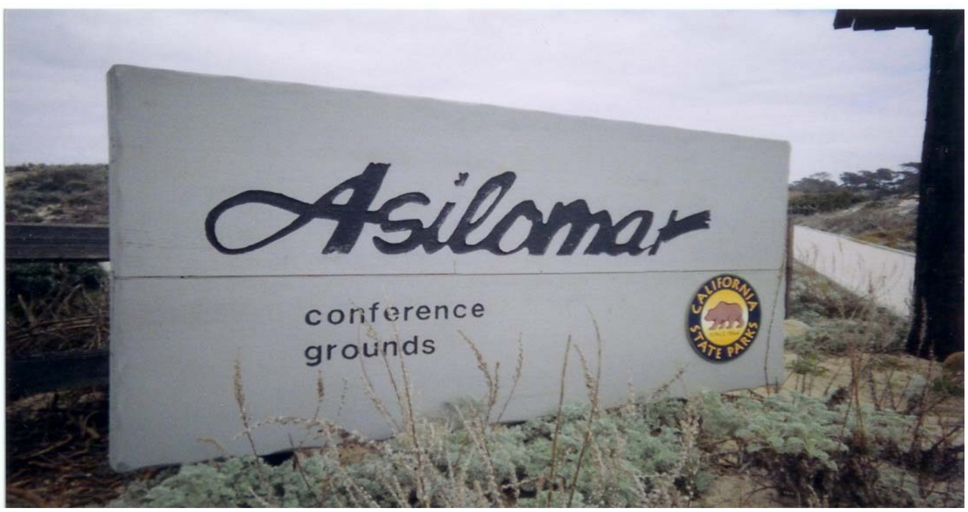
California Water and Environmental Modeling Forum

2011
ANNUAL MEETING
SESSION ABSTRACTS

With Links to Presentations



February 28 to March 2, 2011

Asilomar Conference Grounds
800 Asilomar Boulevard
Pacific Grove, California

P.O. 22529, Sacramento, CA 95822 ◆ 916-833-6557 ◆ cwemf@cwemf.org ◆ www.cwemf.org

SUMMARY OF SESSIONS

Monday,February 28, 2011

Time	Session	Moderator	Location
9:45 -10:15 a.m.	Registration	---	Heather
10:15 a.m.-12:00 noon	1. Flood Modeling	Michael Mierzwa	Acacia
	2. 2010 DSM2 Developments	Tara Smith	Heather
12:00-1:00 p.m.	Lunch	---	Dining Hall
1:15-3:00 p.m.	3. 2010 DSM2 Applications	Nicky Sandhu	Acacia
	4. Evaluating Effects of Climate Uncertainty in Long-Term Planning Studies	Mike Tansey	Heather
3:15-4:00 p.m.	Registration and Asilomar Check-in	---	Social Hall
4:15-6:00 p.m.	5. 2010 Developments and Applications of CalLite	Nazrul Islam	Acacia
	6. Modeling for Creative Delta Water Solutions	Jay Lund	Heather
6:00-7:00 p.m.	Dinner	---	Dining Hall
7:00-10:00 p.m.	7. Evening Program – Reception and Poster Session	---	Toyon
7:30-8:00 p.m.	2010 Distinguished Life Membership Award and Certificates of Appreciation	Tara Smith	Heather
8:00-9:00 p.m.	Keynote Speaker – Art Baggett	Mike Deas	

Tuesday, March 1, 2011

Time	Session	Moderator	Location
7:30-8:15 a.m.	Breakfast	---	Dining Hall
8:15-9:15 a.m.	8. CWEMF Activities / Annual Business Meeting	Paul Hutton	Heather
9:15-10:00 a.m.	9. Pop-Up Talks I: 5-Minute Overviews of Modeling Work	Nigel Quinn	Heather
9:15-10:00 am	Registration		Social Hall
10:15 a.m.-12:00 noon	10. Advances in Climate Change Assessment	Jamie Anderson	Heather
	11. Modeling and Forecasting Drinking Water Quality	Ted Swift	Acacia
12:00-1:00 p.m.	Lunch	---	Dining Hall
1:15-3:00 p.m.	12. Technical Analysis in Support of California Water Plan Update 2013	Rich Juricich	Acacia
	13. Bay-Delta Conservation Plan Modeling Activities	Parviz Nader	Heather
3:15-4:00 p.m.	14. Pop-Up Talks II: 5-Minute Overviews of Modeling Work	Stacy Tanaka	Heather
4:15-6:00 p.m.	15. 2010 HydroGeoSphere Enhancements and Applications	George Matanga	Acacia
	16. Development and Application of Sediment Transport Models in California	Jamie Anderson	Heather
6:00-7:00 p.m.	Dinner	---	Dining Hall
7:00-10:00 p.m.	17. Evening Program: Reception	Tara Smith	Heather
7:30 - 7:45 p.m.	2011 Distinguished Life Membership Award		
7:45 - 8:45 p.m.	Fischer Award / Presentation by Recipient		
8:45 - 9:45 p.m.	Career Achievement Award / Presentation by Recipient		

Wednesday, March 2, 2011

Time	Session	Moderator	Location
7:30-8:15 a.m.	Breakfast	---	Dining Hall
8:15-10:00 a.m.	18: Multi-Dimensional Delta Modeling	Ben Bray	Heather
	19: IWFM & IDC 2010 Enhancements and Applications	Tariq Kadir	Acacia
10:15 a.m.-12:00 noon	20:Development Progress on the Multi-Dimensional Model REALM	Eli Ateljevich	Heather
	21:Estimating in-Delta ET and Municipal Uses	Nigel Quinn	Acacia
12:00-1:00 p.m.	Lunch / Check-Out	---	Dining Hall
1:15-3:00 p.m.	22: Development Updates of CalSim 3.0	Hongbing Yin	Evergreen
	23: San Joaquin River Restoration Modeling	Peter Vorster	Oak Shelter

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Session 1. Flood Modeling

Hydraulic Modeling to Support Channel Evaluation and Maintenance on the Sacramento River Flood Control Project: A Case Study for the Bear River at the Union Pacific Rail Road Crossing - MD Hague and Joseph Chang (CA DWR)

Flood control facilities along the Bear River is part of the Sacramento River Flood Control Project (authorized under the Flood Control Act of March 1, 1917 and as modified by the Acts of 1928, 1937, and 1941) and was constructed by the US Army Corps of Engineers (Corps) in various phases from the late 40's to the early 50's. Upon completion, operations and maintenance of the flood control facilities was then turn over to the State. Pursuant to Section 8361, Section 12648.1, and Section 12656.5 of the California Water Code, specifically Section 8361 (f), the Department of Water Resources (DWR) is responsible to maintain and operate "the channels and overflow channels of the Sacramento River and its tributaries and the major and minor tributaries' flood control projects…" The State's obligations for performing channel-specific maintenance activities are also stipulated in the Corps' Operations and Maintenance manual and in the Memorandum of Understanding Respecting the Sacramento River Flood Control Project dated November 30, 1953.

DWR has historically performed routine maintenance of the channel as prescribed by the requirements listed above. These activities were recently reorganized and incorporated into the California FloodSAFE Initiative under the Channel Maintenance Program to systematically evaluate and correct potential channel conveyance deficiencies in the State-federal flood control system. This project was initiated to determine if there was a potential deficiency in the channel capacity at the vicinity of the Union Pacific Rail Road Crossing as a result of routine maintenance observation that one of the two low flow channels in the Bear River have degraded due to accumulation of sediment. A hydraulic model was developed to analyze and evaluate the channel's conveyance capacity along lower Bear River and to support the design of a possible maintenance alternatives. This contribution discusses about the development, calibration and application of a one dimensional HEC-RAS steady state hydraulic model to support the channel maintenance along lower Bear River.

Community Hydrologic Prediction System: A Framework for Expanding Flood Forecast and Water Resources Support Services - Alan Haynes (NOAA-NWS)

The California Nevada River Forecast Center (CNRFC) recently replaced its hydrologic forecasting system, known as the National Weather Service River Forecast System (NWSRFS), with a new framework called the Community Hydrologic Prediction System (CHPS). CHPS is based on Delft FEWS from Deltares, Inc. in the Netherlands. CHPS is extremely flexible and will allow the CNRFC to build on its past investments in watershed calibrations while opening the door for new modeling and forecasting techniques. Over the next couple of years, CHPS will permit the CNRFC to implement the Hydrologic Ensemble Forecasting System (HEFS). HEFS facilitates the execution of hydrologic models in an ensemble mode, capturing the uncertainty in the forecast. Beyond HEFS, CHPS will make possible the infusion of hydraulic and hydrodynamic models for various forecast segments within the CNRFC domain, potentially expanding the ability to better forecast stages in areas like the Sacramento –San Joaquin Delta and to consider simulating other parameters related to water resource management.

