongbing Ying, Erik Reyes, Francis Chung (California Department of Water Resources)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
One of significant uncertainties in climate change impact study is the selection of climate model projection including the choosing of greenhouse gas emission scenarios. With the new generation of climate model projection, CMIP5, coming into use, CCTAG selected 11 climate models and two RCPs (rcp4.5 and rcp8.5) for California. Previous DWR climate change study was based on 6 CMIP3 climate models and two emission scenarios (SRES A2 and B1) which were selected by CAT. It is an unanswered question that how the selection of these climate model projections and emission scenarios affect the assessment of climate change impact on future water supply of California CVP/SWP project. This work will run the water planning model CalSim in DWR with 44 CMIP5 and 12 CMIP3 climate model projections to investigate the sensitivity of climate model impact study on future water supply in the CVP/SWP region to the section of climate model projection.

It was found that in 2060 CMIP5 projects the wetting trend in Northern California while CMIP3 projects the drying trend in the entire California on the average. And CMIP5 projects about half-degree more warming than CMIP3. As a result, Sacramento River rim inflow increases by 8% for CMIP5 and reduces by 3% for CMIP3. In spite of this difference in rim inflow, north of Delta carryover storage will be reduced both under CMIP5 (13%) and under CMIP3 (20%) in 2060. And south Delta export will be reduced both for CMIP5 (8%) and for CMIP3 (15%).

2. Assessing Impacts of Climate and Socioeconomic Changes on Central Valley System Risk and Reliability 3.7 MB

Presenter(s): Brian Van Lienden (CH2M) and Tapash Das (CH2M)
Presenter(s) Email Address(es): brian.vanlienden@ch2m.com , tapash.das@ch2m.com
Collaborators: Armin Munevar (CH2M)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
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. A system risk and reliability assessment was 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 was developed. Climate projections available from CMIP5 climate model simulations consistent with the most recent Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR5) was used to perform assessments of future water supplies in the Central Valley. The performance of the Central Valley water system was 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 Sacramento-San Joaquin River Basins Study CalLite-CV Model and other performance assessment tools. Performance metrics for each resource area were developed to articulate existing and future system vulnerabilities under the range of potential future conditions. The results from the suite of models used to guide the development of water management actions to address system risks will be presented

3. Development of Water Management Actions and Portfolios to Address Central Valley System Risks  **0.6 MB**

Presenter(s): Armin Munevar (CH2M)
Presenter(s) Email Address(es): Armin.Munevar@ch2m.com
Collaborators: Brian Van Lienden (CH2M), Arlan Nickel (Reclamation)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
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 included 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, combinations of such actions, or portfolios were developed to evaluate risk while achieving differing levels of economic, environmental, and social benefits. The approach and the development of water management actions and adaptation portfolios used in the Basins Study will be presented.

4. Evaluation of Portfolio Performance and Trade-offs in Management of Future Central Valley System Risks  **1.1 MB**

Presenter(s): Michael Tansey (Reclamation)
Presenter(s) Email Address(es): mtansey@usbr.gov
Collaborators: Arlan Nickel (Reclamation), Brian Van Lienden (CH2M), Charles Young (SEI)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The Sacramento-San Joaquin Basins Study explored seven adaptation portfolios each consisting of a variety of water management actions. These thematic portfolios were evaluated to determine their effectiveness in adapting to potential risks posed by future socioeconomic and climate changes. The effectiveness of the portfolios was evaluated in seven major water resource management categories including water deliveries, water quality, hydropower, flood control, recreation, fish and wildlife habitats, ESA species, flow dependent ecological resiliency and the economic impacts of water supply changes. The robustness of the portfolios relative to future uncertainties and tradeoffs between their performances were also examined.

5. Next Steps for the Sacramento and San Joaquin Basins Study 0.3 MB

Presenter(s): Arlan Nickel (Reclamation)
Presenter(s) Email Address(es): anickel@usbr.gov
Collaborators: Michael Tansey (Reclamation), Brian Van Lienden (CH2M)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The completion of the Sacramento-San Joaquin Basins Study is a major advancement in the understanding of potential future impacts of climate and socioeconomic changes on the CVP, SWP and local water management systems. The collaboration between Reclamation and the Basins Study partners is a model for the development of more refined adaptation portfolios. Current and future opportunities for collaboration with Reclamation's WaterSmart and other programs will be presented.

Session 22. NHD Hydro Spatial Data Review 2016

1. The National Hydrography Dataset (NHD) and National Hydrography Dataset Plus (NHDPlus)

Presenter(s): Alan Rea, USGS National Geospatial Program
Presenter(s) Email Address(es): ahrea@usgs.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The National Hydrography Dataset (NHD) is the U.S. Geological Survey's geospatial dataset used to portray surface water in The National Map. The NHD represents the drainage network with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and streamgages. The NHD also includes a linear referencing system based on reach codes that functions like a street address, and network connectivity information that enable analysis and discovery of information upstream or downstream of a point of interest.