2012: A Hydrology Odyssey – Brad Moore and John High (USACE)

The Sacramento-San Joaquin River Basins Comprehensive Study (Comp Study) was undertaken by the US Army Corps of Engineers and the California Department of Water Resources (DWR) in 1997-2002. To meet the study's goals of characterizing flood risk in the basins and identifying risk management strategies, the Corps and DWR analyzed flood hazard throughout the basins. Procedures used for that system-wide analysis were innovative and produced meaningful results that have enjoyed a long life. Flood flow frequency relationships, hydraulic models, levee fragility curves, and potential damage relationships developed for the Comp Study have served as the foundation for numerous planning, designing, operating, and permitting studies by the Corps, DWR, and local agencies.

DWR initiated its FloodSAFE effort in 2007, aiming to develop the Central Valley Flood Protection Plan (CVFPP)--a new plan for managing better flood risk in the Central Valley. To support development of the CVFPP, DWR and Corps experts agreed that the Comp Study results and models should be reviewed, then updated and enhanced if feasible. The resulting effort by the Corps and DWR includes refining flood frequency relationships with recent observations of flood flows, developing hydraulic models that incorporated better resolution terrain data, and incorporating recent advances in hydrologic and hydraulic modeling.

This presentation provides an overview of the procedures and products of the Comp Study and the corresponding procedures and products of the on-going Central Valley hydrology study (CVHS). In the presentation, procedures and products are compared and contrasted, with emphasis on the enhancements due to the CVHS. The conclusions are (1) the Comp Study models and results are the best available tools in the interim for characterizing flood hazard in the Central Valley for current planning designing, operating, and permitting projects; (2) although the methods used in the Comp Study and CVHS are different, the format of the results is consistent; and (3) the models and procedures provided by the CVHS will better support future planning, designing, operating, and permitting studies by DWR, the Corps, and local agencies.

Forecast Coordinated Operations in the San Joaquin Valley: Dealing with Limited Channel Capacity and High Outflows in 2011 **- MD Hague (CA DWR)**
Abstract not available.

Session 2. 2010 DSM2 Developments

Improvements to the Qual Computational Scheme in DSM2 (Version 8.1) **2.1 MB**
Lianwu Liu (CA DWR)

An important property of numerical models is that the simulation gets better as time and spatial steps are refined, with the model eventually "converging" to a solution determined by the underlying physics and equations. In qualitative testing, QUAL was found to converge slowly and to exhibit erratic behavior with very small (one minute) steps. The poor qualitative convergence results from two ad hoc features of the code: parcel recombination in the Lagrangian advection scheme, and a spatially dependent mixing scheme for dispersion. Corrections are proposed here to minimize both problems. Tests show that with these changes, the new model shows good convergence with respect to time step and parcel size. Recommended time step is 5 minute, and minimum parcel size 500 ft. The new model needs to be calibrated before we can compare new results with previous model results thoroughly.

DSM2 Comparison Report Tool **0.35 MB**
En Ching Hsu (CA DWR)

DSM2 model input and output changes are usually analyzed with existing tools involving manual steps that are cumbersome and inefficient. This tool automates the comparison process in a systematic and repeatable way thereby reducing duplicate effort and human errors. The tool reads DSM2 input and output and generates a HTML report based on instructions in a configuration file. The report is useful in viewing observed and modeled time series, model output comparison and calibration plots. The interactive time series plot gives users the options to adjust time windows, overlay water year types and view the differences. As for details, a demonstration will be presented in the meeting.

DSM2 Grid Map Tool 3.3 MB
Nicky Sandhu (CA DWR)

DSM2 is a 1-D hydrodynamics model for which the model input is based on geographical features. The information for DSM2 grid elements needs to be derived from GIS (Geographical Information Systems) and retained along with the input to the model.DSM2 Grid Map is an application that attempts to integrate the GIS data with the DSM2 model input resulting in a GIS based visualization and model grid editing tool. Users can see the locations of the model elements overlayed on a Google Map and can place the model grid elements such as nodes, channels, reservoirs and gates using the map as a guide. Furthermore cross sections for a channel and reservoir bottom elevations can be calculated and edited using the digital elevation data based on available bathymetry data. The technical details along with screenshots of this application will be shown in this presentation.

Developing a Testing Framework for a 1-D Transport Model **- Eli Ateljevich (CA DWR)**
Abstract not available.

Session 3. 2010 DSM2 Applications

Water Quality Modeling in the Delta: It's Not Just Salinity Anymore 7 MB
Marianne Guerin (Resource Management Associates)

Developments in the modeling of upstream nutrient boundary conditions on a daily basis by WARMF have led to the need to reconcile WARMF boundary conditions with the sparse monthly measurements used in previous DSM2 nutrient models. The incorporation of Liberty Island allows the opportunity to assess the effect of this large open water area on downstream nutrient dynamics. Consequences in the historical DSM2 nutrient model application are described, and also in the historical DSM2 DOC model.

Simulating Spills in Delta Channels: Advance Planning and Real-Time Response 2.9 MB
Deanna Sereno (Contra Costa Water District)

The objective of this application is to determine the concentration of a contaminant at drinking water intakes resulting from an accidental or deliberate release at a given location in the Delta. The Delta Simulation Model 2 (DSM2) has been used to characterize the mixing conditions within the Delta, using the 82-year planning model to provide a variety of hydrologic conditions. Furthermore, in cooperation with the Department of Water Resources, real-time and forecasted conditions are modeled in DSM2 to determine the transport of specific spills, when they occur.

Using DSM2 to Explore the Feasibility of Using Low Head Pumps to Improve South Delta Water Quality **Jamie Anderson (CA DWR)** 4.2 MB

The Delta Simulation Model 2 (DSM2) has been used to investigate improving South Delta water quality and circulation in response to a State Water Resources Control Board Draft Feasibility Study Plan. The study calls for investigating the use of low head pumps in conjunction with the temporary agricultural barriers to improve circulation and water quality in the South Delta during the summer and fall, times when meeting the D1641 salinity standards can be challenging. Three configurations of low head pumps were examined for a range of pumping rates. Additional alternative scenarios also looked at adding low head pumps and changing the heights of the temporary barriers to enhance circulation. Impacts of the low head pumping scenarios on water quality standard compliance, salinity, flow and water levels will be presented.

Session 4. Evaluating Effects of Climate Uncertainty in Long-Term Planning Studies

Overview of Central Valley Project Integrated Resource Plan (CVP IRP) – Technical Approach Brian Van Lienden (CH2M Hill) and Edward Winkler (CH2M Hill) **2.1 MB**

The Central Valley Project (CVP) is faced with numerous water resources management challenges, including increasing imbalances between its available supply and the demand of its contractors and future uncertainty due to changes in climate and socio-economic conditions. The CVP Integrated Resource Plan (CVP IRP) is being developed to help Reclamation chart a path forward for the CVP to address the management of water resources in the face of this future uncertainty. The CVP IRP employs a scenario-based planning approach that evaluates the effectiveness of potential water management actions to increase supply and reduce demand under a range of potential future climate and socioeconomic conditions. An integrated model package has been developed that estimates climate and socio-economic influenced surface water hydrology and urban and agricultural demand and simulates CVP system operations and regulatory requirements to estimate supplies and demands within each of the CVP's 10 separate divisions. This model package is used to assess the effectiveness of a range of water management actions, including system-wide actions such as new surface storage or conveyance and local actions such as water use efficiency and recycled water, to increase supply and reduce demand for each CVP division. The effectiveness, acceptability, and efficiency of multiple potential water management actions will be evaluated for a broad range of water supply, water quality, temperature, economics and power objectives in order to understand the benefits and costs of potential actions.

Climate Scenarios and Regional Climate Modeling for the Central Valley Project Integrated Resource Plan (CVP IRP) **- Armin Munévar (CH2M Hill) and David Yates (NCAR)**

The Central Valley Project Integrated Resource Plan (CVP IRP) is considering climate change information to better characterize future water supply and demand for the CVP. Future climate projections, derived from General Circulation Models (GCMs), require downscaling to be applicable at local-scales. Statistical downscaled climate projections were used to drive the Variable Infiltration Capacity (VIC) regional hydrologic model to produce fields of meteorological and hydrological variables throughout California. The meteorological fields were compared against station observations from the California Irrigation Management and Information System (CIMIS) at representative locations in the Central Valley. In a parallel effort, higher resolution meteorological fields from the North American Regional Climate Change Assessment Program (NARCCAP) regional climate model (RCM) scenarios were analyzed at the same locations. Information developed from both the statistically downscaled-VIC modeling and NARCCAP RCM information was used to characterize local-scale changes in meteorological variables for analysis of the effects of climate change on crop evapotranspiration and yields in the main agricultural regions of the Central Valley.

Current work under the CVP IRP, is building on the ensemble-based climate scenarios of the Bay Delta Conservation Plan (BDCP). Recognizing that inter-annual and decadal scale variability is not as well simulated under the current GCMs as the annual and monthly climate states, transient climate change distributions are being blended with annual sequences of natural variability to generate more descriptive sequences of future variability. These new approaches are believed to provide more robust scenarios of hydroclimatic variability than current exist for California water planning.