The National Hydrography Dataset Plus (NHDPlus) enhances the NHD by incorporating two other USGS datasets, seamless elevation data from the 3D Elevation Program (3DEP), and delineations of drainage divides from the Watershed Boundary Dataset (WBD). The NHDPlus comprises an integrated suite of hydrologic geospatial data sets, including a hydrographic stream network, polygonal catchment areas representing incremental drainage areas for each stream network element, and Digital Elevation Model (DEM) derivatives including flow direction and flow accumulation grids. The USGS and U.S. Environmental Protection Agency (USEPA) collaborated to produce two versions of the National Hydrography Dataset Plus (NHDPlus V1 and NHDPlus V2), using the Medium-Resolution NHD at 1:100,000 scale, 30-meter elevation data from 3DEP, and WBD. Now the USGS has begun work on NHDPlus High Resolution (NHDPlusHR), which uses techniques and software from NHDPlus V2 with the NHD High Resolution (1:24,000-scale or better), 10-meter elevation data from 3DEP, and WBD. Many applications have been built upon the previous versions of NHDPlus, and we anticipate that even more will make use of the NHDPlusHR.

Introduction to the National Hydrography Dataset (NHD) 5.3 MB
NHDPlus Update 7.2 MB
Elevation-Hydrography Integration 2.8 MB

2. National Watershed Boundary Dataset Overview

Presenter(s): Susan G. Buto (U.S. Geological Survey)

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

Collaborators:

Permission to Post pdf of Presentation on CWEMF Website: No

Abstract:

The Watershed Boundary Dataset, a companion dataset to the National Hydrography Dataset, is a nationally consistent, seamless, and hierarchical hydrologic unit boundary dataset based on topographic and hydrologic features across the United States. This dataset provides a consistent framework for local, regional, and national applications to help manage, archive, exchange, and analyze data by hydrologic units. This presentation will provide an overview of current activities around the Watershed Boundary Dataset with emphasis on stewardship and enhancements affecting users in California. The presentation also will focus on upcoming improvements intended to improve integration of Watershed Boundary data with other national hydrography data and the utility of the data for scientific investigations.

3. Data Wrangling with Reachcodes  **2.5 MB**

Presenter(s): Jeff Kapellas and Stephanie Bucknam

Presenter(s) Email Address(es): Jeff.Kapellas@waterboards.ca.gov
Stephanie.Bucknam@waterboards.ca.gov

Collaborators:

Permission to Post pdf of Presentation on CWEMF Website: Yes

Abstract:

The California Water Resources Control Board regulates water quality and water rights in the state. The Water Board has implemented the National Hydrography Dataset as the primary hydrologic framework dataset to enable staff to associate data from discreet systems. This presentation will demonstrate how the board has used the NHD to integrate water quality assessment, water rights, and basin planning processes.

4. Status of National Hydrography Dataset (NHD) Stewardship for California  **2.2 MB**

Presenter(s): Jane Schafer-Kramer, California Department of Water Resources

Presenter(s) Email Address(es): jane.schafer-kramer@water.ca.gov

Collaborators: Carol Ostergren (US Geological Survey)

Permission to Post pdf of Presentation on CWEMF Website: Yes

Abstract:

"The best sources of information about changes in local hydrography are users closest to the data, such as State and local governments, as well as Federal land management agencies, and other users of the data. The need for local knowledge has led to the creation of a collaborative data stewardship process to revise and maintain the NHD." (http://pubs.usgs.gov/fs/2014/3084/pdf/fs2014-3084.pdf) The California Department of Water Resources is in the process of building a program to take on the role of steward for the California portion of this important data set. This short presentation is an update on the status of NHD stewardship for the State.

5. **USGS National Geospatial Program 3D Elevation Program for Understanding California's Surface Waters** 5.3 MB

Presenter(s): Carol Ostergren (US Geological Survey)

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

Collaborators: Al Rea, Drew Decker, Susan Buto (US Geological Survey)

Permission to Post pdf of Presentation on CWEMF Website: Yes

Abstract:

The national 3D Elevation Program, also known as 3DEP, has become a focal point around which states can bring together communities of practitioners whose programs depend upon mission-critical terrain datasets such as lidar. As the managing body for lidar across the nation, the 3DEP program of work includes development of strategies for stakeholder communities, data acquisition partnerships, standards and specifications, and, most importantly, high-quality elevation data that can support the generation of hydrography information. This presentation will describe the current status for CA in terms of data coverage, funding awards for the first three cycles, partnership strategies and progress for CA, and examples of high-resolution lidar-derived hydrography.

Session 23. Advanced Conjunctive Use Analysis with MODFLOW One Water

1. **Use of MODFLOW-OWHM to Simulate Land Subsidence**

Presenter(s): Jonathan Traum

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

Collaborators: None

Permission to Post pdf of Presentation on CWEMF Website: yes

Abstract:

"Significant and unreasonable land subsidence that substantially interferes with surface land uses" is one of the six undesirable results identified in California's Sustainable Groundwater Management Act (SGMA). This presentation discusses (1) what is subsidence, (2) undesirable effects related to subsidence, (3) considerations for whether to include subsidence in a groundwater simulation, (4) how subsidence is simulated within MODFLOW-OHWM, (5) sources of subsidence data, and (6) how subsidence is simulated in the updated Central Valley Hydrologic Model (CVHM2). In addition, preliminary results of a case study of a proposed conjunctive use project will be presented. This project is proposing to pump additional groundwater during drought periods in order to supplement reduced surface-water supplies from the Central Valley Project. CVHM2 is used to estimate the distribution and magnitude of groundwater-level declines and land subsidence due to the additional stresses.

2. **Development of the Sonoma Valley Integrated Hydrologic Flow Model**

Presenter(s): Andy Rich, Sonoma County Water Agency

Presenter(s) Email Address(es): arich@scwa.ca.gov

Collaborators: Marcus Trotta, Sonoma County Water Agency

Permission to Post pdf of Presentation on CWEMF Website: No

Abstract:

The Sonoma Valley Groundwater basin is located at the northern end of the San Pablo Bay, in between Napa Valley and Santa Rosa plain. Recent groundwater observations indicate an increase in rates of waterlevel declines in portions of the southern valley. The watershed and the valley floor

have undergone a land use transformation characterized by growth in urban, rural and agricultural sectors. Here we present results from the development of an integrated groundwater flow model constructed as a tool in support of the voluntary Sonoma Valley Groundwater Management Plan. The model incorporates a new hydrostratigraphic framework constructed through the analysis of geologic maps, well-logs, and other sources of information. Model output generated by the Basin Characterization model are used as mountain front recharge inflow. The Farm Package and Modflow One Water Hydrologic Model were used to estimate groundwater pumping, generating results comparable to other studies. Agricultural pumping demands account for delivered water and surface water diversions, while simultaneously integrating climatic influences and land use changes. Model calibration was performed using a variety of waterlevel measurements and differences, and stream discharge and seepage measurements. Model uncertainty analysis was performed to quantify uncertainty in cumulative groundwater storage declines and other components of the groundwater budget. The presentation will conclude with a discussion of climate change scenario modeling.

3. Rio Grande Integrated Hydrologic Modeling Updates with Reservoir Operations Linkage

Presenter(s): R.T. Hanson, U.S. Geological Survey
Presenter(s) Email Address(es): rthanson@usgs.gov
Collaborators: Ian Ferguson (USBR), S.E. Boyce (USGS), Dagmar Llewellyn (USBR), Andre Ritche (USGS), Amy Galanter (USGS)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Groundwater pumping affects surface-water availability by intercepting water that would otherwise discharge to streams and/or by increasing seepage losses from stream channels. Conversely, surface-water management affects groundwater availability by altering the timing, location, and quantity of groundwater recharge and pumping. Analyses of climate change effects on water resources commonly fail to account for these interactions, owing to a lack of models capable of simulating interactions between surface-water and groundwater management, movement, and use.

A new version of the MODFLOW-One Water Hydrologic Flow Model (MF-OWHM) is used to evaluate the role of feedbacks between surface-water and groundwater management and use in the context of climate change effects and adaptation studies. The new MF-OWHM was developed by USBR and USGS by incorporating a fully-integrated surface-water operations module within MF-OWHM. Our ongoing project also is developing an updated and more detailed model that better separates the supply and demand components, which in combination with the linked surface-water operations will allow the assessment of changes in land-use practices, climate change, or other aspects of mitigation or adaptation. This integrated approach allows simulation and analysis of both direct effects as changes resulting from the hydrologic response to climate change or variability and indirect effects as changes arising from the anthropogenic response to direct effects (e.g., changes in groundwater pumping in response to climate-driven changes in water demands or surface-water supplies). Preliminary examples of some of these new features and their effects will be presented from the new Rio Grande Integrated Hydrologic Model (RGTIHM).

4. **Effects of Agricultural Water Transfers in Northern California on Aquifer Declines, Energy, and Food Production**

Presenter(s): Steffen Mehl (CSU Chico)
Presenter(s) Email Address(es): smehl@csuchico.edu
Collaborators: Eric Houk (CSU Chico), Kyle Morgado (South Feather Water and Power), Kevin Anderson (CSU Chico), Nicholas Reid (SHN)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
California imports more water than any other place on Earth and is the largest producer of food in the USA. The majority of California's fresh-water supply is located in the northern part of the State while a majority of the water demand is in the central and southern parts. Large infrastructure projects were developed to transfer northern water supplies to southern water users. In addition to increased water demands, recent drought conditions places additional pressure on northern water supplies. The ability to transfer water places pressure on northern California farmers to sell/lease their water, and decrease production and/or increase groundwater pumping to offset these transfers; however, the impacts of these transfers on regional economies and aquifer levels are often poorly understood. This work examines the effects of water transfers from northern California by using the United States Geological Survey's Central Valley Hydrologic Model (CVHM) to simulate groundwater pumping scenarios corresponding to water transfers. The CVHM allows analysis of the spatial and temporal effects of pumping on the groundwater levels which are used to estimate: (1) the impact of additional groundwater pumping on aquifer levels, (2) the energy costs associated with additional lift due to aquifer declines throughout the region, and (3) the impacts associated with land fallowing for surface water transfers.

5. **Land Subsidence and the Conjunctive Use of Water in the Central Valley: Past, Present, and Future**

Presenter(s): Claudia Faunt (USGS)
Presenter(s) Email Address(es): ccfaunt@usgs.gov
Collaborators: Michelle Sneed (USGS) and Jon Traum (USGS)
Permission to Post pdf of Presentation on CWEMF Website: no, yes after review post meeting
Abstract:
The Central Valley is one of the most productive agricultural regions in California. Because the valley is semi-arid and the availability of surface water varies substantially from year to year and season to season, the agricultural industry developed a reliance on local groundwater for irrigation. Groundwater pumpage has caused severe groundwater-level declines in portions of the valley, resulting in land subsidence. The completion of state and federal water distribution systems by the early 1970s eased the reliance on local groundwater as dependence shifted to diverted surface water. As a result, groundwater levels recovered and subsidence virtually ceased. In the last 20 years, however, land-use changes and an assortment of limitations to surface-water availability—including droughts and environmental flows—have resulted in increased pumping and renewed land subsidence. The spatially variable subsidence has changed the land-surface slope in some places and caused changes to drainage and infrastructure, including surface-water delivery canals. Planning for the effects of subsidence is important for water managers. As land use and surface-water availability continue to vary, long-term groundwater-level and subsidence monitoring, analysis, and modeling are critical to understanding the dynamics of historical and continued groundwater use resulting in groundwater-storage changes and associated subsidence. Modeling tools, such as the USGS Central Valley Hydrologic Model, can be used in the evaluation of management strategies to mitigate adverse

impacts due to subsidence while also optimizing water availability. This knowledge will be critical for successful implementation of recent legislation aimed toward sustainable groundwater use.