Integration of Water Resources Computer Models under the Central Valley Project Integrated Resource Plan (CVP IRP) 4.9 MB

Marcelo Reginato (CH2MHill), Derya Sumer (CH2M Hill), and Brian Joyce (SEI)

The Central Valley Project Integrated Resource Plan (CVP IRP) is addressing numerous water resources management challenges including water supply reliability, operations and climate change. The three currently available models relevant to the CVPIRP, (WEAP, CalLite, and CALSIM) have their own specific focus and strengths but work independently. A robust plan framework requires consideration of the strengths of these available water resources models in an integrated manner, such that insight to relevant questions about the system can be achieved. The integration of the models will include system operations data implemented in CalLite based on CALSIM, and hydrologic and water demands based on WEAP. The new integrated set of tools will be used in planning studies that require evaluation of future hydrology and demands scenarios, simulation of CVP/SWP operations and allocation processes, estimate of imbalance between supply and demand in each CVP division, and analysis of potential system wide and local water management actions to address supply-demand imbalances. Besides an overview of model integration, a simple model scenario comparison between a WEAP stand-alone run and an integrated model approach run is also presented as an example to evaluate model capabilities and model limitations.

Modeling the Effects of Climate on Agricultural Water Demands and Crop Yields 0.6 MB

**Francisco Flores-Lopez (SEI), Chuck Young (SEI), Michael Tansey (USBR),
Armin Munévar (CH2M Hill), and David Yates (NCAR)**

Potential effects on the Central Valley Project (CVP)'s agriculture due to climate change are of growing interest inside Reclamation. Long term planning for the management of water resources requires assessment of the effects of future climate changes on both water supply and demand. Considerable progress has been made on the evaluation of the effects of future climate changes on water supplies, but less information is available with regard to crop water demands and crop yields. Thus, the objective of this project is to produce a data set on crop water use and yield under a range of potential future climate conditions that can be used in the CVP Integrated Resource Plan for planning water resources management and economic assessments integration. In this study we analyze the potential response of crop evapotranspiration to altered weather variables (temperature, precipitation, solar radiation, relative humidity, and wind speed) and increased atmospheric CO_2 concentration. Changes in growing season length, production of biomass and crop yields are also estimated through the use of downscaled climate futures selected to cover a wide range of the existing GCM results. An existing USBR model, the Land, Air, and Water Simulator (LAWS), has been modified to include algorithms that account for the effects of altered weather variables for early, mid, and late 21st century time slices, and the modeling of 24 representative agricultural crops (annuals, deciduous, and non-deciduous perennials) growing in the CVP is described. Results show that atmospheric conditions can have complex and opposing influences on important evaluation metrics such as plant transpiration rates and cumulative water use, duration of the growing season, and crop yields. The magnitude of changes relative to historic conditions could be significant and results will be directly relevant to the development of climate adaptation strategies effecting future water management in California's CVP.

Economic and Hydrological Models Integration: Evaluating Future Climate Change Scenarios Using WEAP and SWAP 1.9 MB

Laura Forni (SEI), David Purkey (SEI), JosuéMedellín-Azuara (U.C. Davis), and Richard Howitt (U.C. Davis)

The integration of economic and hydrological models is essential for future water analysis in California as this will allow for analysis of the effects of agricultural production decisions on water supply and demand at the regional and the basin level. Integrated economic and hydrological modeling for agricultural production regions of the Central Valley is being pursued using the SWAP (State Wide Agricultural

Production) economics model and a hydrological/water management model developed on the Water Evaluation and Planning (WEAP) platform. Harmonization between model domains and disaggregation patterns from SWAP and WEAP is undertaken by employing a maximum entropy filter at a regional level. The linkage between WEAP and SWAP consists on assigning the demand priorities used in the WEAP allocation regime based a step function approximation of regional agricultural water demand functions derived from SWAP.

The integrated ECONOWEAP model will be used to simulate the 18 socio-economic-climate scenarios developed for the CVP IRP. Because the ECONWEAP will be using crop water use and yield data informed by these same scenarios, the analysis of climate effects will be fully consistent for both supply and demands. ECONOWEAP will be able to simulate agricultural management decisions affecting crop selection and acreages planted dynamically in response to climate driven water supplies. This significant advancement in methodology coupled with the scenario based planning approach will provide CVP IRP with greatly improved economic results for planning purposes.

Session 5. 2010 Developments and Applications of CalLite 0.4 MB

CalLite Model Built in WRIMS – Development and Updates 1.4 MB

Nazrul Islam (CA DWR)

The Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR) have developed and maintained a screening-level planning model, CalLite, built using the GoldSim modeling environment. While GoldSim is a powerful platform and the CalLite model has been used successfully, there are some areas in which it cannot provide the level of flexibility and transparency desired by many in the CVP/SWP modeling community. Furthermore, efforts to compare CalLite and CalSim results have been stymied by differences in results caused by the different solution algorithms used by the two models.

Water Resources Integrated Modeling System (WRIMS) developed by DWR and USBR provides an alternative platform to develop CalLite, as it has been used in the CalSim II and CalSim 3.0 developments. WRIMS uses the Water Resources and Environmental Simulation Language (WRESL) code and XA linear programming solver to simulate water resources systems. Potential advantages of using WRIMS and planned enhancements to CalLite are as follows:

- Corroboration studies between CalLite and CalSim will be more directly comparable, as both models will have the same solution algorithm and similar assumptions and data structures.
- Due to lumped hydrology and reduced numbers of solution cycles, CalLite run time can be much shorter compared to that of CalSim.
- Fully functional Forecast Allocation Module will be added in addition to current WSI-DI option.
- Simplified San Joaquin River Module for CalLite will be developed.
- Graphical User Interface to offer flexibility in development and standard functionality.
- Built-in scenario manager without any limit to the number of alternatives.
- Ability to easily track changes and distinguish differences among scenarios.
- Improved results display tools will be developed.
- New features such as daily time step, reservoir routing, Monte Carlo Simulation, groundwater DLL will be added gradually in different phases of this development

CalLite Model Features and Corroboration Study Results 1 MB

Tom FitzHugh (USBR)

The WRIMS version of CalLite includes all the important features of the GoldSim version of CalLite, including the ability to use different historic and future climate scenarios, adjust regulatory standards, add new storage and conveyance facilities, and define different South-of-Delta demands. It also has some additional features that will add to the utility of the software tool. These include: (1) a more detailed representation of the South of Delta area, (2) the ability to model Article 21 and 56 deliveries, (3) addition of Biological Opinion (BO) Reasonable and Prudent Alternatives (RPAs) regulatory standards, and (4) a detailed representation of CalSim project deliveries. In order to replicate CalSim results to a high degree of accuracy, CalLite uses model logic that is almost identical to CalSim, and accretion-depletion terms that adjust for the more aggregated nature of the CalLite schematic. Corroboration studies have been conducted to demonstrate that CalLite replicates CalSim results very accurately under both D-1641 and BO RPA regulatory conditions.

Graphical User Interface for WRIMS CalLite **0.8 MB**
Nancy Parker (USBR) and HaoXie (CA DWR)

The CalLite GUI design has the dual purpose of facilitating both the educational use of CalLite by non-technical stakeholders and multiple study production use of CalLite by model developers and other California water management professionals. The goals established by the WRIMS CalLite development team included the following:

- Maintain and enhance capabilities for scenario creation available in the GoldsimCalLite
- Facilitate developer modification of GUI options through the dynamic use of xml file input to a software framework
- Maintain separation between the GUI and the model - the GUI should be a convenient vehicle by which the model can be run
- Enable scenario management through user-determined directory structures
- Allow easy transfer/sharing of model runs between users
- Avoid the risk of versioning issues with third party software
- Provide robust options for creating output plots, tables, and reports

Pre-Processing and post-processing tools have been developed for the WRIMS CalLite model to assist with model data input preparation and model results analysis.

- The pre-processing tool uses WRIMS in place of other software such as excel or python to prepare CalLite hydrology input data as a function of CalSim input and results.
- The Report Tool post-processes the model output data and generates figures and charts.
- The Web Data Viewer allows the user to view the CalLite results on the Web with schematics displayed on a Google Map.

A Daily Time-step CalLite Model for Sacramento-Delta CVP/SWP Operations **1.8 MB**
Z. Richard Chen (CA DWR)

A California SWP and CVP operation simulation model at daily time-step under the WRIMS platform (CalLiteDOM) is being developed. The objectives of the CalLiteDOM are:

1. to simulate daily reservoir releases (optimized for minimum flow required for fish and water quality, and for flood control at downstream);
2. to simulate weir flows at daily time step;
3. to simulate SWP/CVP delta operations (export and delta cross channel) at daily time-step;

The newly developed CalLite is being imbedded to the CalLiteDOM to obtain the delivery allocations of SWP and CVP at monthly time-step. A linear stream routing method that works with WRESL codes and external functions has been developed and it is being coupled with a multiple-period optimization scheme in order to forecast the reservoir release several days ahead (e.g. 5 days ahead) in order to meet the minimum flow requirements for fish and water quality, and limit the flood flows for flood control at key locations at downstream.