Session 24. California Water Plan Update 2018: Employing New Integrated Water Management Tools for Sustainable Outcomes

1. California Water Plan 2018 – Outcome-based Planning For Better Policy Decisions 4.5 MB
Presenter(s): Paul Massera (California Department of Water Resources)
Presenter(s) Email Address(es): Paul.Massera@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
California Water Plan Update 2018 will build on Update 2013's foundational work and 3 themes of integrated water management, government agency alignment, and investment in innovation and infrastructure. The 2018 Update will focus on key and game-changing State government initiatives which respond to historic drought, unsustainable groundwater basins, substantial flood risk, and declining vital ecosystems. In addition to being State government's long-term strategic water plan, Update 2018 will – for the first time – identify specific intended outcomes (and related metrics to track performance), prioritize near-term State policy and investments, recommend financing methods having more stable revenues, and inform water deliberations and decisions as they unfold.

The 2018 Water Plan will report on: (1) how the key State initiatives (such as the Governor's Water Action Plan, Sustainable Groundwater Management Act, Proposition 1, and Drought Response Executive Orders) interrelate and how effectively they are collectively moving California toward a more sustainable water future; (2) what more must be done over the next few decades; and (3) priority policies and investments needed for the next five years. It will employ (and advocate for advancing) an outcome-based decision framework for informing water policy, planning, regulation, and implementation with the intent of dynamically balancing California's key societal water-dependent values of:

- Providing reasonable levels of public safety
- Supporting a stable economy
- Sustaining vital ecosystems
- Providing for enriching human experiences

2. Strategic Vision and Framework for IWM Data and Tools 1.6 MB
Presenter(s): Rich Juricich (California Department of Water Resources)
Presenter(s) Email Address(es): Rich.juricich@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The Strategic Vision and Framework for IWM Data and Tools (Work Plan) describes the current state of data and tools used by the Department of Water Resources' (DWR) Division of Integrated Regional Water Management (DIRWM) and Division of Statewide Integrated Water Management (DSIWM). It documents the vision, objectives, and related actions that DIRWM and DSIWM will take in moving toward implementation of an integrated data framework that will facilitate sustainable water

management with robust data collection by DWR, transparent data reporting by Groundwater Sustainability Agencies (GSAs) and other local agencies, enterprise data management and exchange, and defensible water budgets at both local and watershed scales to support SGMA implementation. This Work Plan aims to connect the Sustainable Groundwater Management Program (SGMP), the California Water Plan (CWP), and other DWR programs through an integrated data framework to support achieving sustainable water management goals of the Governor's California Water Action Plan (CWAP) and the Sustainable Groundwater Management Act (SGMA).

3. Comprehensive Water Budget Pilots for Tulare Lake and Central Coast Hydrologic Regions

Presenter(s): Abdul Khan (California Department of Water Resources)
Presenter(s) Email Address(es): Abdul.Khan@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The project will develop a watershed-based water budget framework and water reliability maps (WRMs) for watersheds and underlying groundwater basins to support the implementation of the Sustainable Groundwater Management Act (SGMA) and the transition of water supply and balance computation for developed water supplies for the California Water Plan (CWP) to watershed-based water budget development. The project will be completed in multiple phases. For Phase 1 and Phase 2 of the project, two pilot projects: (1) Tulare Lake, a Central Valley hydrologic region; and (2) Central Coast, a non-Central Valley hydrologic region are identified. The lessons learned from the two pilot projects will be used to develop recommendations for refining the watershed-based water budget framework, enhancing the two pilot projects, and implementing the water budget framework in the rest eight hydrologic regions of California in multiple phases. Phase 1 will include the following: (i) Tulare Lake Hydrologic Region pilot project with California Department of Water Resources (DWR)'s C2VSIM model and data, which will include water budget and WRMs. Phase 2 will include (i) update of C2VSIM data for Tulare Lake Hydrologic Region with readily available information from CWP and local agencies; (ii) update of Tulare Lake water budget and WRMs; (iii) development of the water budget framework; (iv) Central Coast Hydrologic Region pilot project with water budgets and WRMs; and (v) revised water budget framework based on lessons learned from the two pilot projects.