Session 6. Modeling for Creative Delta Water Solutions

Water Management Costs and Adaptations with Delta Restrictions, Climate Change, and Expanded Urban Water Conservation **- Rachel Ragatz (U.C. Davis)**

Changes in climate, population, water conservation, and the Sacramento-San Joaquin Delta will have effects on water management, the economy, and the environment in California. This thesis uses an integrated statewide hydro-economic model to examine the water supply and cost implications of changes in urban water conservation, Delta export capacity, and a dry form of climate warming for water management in California with population and infrastructure conditions projected for 2050. Adaptation options include coordinated use of system re-operation, remaining Delta pumping capacity, urban water conservation, water markets, conjunctive use of ground and surface water, seawater desalination, and expanded water recycling. Results indicate that, depending on the climate and Delta export conditions, 30% urban water conservation could save California from $400 million to $2.3 billion annually (neglecting conservation implementation costs) implying an annual cost for implementing urban conservation of $622 – $1,162/ acre foot. Existing surface water storage capacity becomes less useful with a warmer, drier climate. Recycled water and desalination are expanded primarily when no Delta exports are available and become much less economical with high levels of urban water conservation.

Use of Remote Sensing in Economic Analysis of Agricultural Production South of the Delta **Josué Medellín-Azuara (U.C. Davis)** **5 MB**

In this study we explore the potential of using remote sensing data in combination with a self-calibrated model of agricultural production in economic analysis of land fallowing. We use agriculture south of the Delta in the San Joaquin River and Tulare basins as our case study. Remote sensing information on actual evapotranspiration, biomass, and land use for the water year 2009-2010 is employed to estimate potential gains from more disaggregated information on agricultural yields and water use distribution in agricultural production south of the Delta. The self-calibrated agricultural production model is used as a framework to economically evaluate policy alternatives. Results show that better knowledge of the distribution of agricultural yields and water use provides significant insights for policy design and evaluation.

How the Delta Flowed – Retrospective Modeling of Historical Delta Hydrodynamics
William Fleenor (U.C. Davis)

While debates continue on the meaning of 'restoration' for the San Francisco Bay-Delta, we have little knowledge of the historical effects of anthropogenic influences on the system. The presentation will show the results of an examination of historical hydraulic changes made to the system over a period of 150 years (1850-2000) and how that may have affected the ecosystem. The work is based on historical records of physical changes to the system and was assisted by research done by the San Francisco Estuary Institute.

Dual Stressors – Interactions between Delta Exports and Sacramento Wastewater Discharges **- William Fleenor (U.C. Davis)**

With an ever increasing demonstration of need for changes in the San Francisco Bay-Delta today, the most common sport is shifting responsibility for the problems and benefit from any improvements. This, of course, stems from attempting to shed monetary responsibility for solving the problems. One classic example is the finger pointing between the Delta dischargers and the exporters where each wants to highlight the other as the 'silver bullet' that would solve all the problems. Of course, nothing is that simple and this modeling work demonstrates that even these two seemingly separate problems are actually interconnected and can never be considered separately. The Delta must be looked at as a whole and not just piece by piece.

Session 7. Poster Session

Consumptive Use Program + (CUP+) Model - **Morteza N. Orang (CA DWR) and Richard L. Snyder (U.C. Davis)**

A user-friendly Microsoft Excel application program "Consumptive Use Program +" or "CUP+" was developed to help growers and water agencies determine reference evapotranspiration (ET_o), crop coefficient (K_c) values, crop evapotranspiration (ET_c), and evapotranspiration of applied water (ET_{aw}), which provides an estimate of the net irrigation water diversion needed to produce a crop. The application also can be used to study the impact of climate change on evapotranspiration and irrigation water needs.

CUP+ computes reference evapotranspiration (ET_o) from daily solar radiation, maximum and minimum temperature, dew point temperature, and wind speed using the daily Penman-Monteith equation. In addition, the program uses a curve fitting technique to derive one year of daily weather data from the monthly data and to estimate daily ET_o. It also uses daily rainfall data to estimate bare soil evaporation as a function of mean of ET_o and wetting frequency in days. A bare soil K_c value is calculated to estimate the off-season evapotranspiration and as a baseline for in-season K_c calculations. CUP+ accounts for the influence of orchard cover crops on K_c values and it accounts for immaturity effects on K_c values for tree and vine crops. Further, the program computes and applies all ET_o and K_c values on a daily basis to determine crop water requirements by month, by season, by year. The soil water balance model is similar to that used in the Simulation of ET of Applied Water (SIMETAW) application program, which was also developed as a cooperative effort between the University of California (UC) and the Department of Water Resources (DWR). The application outputs a wide range of tables and charts that are useful for irrigation planning.

Effects of Projected Climate Change on the Hydrology in the Mono Lake Basin, California **Darren L. Ficklin (Santa Clara University)**

The Californian Mono Lake Basin (MLB) is a fragile ecosystem, for which a 1983 ruling carefully balanced continued water diversions with ecological needs, albeit without the consideration of global climate change. To date, the hydroclimatologic response to the impact of projected climatic changes in the MLB has not been comprehensively assessed and is the focus of this study. To this end, downscaled temperature and precipitation projections from 16 Global Climate Models (GCMs), using two emission scenarios (B1 and A2), were used to drive a calibrated Soil and Water Assessment Tool (SWAT) hydrologic model to assess the effects on streamflow on the two significant inflows to the Mono Lake Basin, Lee Vining and Rush Creeks. For the MLB the GCM ensemble output suggests significant increases in annual temperature, averaging 4.6 and 7.3 °C for the B1 and A2 emission scenarios, respectively, with concurrent small (1-3%) decreases in average annual precipitation by the end of the century. Average annual total evapotranspiration is projected to increase by 10 mm by the end of the century for both emission scenarios. SWAT modeling results suggest a significant hydrologic response in the MLB by the end of the century that includes a) decreases in annual streamflow by 15% as compared to present-day conditions b) an advance of the peak snowmelt runoff to one month earlier (June to May), c) a decreased (10-15%) occurrence of 'wet' hydrologic years, and d) and more frequent (7-22%) drought conditions. Both ecosystem health and water diversions may be affected by reduced water availability in the Mono Lake Basin by the end of the century.

Using Modeling to Complement Monitoring Data - **George Nichol (SWRCB)**

Four projects are presented where modeling has helped to expand on the monitoring data collected. These projects utilize the modified Streeter-Phelps dissolved oxygen model for maintaining dissolved oxygen criteria at the 7Q20 flows: the HEC-RAS hydrodynamic model for obtaining hydraulic elements needed for establishing environmental flow requirements; the SWAT and FLUX sediment models for obtaining suspended sediment concentrations, durations, and frequency of occurrence for a sediment TMDL, and a partitioning model for an organic contaminant that enters fish tissue in a lake.

Comparing Actual and Unimpaired Flow in the San Joaquin River Basin - **Mark Gowdy and Lucas Sharkey *(SWRCB)***

Dams, diversions, and consumptive use have greatly altered the hydrology of the San Joaquin River (SJR) and its major tributaries. A State Water Resources Control Board staff analysis of SJR Basin flow alteration compares actual observed flow against unimpaired flow. The analysis focuses on flow characteristics of the SJR Basin as measured at the inflow to the Sacramento-San Joaquin River Delta near Vernalis, but also analyzes flows on major SJR tributaries: Stanislaus River, Tuolumne River, Merced River, and the Upper SJR upstream of Friant Dam.

Unimpaired flow is roughly the flow that would occur absent dams, diversion, and consumptive use. Monthly estimates of unimpaired flow for the San Joaquin at Vernalis are from the Department of Water Resources (DWR) 2007 "California Central Valley Unimpaired Flow Data" report for 1923 to 2003. Daily estimates of unimpaired flow for the Stanislaus River, Tuolumne River, Merced River and Upper SJR are from the DWR California Data Exchange Center for roughly the early 1990s to the present. Unimpaired flow as calculated by DWR, or some other similar approximation of natural hydrology, are being considered by the State Water Resources Control Board as a basis upon which to establish flow objectives for the SJR at Vernalis.

The Role of Extreme Weather in Reservoir Temperature Management, A Case Study: Camanche Reservoir October 2009 - **Benjamin Bray (East Bay Municipal Utility District)**

This case study presents the effect of two extreme storm events on Camanche Reservoir's hypolimnion (i.e. cold water pool) in October 2009. The first event – occurring on October 10th to 13th – was a wet and windy storm event with peak rainfall intensity of 0.15in/hr, cumulative total precipitation of 1.42", peak wind speed of 27mi/hr (the highest wind speed recorded for October since the meteorological station was installed at Camp Pardee in 1997), and sustained ESE wind greater than 10 mi/hr for 30 hours. The second event – occurring on October 26th to 28th – was cold, dry, and windy with no measurable precipitation, bi-modal wind distribution with peak wind speeds of 13 and 10 mi/hr, and sustained WNW winds greater than 5 mi/hr for 43 hours. District monitoring equipment recorded the Camanchehypolimnion response to both storm events. During the first event, the epilimnion (i.e. warm surface layer) extended 55 feet in depth from elevation 175' to 120' while cooling from 19.6°C to 19.1°C in a 24 hour period. After the event passed, stratified layers re-established and the hypolimnion volume was reduced from 97TAF before the storm to 67TAF after the storm, a 45% decrease due to turbulent mixing. During the second event, sustained winds combined with cold air temperatures – below the temperature of the entire reservoir water column – over the three-day period resulted in significant heat loss. A 35% decline in hypolimnion volume was observed after several days-long recovery period.

California Water: Cost and Supply Implications Water Conservation and Varying Delta Exports in a Warmer, Drier Climate - **Rachel Ragatz (U.C. Davis), Jay Lund (U.C. Davis), JosuéMedellín-Azuara (U.C. Davis), Eleanor Bartolomeo (U.C. Davis), Will Sicke (U.C. Davis), Matthew Bates (USACE), Sachi De Souza (U.C. Davis)**

See Session 6 Abstract

Subsurface Imaging: Challenges of Interpolation with High Resolution Direct Push Methods - **Jason H. Davison and Peter K. Kitandis (Stanford University)**

Subsurface imaging with large data sets creates unique challenges previously unseen by hydrogeologists. Traditional characterization techniques rely on expensive low-resolution measurements, while modern direct-push tools are capable of measuring nearly continuous records of the subsurface. In order to incorporate large data sets, we propose a new robust method that minimizes the least absolute differences (L1-norm minimization) and we compare it with standard geostatistical methods (kriging and nearest neighbors).

Southern California without the Imports? - Eleanor Bartolomeo (U.C. Davis)

This study uses CALVIN to analyze the effect of future water shortages on Southern California for a 2050 level of development under economically optimal conditions. Southern California draws most of its water from sources north of the Tehachapi Mountains or from the Colorado River. In the long term, damages to infrastructure or prolonged droughts in the basins where water is imported from may compromise future supplies to southern California. We explore in-region response to changes in water supply considering indoor and outdoor residential uses, operating and shortage costs alternative water sources such as water recycling and seawater desalination. Results show that decreased water imports from north of the Tehachapis may have a larger effect on shortage and operating costs than decreased water imports from the Colorado River via the Colorado River Aqueduct. Furthermore, small agricultural regions near major urban centers are the likely first sellers of water for urban uses if the required conveyance and institutional capacity is in place.

Interdependence of Climate and Land Surface Hydrology in the Central Valley: The Use of Modeling and Remote Sensing - Francisco Munoz-Arriola (Scripps Institution of Oceanography, UCSD), Michael Dettinger (Scripps Institution of Oceanography, UCSD and USGS), Randall Hanson (USGS), and Daniel Cayan (Scripps Institution of Oceanography, UCSD and USGS)

Central Valley is one of the most important agricultural areas in the world. Large farmed surfaces and important ecosystems coincide in this region inhabited by nearly 3.8 million people. The present work presents an on-going effort toward understanding the interdependence between climate and surface water-groundwater interactions. On one hand, we want to answer the question: How Evapotranspiration-Soil Moisture association changes in the alluvial plains, subject to and intensive irrigation, and in the mountainous regions, were surface water dominate the dynamics of the hydrological cycle? And how interactions surface water-groundwater vary in a changing climate? To answer the first question, we use the Variable Infiltration Capacity model, which is a land surface model running at 1/8th degree resolution and using MODIS LAI data, representing a variable cycle of vegetation activity from 2001 to 2010. In the second question, we use VIC to provide the boundary conditions to the hydrologic model with the Farm Process (MODFLOW-FMP). In this case we are currently evaluating the variability of water releases and surface water inputs to Central Valley and their interdependence with climate. The experiments above represent important variables that will allow us to identify the irrigation activity and groundwater pumpage as the climate varied in the past and change in the future of Central Valley and the surrounding mountainous watersheds

Application of the Central Valley Hydrologic Model to Simulate Groundwater and Surface-Water Interaction in the Sacramento-San Joaquin Delta. - Lisa Porta (CH2M HILL), Peter Lawson (CH2M HILL), Nathan Brown (CH2M HILL), Claudia Faunt (USGS), and Randall Hanson (USGS)

The Sacramento-San Joaquin Delta includes complex interactions among surface-water and groundwater supplies, diversions and exports, and agricultural irrigation and drainage activities. Several numerical-flow models exist for assessing Delta hydrodynamics, water-quality issues, and crop consumptive use and associated applied-water demand .However, these models do not explicitly represent the hydrogeology or the interaction of groundwater and surface water. Many islands are below sea level; the shallow groundwater, which is generally of poor quality, is drained to maintain groundwater levels below the crop root zone. As a result, infiltration of surface water occurs from the surrounding canals and streams. This infiltrated surface water is an important component of Delta island water budgets.

The U.S. Geological Survey's Central Valley Hydrologic Model (CVHM) incorporates the Farm Process within MODFLOW that permits the computation of crop-water demands within water-budget subareas, and simulates the various sources of water to these farms (e.g., precipitation, groundwater evapotranspiration, routed and non-routed surface water, and groundwater pumpage). The CVHM was applied to the Delta by refining a subarea of the grid and incorporating additional surface-water features. The new model, CVHM-Delta (CVHM-D), incorporates 23 new water-budget subareas, selected streams, and simulated diversion points for crop irrigation. With these updates, CHVM-D is capable of simulating groundwater levels and water budgets in the Delta at a finer resolution than the CVHM.

The CVHM-D can be used to help address Delta-related water-budget questions such as:

- How much water will need to be drained from the islands to keep groundwater levels below the crop root zone?
- How much surface water will need to be diverted for irrigation on the islands?
- How much groundwater will need to be pumped to supplement water delivery needs?

Climate Change Impacts to Local Water Management in the San Francisco Bay Area - William Sicke, JosuéMedellín-Azuara, and Jay Lund (U.C. Davis)

Climate change will affect the temporal and spatial distribution of precipitation and will result in sea level rise. These climate change impacts will change the reliability of water supplies and cause water shortages. To meet future urban water demand in the San Francisco Bay Area local water managers will have to adapt by changing water supply portfolios. An engineering economic model, CALVIN which optimizes water resource allocation for the state of California was used to investigate the effects on water supply of a warm dry climate and sea level rise and promising adaptations for San Francisco Bay Area water managers. The modeling suggests that under climate change scenarios Bay Area urban water demand will be largely met, but at a cost. This cost will be in purchasing water from the agricultural sector (agricultural opportunity cost), and costs of expensive water supply alternatives such as water recycling and desalination. The modeling also demonstrates the importance of water transfer and intertie infrastructure to facilitate flexible water management among the water managers in the San Francisco Bay Area.

Large-Scale Inverse Modeling with an Application in Hydraulic Tomography - Xiaoyi Liu and Peter Kitanidis (Stanford University)

Hydraulic tomography has been suggested as a promising method for estimating subsurface hydraulic conductivity distributions – a key prerequisite for performing accurate and realistic flow and transport simulations. This method tends to produce large data sets and requires to resolve variability on a fine grid, which demands inverse modeling methods that can efficiently handle large scale problems, for instance, with millions of unknowns and perhaps hundreds of thousands of observations. We propose in this presentation a Bayesian inverse modeling methodology that is suitable for large-scale problems. This stochastic approach can take advantage of modern computer architectures and high-performance computational techniques. We have applied this methodology to a laboratory hydraulic tomography problem, where we successfully estimated half a million unknowns that represent the hydraulic conductivity field of the sandbox at a very fine scale. We then compared the results with a few other inverse methods and found that the proposed methodology performed better than the other methods in several aspects, including computation time and memory requirement.

Evaluation of 2-D modeling at the Merced River-San Joaquin River Confluence - Henry Pai (U.C. Merced)

River confluences present a challenging environment for both data collection and hydrodynamics and advection-dispersion modeling. The Merced River-San Joaquin River confluence provides a site with distinct water salinity signatures where hydrodynamic mixing models can be readily tested. This work describes the application of a robotic delivery system for water velocity and specific conductivity measurements whose infrastructure is sufficiently agile to enable analysis of several cross-sections along the confluence within a week-long study. The volumetric water flow estimates from the cross-sectional water velocity field were comparable (within 10%) to those recorded at a nearby gaging station. With the river bed elevation and water surface elevation determined by echo-sounding and surveying, a 2-D, finite element hydrodynamic model, RMA2, is parameterized with additional fitting parameters including bed roughness coefficients and eddy viscosities. Assuming stationary conditions, the best fit model had an absolute percent difference (AAPD) between the modeled and observed lateral velocity profile furthest downstream cross-section of 31.87%, a -2.47% difference between modeled and observed water surface elevation, and the best qualitative shape-fit agreement between the modeled and observed lateral velocity profile. For further validation, the best fit advection-dispersion model in RMA4 resulted in a 7.78% AAPD and best qualitative shape agreement between the modeled and observed lateral salinity concentration profile for the furthest downstream cross-section. This work demonstrates that high-resolution data collection coupled with appropriate model settings can provide reasonable 2-D hydrodynamic and advection-dispersion simulations in for river confluence zones.