4. Water Available Estimates by the California Department of Water Resources 1.6 MB

Presenter(s): Devinder S. Dhillon & Romain Maendly (California Department of Water Resources)
Presenter(s) Email Address(es): Devinder.Dhillon@water.ca.gov, Romain.Maendly@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Indicate Yes
Abstract:
As part of the Sustainable Groundwater Management Act, the California Department of Water Resources (DWR) is directed to "prepare and publish a report by December 31, 2016, that presents DWR's best estimate, based on available information, of water available for replenishment of groundwater in the state." For purposes of this report, the notion of "Water Available for Replenishment of Groundwater" includes two parts. The first part, "Water Available," represents a quantity of water that could be developed by one or more water available methods (surface water, conservation, recycled, desalination, etc.). Second, water can be managed in a way that results in groundwater replenishment, the physical process of augmenting a groundwater basin, by natural or

artificial means. DWR will provide planning estimates of water available, by method, for the state. The presentation will focus on the tools, methodologies and assumptions to estimate "Water Available." For surface water, two modified water available analytical approaches are being used outside the Central Valley: 1) Gage Data Method and 2) Water Evaluation and Planning (WEAP) tool. Both methods provide a simple planning estimate of water available for each hydrologic region (as distinctive from a water available analysis as required for a water right permit). DWR will estimate the entire quantity of surface water that is in excess of total water use, using current operations and regulatory requirements. For conservation, recycling, desalination, water transfers, and other water available methods, planning estimates of potential water available from the *California Water Plan Update 2013* will be used.

Session 25. Dealing with Drought: Data, Modeling, and Strategies

1. The California Drought of 2012-15 and Comparison to Past Droughts  **0.5 MB**
Presenter(s): Maurice Roos, DWR
Presenter(s) Email Address(es): Maury.Roos@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Although the current water year now appears to be better perhaps enough to be ending a 4 year string of dry years, 2012-15-was a period of severe drought in California. It was especially dry across the middle part of the State especially the San Joaquin River region which includes the southern Sierra Nevada. The past couple of years have seen severe cuts in water delivery from federal, State, and local water projects as well as a record low snowpack in 2015. The shortfall was partly made up by additional groundwater pumping from over drafted ground water basins and by fallowing land. Existing reservoirs do not provide enough water storage capacity to handle a multiyear drought.

2. Hydroclimatic Characteristics of the 2012-2015 California Drought in a Historical Context 
Presenter(s): Kevin He, DWR Division of Flood Management
Presenter(s) Email Address(es): kevin.he@water.ca.gov
Collaborators: Mitchel Russo and Michael Anderson, DWR Division of Flood Management
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
California experienced an extraordinary drought from 2012-2015 (which continues into 2016). The drought had both well perceived and more profound adverse impacts on the economy, society, and environment of the state. This work, from a hydrologic perspective, reviewed the development of this drought and examined its characteristics including extent and magnitude. Historical precipitation, temperature, snow water equivalent, full natural flow (observed and reconstructed), and reservoir storage data were collected and analyzed for this purpose. Preliminary results indicated that the 2012-2015 drought was unparalleled in 14 out of 20 indices investigated. The drought was characterized with record low snowpack, record high temperature, as well as exceptionally low precipitation, April-July runoff, and reservoir storage. In general, the drought conditions in San Joaquin, Tulare, Central Coast, and South Coast regions were more severe than other regions.

3. Modeling Challenges for the 2015 Emergency Drought Barrier 2.1 MB
Presenter(s): Ming-Yen Tu and Kijin Nam
Presenter(s) Email Address(es): Ming-Yen.Tu@water.ca.gov, Kijin.Nam@water.ca.gov
Collaborators: Department of Water Resources
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
This presentation will summarize the computer modeling analyses (including 1-D and 3-D hydrodynamic modeling) for using the temporary barrier at the False River as a drought management tool to protect the water quality in the Sacramento-San Joaquin Delta during the 2015 drought. Based on forecasted flow and salinity boundary conditions, DSM2 (1-D model) was used to analyze potential salinity effects by comparing the with- and without-barrier scenarios. DSM2 was further run as part of an iterative water cost analysis that estimated the potential amount of water saved in upstream reservoirs if the drought barrier were installed. SCHISM (3-D Bay-Delta model) was used to investigate more detailed aspects of the effect and efficacy of the emergency drought barrier at the False River, such as the effect on flow patterns and salinity transport in the central Delta. The effort helped us to better answer questions concerning the barrier and also about the Delta under drought conditions.

4. Lessons from Recent California Droughts 2.2 MB
Presenter(s): Jay R. Lund (UC Davis Center for Watershed Sciences)
Presenter(s) Email Address(es): jmedellin@ucdavis.edu
Collaborators: Josué Medellín-Azuara (UC Davis Center for Watershed Sciences)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Crises like droughts bring great learning opportunities to better understand and improve water systems. California's economic powerhouse relies on highly engineered water systems to fulfill large and growing urban and agricultural water demands. Current and past droughts show these systems are highly robust and resilient to droughts, as they recover promptly. However, environmental systems remain highly vulnerable and have shown less resilience to drought, with each drought bringing additional native species closer to extinction, often with little recovery following the drought. This presentation provides an overview of the economic and ecosystem impacts of the recent multi-year drought in California in the context of a global economy. We explore the potential of water markets, groundwater management and use of remote sensing technology to improve understanding of adaptation to drought. Insights for future management of water resources and scientific work are discussed.

5. Drought Management Practices - International Context 3 MB
Presenter(s): Pavithra Prakash
Presenter(s) Email Address(es): pavprakash@ucdavis.edu; pavi.iitm@gmail.com
Collaborators: University of California, Davis
Permission to Post pdf of Presentation on CWEMF Website: YES
Abstract:
Drought is among the most damaging and least understood of all such hazards. Although some droughts last a single season and affect only small areas, many historical record shows that droughts

have sometimes continued for decades and have impacted larger regions of North America, West Africa, and East Asia. Despite the repeated occurrences of droughts throughout human history and the large impacts on different socio-economic sectors, only few/no concerted efforts have been made to initiate a dialogue on the formulation and adoption of national drought policies.