Managing California's Water: Insights from Interviews with Water Policy Experts - **Sarah Null (U.C, Davis), Eleanor Bartolomeo (U.C. Davis), Jay Lund (U.C. Davis), and Ellen Hanak (Public Policy Institute of California)**

This study synthesizes the results of interviews with over 100 water policy experts from a range of sectors and regions within California, conducted in the spring and summer of 2010. Respondents were asked to provide open-ended answers to questions regarding California's long-term water policy challenges and potential solutions. Top long-term policy problems cited include management of the Sacramento-San Joaquin Delta, unsustainable water supplies, lack of comprehensive groundwater management, threats to water supply and flood risk from climate change, and problems with the administration of the Endangered Species Act. In addition to a range of specific management solutions, respondents emphasized the importance of public education, strengthened leadership and reduced influence of special interests, development of a sustainable funding system, and more holistic resource management as solutions to California's long-term water challenges.

Resolving Hydrology Budgets for Westside Salinity Management - **Lisa Holm (USBR), Jonathon Goetz (MWH), Jamil Ibrahim (MWH), Nigel Quinn (LBNL/USBR) Heather Shannon (MWH), Josh Yang (MWH), Joel Herr (Systech Water Resources)**

The WESTSIM and WARMF-SJR models are being used in tandem to improve understanding of salinity and nitrate balances in the western San Joaquin Basin. WESTSIM is an application of the IWFM Version 3.02, a surface-groundwater model accounting for agricultural and urban driven hydrology within the entire CVP service area. WARMF-SJR is a comprehensive surface water hydrology and water quality model formulated as a decision tool for TMDL development and water quality impact assessment studies. Major challenges in this study include resolving water budgets for two models with different theoretical constructs for aquifer deep percolation, estimating surface irrigation return flows for water districts with water surpluses and calculating subsurface drainage return flows under deficit irrigation.

Session 10. Advances in Climate Change Assessment

Hydrologic Projections to Support Climate Change Vulnerability Assessments in the Western U.S. **3.4 MB**

Subhrendu Gangopadhyay, Tom Pruitt, Levi Brekke, and David Raff (USBR)

In response to the SECURE Water Act (PL111-11, Section 9503), the U.S. Department of Interior's Bureau of Reclamation (USBR) is assessing climate change risks to water and environmental resources in "major Reclamation river basins" across the Western United States including the Colorado, Columbia, Klamath, Missouri, Rio Grande, Sacramento, San Joaquin, and Truckee basins. The legislation calls for Reclamation to provide periodic reports to Congress that includes, climate change implications for basin hydrology (snowpack, runoff, groundwater) and Reclamation operations related to water deliveries, fish and wildlife, water quality, hydropower generation, flood control, and recreation. The assessment in these eight river basins is being performed under a Reclamation activity called the West-Wide Climate

Risk Assessments (WWCRA). The goal of the WWCRA activity is to report climate change implications for basin hydrology and Reclamation's operations.

An initial focus of WWCRA is to develop an archive of hydrologic projections derived from the bias corrected and spatially disaggregated (BCSD) climate projections. This archive of hydrologic projections will permit consistent water supply risk assessments throughout the Western United States. This resource has been developed and is serving Reclamation's near-term reporting activities under Secure Water. Subsequently, this resource will be made publicly available for general assessment purposes in the Western U.S. This presentation will focus on the development of this hydrologic projection archive and present example results. Documentation is under development and expected to be complete during March 2011. Web-service expected Spring 2011 with intent to serve monthly water balance products and some daily water balance products (tentatively planned to be co-located with an online climate projections resource).

Incorporating Climate Change into the Central Valley Flood Protection Plan **0.6 MB**
Michael Anderson (CA DWR)

Traditional climate change impacts analyses for supply-based water management studies may not be suitable for flood-based water management and planning studies. Flood management is based on an understanding of a given event which has different ties to climate than the seasonal to interannual evolution of the hydrologic cycle used in supply-based water management studies. Recently identified elements of extreme precipitation events for California include processes that are either not represented in Global Climate Models (GCMs) or are yet to be well understood and modeled. Given these factors a group of scientists and engineers have worked together to develop a methodology for incorporating climate change into flood planning activities. This talk will provide background information on the California Department of Water Resources Division of Flood Management's climate change hydrology program and its ties to the methodology for including climate change in the Central Valley Flood Management Plan.

A New Insight towardsEstablishing a Baseline for Uncertainty Analysis in Projected Climate Change **Messele Ejeta (CA DWR)** **0.4 MB**

The assessment of the impact of climate change on California's water projects that started in 2005 and continued analyses of historical and projected hydrological data focus on the idea of stationarity and a shift from it due to elevated greenhouse gas (GHG) concentration in the atmosphere. Stationarity has been qualitatively defined elsewhere as the idea that natural systems fluctuate within an unchanging envelope of variability. The analysis behind this presentation uses long-term precipitation data at various locations and estimated natural streamflow data of various watersheds in California to provide a formulation for hydrological stationarity. Based on this analysis and formulation, a paradoxical problem is observed. This problem, termed hereafter as the paradoxical hydrological stationary problem, shows that the average of the precipitation as well as estimated natural streamflow data for any given climate period on record can be approximated using that of any other climate period with very high level of certainty while it couldn't be for a shorter period, so far. This observation led to further analysis of the data in relation to NASA's records of Saros series and cycles. The results of this further analysis point to the cause of stationarity that is inherently deterministic. This presentation will provide an initial deterministic baseline for hydrological stationarity, which can be used to estimate the marginal change from it due to elevated GHG concentration in the atmosphere. Sample results using precipitation data at Davis, California, for five Saros cycles of a defined series will be used to show how some baseline drought conditions in California could be established. The presentation will also provide recommendations for further analysis of this breakthrough in our understanding of hydrology as well as for addressing uncertainty in the assessment of the impact of climate change on water and other resources.

Impact of Warming on Outflows from Selected Upper Watersheds in California 6 MB
Guobiao Huang, Tariq Kadir, and Francis Chung (CA DWR)

Physically-based, distributed hydrologic models are important tools for evaluating long-term hydrologic changes in California. The Precipitation Runoff Modeling System (PRMS) applied to the Upper Feather River Basin (UFRB) in the California Sierra Nevada (CSV) was used to study the observed changes from historical warming, effect of climate warming with prescribed 1℃ to 4℃ warming, and resulting impacts of 12 GCM projections. The semi-distributed Soil Water Assessment Tool (SWAT) was also applied to the UFRB as emulation for PRMS to allow extension of work to other upper watersheds in the CSV. After model calibration and validation of SWAT using monthly and daily unimpaired stream outflows, comparison of the SWAT and PRMS applications showed similar model performance (e.g. R^2 and Nash-Sutcliffe model efficiency values are both greater than 0.80) and similar hydrologic sensitivity to climate warming. SWAT models of five other watersheds (Shasta Lake, Yuba River, and the American River in the northern Sierras, and the Tuolumne River and Merced River in the southern Sierras) were also developed using the daily climate forcing data of Hamlet and Lettenmaier (2005) 1915-2003 complete 1/8 degree grid dataset. Model calibration and validation are based on observed or reconstructed monthly/daily unimpaired streamflow at the watershed outlets. The parallel PEST optimization package was used in model calibration. The monthly Nash-Sutcliffe model efficiency values for both calibration and validation range from 0.82 to 0.91. The SWAT models will be used to study the effect of imposed warming on the upper watershed hydrology and ultimately as input into reservoir simulation models to determine impacts on downstream water supply of the Central Valley of California.

Recent Developments and Comparisons of Statistical and Dynamical Downscaling Techniques **- Jianzhong (Jay) Wang, Hongbin Yin, and Francis Chung (CA DWR)**

This presentation will report the status of the development of 2km PRISM (Parameter-elevation Regressions on Independent Slopes Model) based Bias Correction and Spatial Disaggregation (BCSD) downscaling scheme at the Bay-Delta Office of California Department of Water Resources. Also provided is the comparison with 1/8th degree (~ 12km) BCSD downscaling scheme by Maurer et al. (2002). Furthermore, Characteristics and deficiencies of BCSD downscaling have been investigated and the comparisons with 12km dynamic downscaling product done by the WRF (Weather Research and Forecasting model) atmospheric model have made in terms of mass conservation and precipitation-temperature interdependency.