Given the current concerns with climate change, projected increases in the frequency, intensity, and duration of droughts and resulting impacts on many sectors, in particular food, water, and energy, there is cause for concern regarding the lack of drought preparedness and appropriate drought management policies for virtually all nations. Lack of a clear national drought policy implies that governments at the national, state, and community levels will continue with the status quo, i.e., reacting to the impacts of drought with little coordination between national, state, and local agencies.

The time is now mature for nations to move forward with the development of a pro-active, risk-based national drought policy that includes effective monitoring and early warning systems to deliver timely information to decision makers, effective impact assessment procedures, pro-active risk management measures, preparedness plans aimed at increasing the coping capacity, and effective emergency response programs directed at reducing the impacts of drought. This presentation will focus on few of the nations who have initiated effective drought management plans and policies towards achieving the desired goals to lessen the societal vulnerability to drought.

Session 26. Multi-D Modeling

1. **Flow Distribution at Fremont Weir, Sutter Bypass, Sacramento River, and Yolo Bypass by 2-Dimensional Hydraulic Model** **10 MB**

Presenter(s): Sungho Lee / Ph D, PE/ CVFPB (Central Valley Flood Protection Board), DWR
Presenter(s) Email Address(es): Sungho.Lee@water.ca.gov
Collaborators: -
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
The flow distribution at Left and Right Fremont Weir, Sutter Bypass, Sacramento River and Yolo Bypass has been studied using 2-dimensional hydraulic model. Three cases (High Flow Discharge, Medium Flow Discharge and Low Flow Discharge) are simulated to calibrate hydraulic parameters near the Sacramento River including the Sutter Bypass and Fremont Weir.

The findings of the study indicate that there are differences of flow distribution between Left Fremont Weir and Right Fremont Weir. It shows that 12% (Right Fremont Weir) and 88% (Left Fremont Weir) of total discharge for high and medium flood discharge, and 17.5 % (Right Fremont Weir) and 82.5%(Left Fremont Weir) of total discharge for low flood discharge. It means that main stream of Sutter Bypass flows to Left Fremont Weir during high and medium flooding.

This model will be used to support the Basin wide and Regional flood planning study near the Fremont Weir, Sutter Bypass, Sacramento River and Yolo Bypass.

Flood Flow Discharge Animation 1 **(.avi; 147 MB)** Flood Flow Discharge Animation 2 **(.avi; 99 MB)**

2. **Bay-Delta SCHISM** 2.4 MB
Presenter(s): Eli Ateljevich
Presenter(s) Email Address(es): Eli.Ateljevich@water.ca.gov
Collaborators: Department of Water Resources
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
This talk focuses on applications to Emergency Drought Barrier, but incorporates recent aspects of development including a novel locally adaptive, terrain-conforming gridding system and recent temperature calibration. The Bay-Delta SCHISM successfully predicted most aspects of the with-barrier flow field, but uncertainty arises in transport due to consumptive, and vegetation control on lateral mixing in Franks Tract.

3. **Three-dimensional Modeling of Suspended Sediment and Turbidity throughout the Sacramento-San Joaquin Delta**
Presenter(s): Aaron Bever (Anchor QEA)
Presenter(s) Email Address(es): abever@anchorqea.com
Collaborators: Michael MacWilliams
Permission to Post pdf of Presentation on CWEMF Website: No
Abstract:
The 3D UnTRIM Bay-Delta hydrodynamic and sediment transport model was used to predict the suspended sediment concentration throughout the Sacramento-San Joaquin Delta. The 3D suspended sediment concentration was converted to turbidity and the turbidity then underwent data assimilation using data from turbidity monitoring sensors throughout the Delta. This method preserves both the Delta-scale and the small-scale lateral and vertical turbidity gradients predicted by the 3D model while also predicting the magnitude of the turbidity throughout the Delta as a whole.

4. **Subgrid Bathymetry for Seamless 1D, 2D, and 3D Hydrodynamics and Sediment Transport Modeling in SUNTANS**
Presenter(s): Oliver Fringer
Presenter(s) Email Address(es): fringer@stanford.edu
Collaborators: Yun Zhang, Ivy Huang, Derek Fong, Stephen Monismith
Permission to Post pdf of Presentation on CWEMF Website: No
Abstract:
I will present results of three-dimensional modeling of hydrodynamics and sediment transport in a salt marsh in San Francisco Bay using the finite-volume, unstructured-grid SUNTANS model. The model domain is characterized by broad, shallow, and densely vegetated marshes that are incised by narrow channels, some of which are engineered to restrict seaward sediment transport with culverts. Owing to the channelized nature of the system and the desire to study sediment transport patterns over seasonal and decadal time scales, we develop a framework that allows the SUNTANS model to simulate the network of channels using a single along-channel dimension. Implementation of subgrid bathymetry ensures that the one-dimensional model captures the same flow rate and stage as the two- and three-dimensional implementations of SUNTANS. Furthermore, subgrid parameterization of sediment transport processes allows the one-dimensional model to reproduce most of the three-dimensional sediment dynamics at a fraction of the computational cost. I will discuss tradeoffs between accuracy and efficiency of the hierarchy of models, as well as implementation of a culvert and the marsh drag model and their effects on sediment transport.