Session 11. Modeling and Forecasting Drinking Water Quality

Identification of the Sources of Drinking Water Pollutants Using the WARMF Watershed Model **Joel Herr (Systech Water Resources)** 0.7 MB

The drinking water intakes in the Sacramento-San Joaquin River Delta are subject to pollutant loading from San Francisco Bay, from within the Delta, and from the upstream river watersheds. The watersheds are large contributors of organic carbon and salinity which impact drinking water quality. Suspended sediment from the watersheds is associated with Delta Smelt mobilization within the Delta and can impact the ability to pump from the Delta. To address these multiple concerns, the Watershed Analysis Risk Management Framework (WARMF) was applied to the Sacramento, San Joaquin, and Delta tributary watersheds and linked to a Delta model at the tidal zone interfaces. WARMF uses meteorology, diversion, irrigation, and point source data to dynamically simulate the watersheds downstream of the major reservoirs on a daily time step. The model was calibrated to historical in-stream monitoring data and then applied to run scenarios in a planning mode and in a forecasting mode. In planning mode, WARMF simulated the watersheds over a historical time period under current conditions and under various future scenarios to track pollutants back to their sources including urban, agricultural, and natural land uses, point sources, and upstream inflows. Comparing the model scenarios with each other provided a scientific method of evaluating the potential effect of different watershed management actions on future water quality. In forecasting mode, WARMF processed real-time meteorology data and forecasts of precipitation and reservoir releases to predict flow and turbidity entering the Delta two weeks into the future. Comparison between forecast and hindcast simulations over the same time periods demonstrated the accuracy achievable in forecast mode.

Simulation of Historical Flows and Water Quality in the California Aqueduct Using DSM2 **Siqing Liu and Bob Suits (CA DWR)** **2.8 MB**

DWR Bay Delta Office staff has developed a DSM2 simulation of 1990 through 2010 historical flow, EC, and bromide conditions for the California Aqueduct. This simulation builds upon earlier work by CH2MHill which developed and calibrated the DSM2 extension for the California Aqueduct, South Bay Aqueduct, and Delta-Mendota Canal using data from 2001 through 2004. In this presentation, key modeling assumptions and results from the historical simulation will be presented.

Development of Water Quality Data for DSM2 Modeling of the California Aqueduct and Delta-Mendota Canal **Marcia Scavone-Tansey (CA DWR)** **1.2 MB**

The Municipal Water Quality Investigations Unit (MWQI) was asked by the Department's Bay Delta Office (BDO) to provide updated inflow and validation data for electrical conductivity (EC), bromide, and dissolved organic carbon (DOC) to refine the current dataset used in the Delta Simulation Model Version 2 (DSM2) for the California Aqueduct (CA Aqueduct) and the Delta Mendota Canal (DMC). MWQI used several sources to identify inflow and validation data. Data sources used were the California Data Exchange Center (CDEC), the Water Data Library (WDL), and information provided by the U. S. Bureau of Reclamation (USBR). Data was collected at stations along; a) the CA Aqueduct from the Banks Pumping Plant to Pyramid Lake on the West Branch and Silverwood Lake on the East Branch, b) the South Bay Aqueduct (SBA) from the South Bay Pumping Plant to the Santa Clara Terminal Tank, and c) from the Jones Pumping Plant to the Mendota Pool. The period of record analyzed was from January 1990 to the present.

Analysis of DSM2 Aqueduct Extension Closure Terms and Locating Data Sources for the Delta-Mendota Canal and California Aqueduct **3.1 MB**
Bryant Giorgi and Amardeep Singh (CA DWR)

As part of the Municipal Water Quality Investigation Program (MWQI), an extension to DSM2 was developed in order to extend hydrodynamic and water quality modeling capabilities from the Sacramento-San Joaquin Delta down the California Aqueduct and the Delta-Mendota Canal. To use the extension for historical simulations and to verify the model, a historical record of hydrodynamic conditions within the projects from 1990 to the current month was compiled. Due to meter inaccuracies and unquantifiable flows the inflows to the system do not equal the flows out of the system even when storage changes are considered. This imbalance in the flows has the potential to cause errors within the extension and had to be addressed. This talk is about the sources of the data, the causes and effects of the water imbalance, and ways to compensate for the imbalance.

Session 12. Technical Analysis in Support of California Water Plan Update 2013

Quantifying Regional Portfolios of Water Supplies and Uses 2.1 MB
Todd Hillaire (CA DWR)

During the past decade, the California Water Plan Update has incorporated refinements into the spatial scale and level of analysis for evaluating and reporting annual water conditions. These annual water conditions are reported in the Water Portfolio products. The Water Portfolios are a data framework for describing actual water year conditions that includes both the quantity and quality of water supplies, uses, and their final disposition. The results are typically summarized annually for hydrologic regions even though the input data and analysis may be collected at more discrete spatial and temporal scales. There is a demand for more detailed regional and sub-regional Water Portfolios, including the input data. This presentation will provide an overview of the processes and availability of data for quantifying regional Water Portfolios.

A Preliminary Analysis of Regional Water Management Responses under Uncertainty for the California Water Plan 1.5 MB
David Groves (RAND Corporation)

The California Department of Water Resources (DWR), for the California Water Plan Update 2013, is building new analytic capabilities for developing and evaluating regional and state-wide water management strategies. These strategies are intended to address growing and diverse water needs under uncertain future hydrologic conditions and available supplies. DWR is exploring the use of new robust decision methods to identify robust and adaptive water management strategies. This talk will describe a recently-completed proof-of-concept analysis that demonstrates the use of Robust Decision Making (RDM) for long-term water planning as part of the CWP Update. RDM is an iterative, analytic decision framework that helps develop adaptive strategies by iteratively evaluating the performance of leading options against a wide array of plausible futures. RDM systematically describes the key vulnerabilities of these strategies using statistical “scenario discovery” algorithms operating on databases of simulation model results and proposes hedging actions or adaptation responses to address the vulnerabilities. Through successive iteration, strategies that are increasingly robust are defined. Final decisions among strategies are made by considering a few robust choices and their remaining vulnerabilities. The analysis utilizes a model of the Sacramento River and San Joaquin River hydrologic regions (described by Brian Joyce in another session).

A Framework for Sustainability Indicators for California Water Resources 1.3 MB
Abdul Khan (CA DWR)

During the development of California Water Plan Update 2009, a recurring question from many stakeholders was how we can ascertain that meeting the resource management objectives of the Water Plan would lead to water resources sustainability for the State and its various hydrologic regions. Responding to that need, one key core value set forth for decision making in Water Plan Update 2009 is, “Determine values for economic, environmental, and social benefits, costs, and tradeoffs to base investment decisions on sustainability indicators.” As part of Water Plan Update 2013, the Department of Water Resources (DWR) has initiated the development of an analytical framework to address this issue head on. The developed framework will be used to identify, compute, and evaluate a set of relevant sustainability indicators that would help monitor progress towards water resources sustainability. The goals and objectives for sustainability will be developed on the basis of the objectives of Water Plan Update 2009 and on-going activities of Water Plan Update 2013. These goals and objectives will consider all three components of sustainability: social, environmental, and economics. A collaborative stakeholder driven process will be used to help develop the vision and vision alignment for the proposed sustainability indicator analysis framework.

[Evaluating Agricultural Production in California Water Management with the SWAP Model]
Farhad Farnam (CA DWR) **2.4 MB**

The use of agricultural production models in California Department of Water Resources (DWR) started in the 1970's. Central Valley Agricultural Model (CVAG) and San Joaquin Valley Optimal Control Model were the first agricultural production models developed by the staff of the DWR. Later on, Central Valley Production Model (CVPM) became the primary model used by DWR for modeling agricultural production and water use. Recently, the Statewide Agricultural Production Model (SWAP) developed by the University of California has been chosen by DWR for modeling California's agriculture. The basis for SWAP is Positive Mathematical Programming (PMP). PMP in the SWAP model is a three-step procedure in which a non-linear cost function is calibrated to observed values of input use in agricultural production. An important result of the PMP approach is that SWAP calibrates exactly to a base year of observed data which increases accuracy within the program. This methodology is applied across model regions where each region can be viewed as representing a profit maximizing representative farmer. This level of aggregation allows for specification of disaggregated environmental and other resource constraints, allowing for more accurate policy modeling.

Session 13. Bay Delta Conservation Plan Modeling Activities

[Challenges in Establishing the Existing Condition and No Action Alternatives] **2.4 MB**
Rob Leaf (CH2MHill)

Continuing uncertainty in the California water regulatory environment makes the long-term planning of Central Valley Project (CVP) and State Water Project (SWP) operations a challenge. In 2008, the Bureau of Reclamation (Reclamation) and the Ca. Department of Water Resources (DWR) published the CVP and SWP Long-Term Operational Criteria and Plan (OCAP) and Biological Assessment (BA) of impacts on species listed under the Endangered Species Act (ESA). In response to the BA, the Fish and Wildlife Service (FWS) issued a biological opinion (BiOp) on the OCAP in December 2008, addressing the impacts of the CVP/SWP operations on delta smelt. In June of 2009, the National Marine Fisheries Service (NMFS) issued a BiOp on the OCAP addressing the impacts of the CVP/SWP operations on salmonids. Both the FWS and NMFS BiOps included a Reasonable and Prudent Alternative (RPA) that the agencies believed would enable the CVP/SWP operations to continue in compliance with the ESA. The FWS and NMFS RPAs included non-operational and operational actions whose potential impact on CVP/SWP operations would vary significantly from one year to the next depending on biological, hydrologic and meteorological variables that are difficult to predict. More recently, in response to lawsuits filed against the BiOp RPAs, District Judge Oliver W. Wanger has been hearing testimony and has issued rulings regarding the BiOps.