5. Biogeochemical Modeling to Inform Nutrient Management Decisions in San Francisco Bay
Presenter(s): Rusty Holleman (San Francisco Estuary Institute)
Presenter(s) Email Address(es): rustyh@sfei.org
Collaborators: Phil Bresnahan (SFEI), Lisa Lucas (USGS), Rosanne Martyr (USGS), Emily Novick (SFEI), and David Senn (SFEI)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
San Francisco Bay has long been recognized as a nutrient-enriched estuary, but one that has exhibited resistance to some of the classic symptoms of nutrient overenrichment. However, recent observations suggest that the Bay's resistance to high nutrient loads is weakening.
As part of the San Francisco Bay Nutrient Management Strategy, we are developing a biogeochemical model of the Bay to characterize nutrient cycling and ecosystem response, and explore the effectiveness of nutrient management scenarios. The water quality model is coupled to a three-dimensional hydrodynamic model, using an offline coupling mode. The offline coupling enables flexibility, both in the choice of hydrodynamic model implementation, and in the range of studies that can be executed from a single set of hydrodynamic model data. To date, the nutrient model has been coupled with hydrodynamics from two separate unstructured hydrodynamic models. Early results from the nutrient model show reasonable agreement with observed concentrations in the portions of the Bay for which the hydrodynamics have been calibrated.

Session 27. Development Updates and Application of CalSim 3.0 (Sacramento Valley)

1. CalSimHydro Updates 0.4 MB
Presenter(s): Mei Lui (Idy) (California Department of Water Resources)
Presenter(s) Email Address(es): mei.lui@water.ca.gov
Collaborators: Zhiqiang(Richard) Chen, Liheng Zhong, Hongbing Yin (California Department of Water Resources), and Andy Draper (MWH)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
CalSimHydro is a hydrologic pre-processor for CalSim 3.0. The hydrologic input it generates for CalSim 3.0 include surface runoff, applied water requirement for rice, non-rice corps, and managed refuge, field deep percolation, and return flow of applied water. CalSimHydro consists of four modules: Rainfall-Runoff, Irrigation Demand Calculator (IDC), Rice, and Refuge. For the past few years, continuous effort has been made to improve and update CalSimHydro. Major updates included: 1) Irrigation efficiencies based on irrigation technology; 2) Daily precipitation from PRISM; 3) Addition of a spin-up period for initial soil moisture. These updates will be discussed in this presentation.

2. Reconstruction of Sacramento Valley Hydrology 0.5 MB

Presenter(s): Z.Q. Richard Chen (Department of Water Resources)
Presenter(s) Email Address(es): ZhiQiang.Chen@water.ca.gov
Collaborators: Mei Lui (Idy), Liheng Zhong, Jianzhong (Jay) Wang, Hongbing Yin (Department of Water Resources) and Andy Draper (MWH)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Abstract:
Many historical hydrological datasets were developed by DWR, USGS, USBR, and local water agencies using observations and models. These datasets are not necessarily compatible with each other. Historical hydrological datasets usually suffer from inconsistency when they span any extended period of time or they are originated from different agencies and models. In order to reconstruct a consistent hydrological dataset across Sacramento Valley, the Sacramento Valley Hydrological Data Assimilation Model (SacDAM) has been developed. The model reprocesses observational and model generated datasets spanning an extended historical period using a CalSim 3.0-based analysis system, to produce a dataset that can be used for hydrological and operational studies in Sacramento Valley. SacDAM assimilates hydrological data from various sources using stream network connectivity, mass balance principle, and user defined weights on flow arcs to produce an analysis of hydrological conditions in the Sacramento Valley. SacDAM's analysis dataset is a best fit of the detailed water system schematic of Sacramento Valley to the available observed and model generated data, taking into account the observational errors and the errors in models. Such dataset can be useful in many applications including CalSim 3.0 model calibration. Preliminary runs of SacDAM are being carried out for the period of October 1921 to September 2009. Modeling methodology and results will be discussed in the presentation.

3. CalSim 3.0 (Sacramento Valley) Model Calibration 0.6 MB

Presenter(s): Mei Lui (Idy) (California Department of Water Resources)
Presenter(s) Email Address(es): mei.lui@water.ca.gov
Collaborators: Zhiqiang(Richard) Chen, Liheng Zhong, Jianzhong(Jay) Wang, Hao Xie, Hongbing Yin (California Department of Water Resources) and Andy Draper (MWH)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Abstract:
In the past few years, continuous improvement and updates have been made to CalSim 3.0 and its hydrologic pre-processor - CalSimHydro. Because of the significance of these changes, it becomes necessary to calibrate the CalSim 3.0 model to these new changes accordingly. The calibration of CalSim 3.0 include following steps: 1) Adjust curve number (CN) to have a better agreement between simulated and observed winter streamflow at major stream gages; 2) Calibrate water use efficiency factors using historical diversion data; 3) develop the closure term to correct hydrology components that are exogenous to the model including rim inflows and surface runoff. More calibration details and preliminary results will be discussed in this presentation.

4. Construction of Hydrology at Historical Development Levels in Sacramento Valley 0.7 MB
Presenter(s): Z.Q. Richard Chen (California Department of Water Resources)
Presenter(s) Email Address(es): ZhiQiang.Chen@water.ca.gov
Collaborators: Ruey-wen Wang, Mei Lui (Idy), Liheng Zhong, Jianzhong (Jay) Wang, and Hongbing Yin (Department of Water Resources)
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
In order to understand hydrological and environmental impacts of CVP, SWP, and other non-project water users to the Sacramento River and the Bay-Delta, a CalSim 3.0 model for the construction of hydrology at historical development levels in Sacramento Valley (CalSim3HDL) was developed.

CalSim3HDL uses CalSimHydro to generate Sacramento Valley hydrology dataset at a historical level of development. This hydrology dataset contains rainfall runoff, applied water requirement, return flow, and deep percolation. No instream flow requirement is imposed in CalSim3HDL. Under pre-project level of development conditions, water users are allowed to divert water based on availability in the stream, and groundwater will be pumped to compensate the shortage of surface diversion when surface diversions are not sufficient to support the diversion requirement (applied water requirement). The results of CalSim3HDL are useful to analyze project impacts of CVP and SWP. Preliminary runs of CalSimHDL are being carried out for the period of October 1921 to September 2013. The results of channel flow, diversion, groundwater pumping and other hydrological conditions in Sacramento Valley will be presented. Modeling methodology will be discussed in the presentation.

Session 28. Water Budgets: An Overview for Supporting SGMA Implementation

1. Water Budget – Utility, Reliability, and Uncertainty 2.3 MB
Presenter(s): Abdul Khan (California Department of Water Resources)
Presenter(s) Email Address(es): Abdul.Khan@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
A water budget is key to assessment of sustainable water conditions; because, it (i) allows tracking of all water supplies and water demands in a geographic area to reduce undesirable results, drought vulnerability, and risks to people, economy, and environment, and (ii) gives a complete picture about water inflows and outflows in a watershed and groundwater basin. In the context of integrated water management, achieving sustainability of California's watersheds and groundwater basins will depend upon the development, understanding, and implementation of sustainable total water budgets. Standardized water budget components and methodologies integrated across federal, State, and local agencies can advance that goal. Consistency in data, their associated spatial and temporal scales, and access to the data across federal, State, and other local agencies is essential. Two key considerations in local, regional, and statewide water budget estimates are reliability and uncertainty. The relevant questions that must be answered are:

- How reliable are the water budget estimates?
- What are key elements of uncertainty in data as well as in the tools used for water budget calculations?
- Do established processes/tools/models for developing water budgets exist? If not, then how

do we resolve the inconsistencies among various methods?

- Do adequate data and tools to develop water budgets at multiple spatial and temporal scales exist? If not, then how can we develop water budgets at different spatial and temporal scales depending on the purpose as well as availability of data and tools?
- Do State and local agencies have adequate resources/funding to develop water budgets?

2. Integrated Water Flow Model (IWFM): A Tool for Effective Water Budgeting in Support of SGMA 1.9 MB

Presenter(s): Can Dogrul (California Department of Water Resources)
Presenter(s) Email Address(es): Can.Dogrul@water.ca.gov
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
Integrated Water Flow Model (IWFM) is a generic integrated hydrologic flow model that simulates land surface, root zone and groundwater flows, and the flow interaction between surface and subsurface. IWFM is developed specifically for basins where agricultural and urban activities to meet their corresponding water demands affect the natural flows. IWFM model applications allow users to parameterize the surface and subsurface physical characteristics, and agricultural and urban water management practices within the basin in order to study and understand the historical response of the water resources in the basin to agricultural and urban development. Future water resources management conditions with or without climate change scenarios can also be studied using these applications to develop short, mid and long term water management plans. The ability to understand and study the historical and future conditions of the water resources within basins is made possible by extensive water budget outputs in IWFM. This presentation will detail different water budgets that can be generated by IWFM, how these budgets can be used to understand the historical stresses on the groundwater resources within a basin and how they can be used to develop groundwater management plans to remedy the undesirable effects of these stresses. On-going developments of new IWFM water budget analysis tools that can aid Groundwater Sustainability Agencies (GSAs) in developing their Groundwater Sustainability Plans (GSPs) will also be discussed.

3. MODFLOW-OWHM Hydrologic Budgets and Case Studies 3.2 MB

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Permission to Post pdf of Presentation on CWEMF Website: Yes
Abstract:
MODFLOW One Water Hydrologic Model (MF-OWHM) can be used to generate several hydrologic budgets that can provide information for Sustainable Groundwater Management Act (SGMA) implementation. The budgets provide information to evaluate if the SGMA defined undesirable results are occurring under existing conditions or will occur under future conditions (with or without management alternatives). The groundwater budget (also called the cell-by-cell budget) can be used to recognize if there is currently or will be a significant reduction in groundwater storage. The cell-by-cell output file can be used by the MODPATH post-processor to estimate groundwater flow paths to help analyze water-quality issues, including seawater intrusion. If the Subsidence Package (SUB) is utilized, the groundwater budget will contain the change-in-storage term for the compressible fine-

grained beds within the aquifers, which can be used to determine if and where significant land subsidence is occurring. The streamflow budget is generated when the Streamflow-Routing Package (SFR2) is utilized. It provides the inflows and outflows to the stream network by stream reach, including groundwater and surface-water exchange, which can be used to determine if there is unreasonable depletion of interconnected surface water. Other budgets generated by MF-OHWM-specific packages and processes include the water-use budget (also called the landscape budget, supply and demand budget, or farm budget) (Farm Process); the unsaturated-zone budget (UFZ package); and the multi-node well budget (MNW2 and MNWI packages). Examples of hydrologic budgets from various MF-OWHM applications throughout California will be presented to show how these budgets can be used to address hydrologic questions related to SGMA.

4. Bringing it All Together: Water Budget Framework **2.9 MB**
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Abstract:
Not available.