Our limited science and understanding of the biology of the species of concern and the associated variability and uncertainty of the biology makes the process of arbitrating between fisheries and water supply needs difficult. The determination of reasonable foreseeable regulatory conditions, assessing the uncertainty in biological, hydrologic and meteorological variables, agreeing on an appropriate set of models and baselines for long-term planning use and subsequently determining potential benefits and impacts of a proposed action is challenging in this context. Over the last two years, DWR, in coordination with Reclamation, FWS and NMFS fisheries experts, has taken on the challenge of updating models to support the Bay Delta Conservation Plan (BDCP) ADEIR/EIS and other potential projects. During 2009, DWR coordinated a series of workshops with these experts to work together in describing the RPA actions in the models. Subsequently, the models were reviewed by the agencies and adopted by DWR for use in describing the Existing Condition and No Action Alternative for the BDCP EIR/EIS. This presentation reports on challenges associated with determining the BiOp RPA related assumptions and the implementation of these assumptions in the planning models used for the BDCP EIR/EIS. Included is a discussion of the approach taken, the uncertainties that impacted the process, and what resolution was achieved by the team. The future will bring similar challenges as the balance between the availability of and needs for water supply become more acute. In summary, as the efforts to describe and evaluate the

California water resources system continue into the future, a collaborative and transparent approach is needed to efficiently and effectively meet the planning needs of the stakeholders and agencies involved.

Climate Change Scenarios and Sensitivity **Armin Munévar (CH2MHill)** **4.3 MB**
Abstract not available.

Integration of Hydrodynamics Modeling at Varying Scales **1.1 MB**
Kyle Winslow (CH2MHill)

As part of the numerical modeling effort to support the Bay Delta Conservation Plan, several models with different spatial scales were employed, including the one-dimensional DSM2 model, the two-dimensional RMA model, and the three-dimensional UnTRIM model. Each model has certain strengths and weaknesses, with the higher order models generally providing a better representation of governing physics, but at the expense of reasonable simulation duration. Since the DSM2 Delta model is generally applied for a 16 year period in planning applications and for environmental documents, efforts were made to corroborate the performance of DSM2 against higher order models for applications involving sea level rise and the creation of tens of thousands of acres of habitat throughout the Delta. The UnTRIM model performed sea level rise simulations and quantified the effects of gravitational circulation on the inland transport of ocean salt. The DSM2 model was calibrated against results from the UnTRIM model by varying the dispersion coefficients. The RMA model was used to perform simulations with the addition of restoration areas, and provided detailed onformation of flow exchanges between local channels and the proposed restoration areas. The DSM2 model was corroborated against results from the RMA model by varying coefficients governing tidal exchange with the restoration areas, which were represented by reservoirs or extended channels in DSM2. Results were favorable in terms of DSM2's ability to represent future conditions in the Delta.

Delta Water Rights Impact Analysis Tool **Xiaochun Wang (CA DWR)** **1.3 MB**

A spreadsheet tool was developed to evaluate the impact of the Delta Habitat Conservation and Conveyance Program (DHCCP) on the Delta water rights holders. The Delta water rights are regulated by the California Code of Regulations, the California Water Code pertaining to water rights, D-1641, various settlement agreements and contracts. The tool checks compliance on the water quality requirements and regulations, and provides a quantitative evaluation of the impacts. The methodology of the implementation, functionalities of the tool, and future improvements will be discussed.

Session 15. 2010 HydroGeoSphere Enhancements and Applications

Brief Presentation of Reclamation's On-going Applications of HydroGeoSphere
George Matanga (USBR) **0.3 MB**

HydroGeoSphere has capabilities to simulate water flow and solute/heat transport over 2D land surface and through 3D variably-saturated subsurface. Incorporation of heat transport into HydroGeoSphere provides a valuable tool in investigating the impact of anthropogenic and non-anthropogenic changes to the atmospheric and hydrological thermal energy system. This computational framework can be used to provide quantitative guidance towards establishing the conditions needed to maintain a healthy ecosystem. On-going and proposed applications of HydroGeoSphere by Reclamation's Mid-Pacific Region are briefly described

Application of HydroGeoSphere in Impact Analysis of Land Subsidence due to Increased Groundwater Withdrawal along the Delta-Mendota Canal 1.2 MB

Kirk Nelson, Nigel Quinn, Lisa Rainger, and George Matanga (USBR)

An application of HydroGeoSphere (HGS) is being developed for the evaluation of potential land subsidence impacts due to additional groundwater withdrawal during drought years in the San Joaquin River Basin. This application makes use of a recently incorporated land-subsidence module in HGS that is based on the SUB package of MODFLOW. This module incorporates Terzaghi's 1D instantaneous compaction principle, allowing for subsidence simulation capabilities. The model setup, as well as evaluation of input data and possible hydrological processes will be discussed. In this work, an effort is made to use, as much as possible, the physical and hydrological input data used in the construction of the USGS Central Valley Hydrologic Model (CVHM). The rationale is that use of common datasets will increase model confidence (in the event of consistent results) and/or facilitate understanding of the most important governing processes of a given problem (in the event of significant differences in model results, because these differences can be linked to differences in process representations); this can also help to identify the appropriate range of conditions to which the various modeling tools that are available can be applied. Initial focus is in the vicinity of the Delta-Mendota Canal for the purpose of analyzing additional groundwater pumpage that has been proposed in the case of dry-year conditions.

Parallelization Framework of the Integrated Surface and Subsurface Flow and Transport Simulator: Parallelization of HydroGeoSphere 1.7 MB

Hyoun-Tae Hwang (University of Waterloo), Edward Sudicky (University of Waterloo), Don Demarco (HydroGeoLogic), and George Matanga (USBR)

HydroGeoSphere (HGS) is a 3D subsurface/2D surface control-volume finite-element hydrologic model describing fully-integrated surface and subsurface water flow and solute and thermal energy transport. Because the model solves tightly-coupled highly-nonlinear partial differential equations, often applied at regional and continental scales (for example, to analyze the impact of climate change on water resources), high performance computing (HPC) is essential. HGS is parallelized by applying a coarse-grained parallel scheme for matrix assembly and by modifying preconditioned BiCGSTAB for matrix solver using OpenMP 3.0 library. The target parallelization includes the composition of the Jacobian matrix for the iterative linearization method and the sparse-matrix solver. The matrix assembly is parallelized by using a coarse-grained scheme in that the local matrix compositions can be performed independently. The parallelization of the solver is achieved by partitioning the domain into equal-size subdomains, with an efficient reordering scheme. The computational flow of the Bi-CGSTAB solver is also modified to reduce the parallelization overhead and to be suitable for parallel architectures. The parallelized model is tested on several benchmark simulations which include linear and nonlinear flow problems involving various domain sizes and degrees of hydrologic complexities: variably saturated flow and integrated surface and subsurface flow scenarios. The performance is evaluated in terms of computational robustness and efficiency, using standard scaling performance measures. The results of simulation profiling indicate that the maximum speedups achieved are 6.0 for GPC using eight threads, which is 75 % of parallel efficiency and 10.0 for TCS using 16 threads. These characteristics are promising for the large-scale analysis of water resources problems involved integrated surface/subsurface flow regimes.

Comprehensive Optimal Management Planning of Integrated Aquifer and Surface Water Resource Systems 3.2 MB

Larry Deschaine (HydroGeoLogic), VarutGuvanasen (HydroGeoLogic), Don DeMarco (HydroGeoLogic), Xinyu Wei (HydroGeoLogic), János D. Pintér (Özyeğin University, Turkey), Kirk Nelson (USBR), and George Matanga (USBR)

Optimal management of integrated surface water / groundwater systems has increasingly become an interest of regional water resource managers. Current advancements in computer technologies and hydrological models have provided users the capabilities to simulate the integrated system at finer temporal and spatial resolutions. Optimization has also been a prosperous field due to the advancement in computer science. A conjunction of the two may provide a good decision-making methodology for future water resource managements. In this project, a linkage of HydroGeoSphere (HGS) and an LGO optimizer is used for process simulation and water-allocation optimization in a fully-integrated surface/subsurface water framework. HydroGeosphere is a fully integrated model in that 2D surface and 3D variably-saturated flow equations are solved simultaneously. This approach facilitates accurate evaluation of flow and transport processes within and at interface of surface and subsurface water regimes. In the linkage, HydroGeosphere is linked with both linear and nonlinear optimizers. Specifically, a recently developed Lipchitz Global Optimization (LGO) module is used. LGO is a derivative-free global (as well as local) optimization tool, including the following optional features: Branch-and-bound global search method (BB), Global adaptive random search (GARS), Multi-start based global random search (MS) and Constrained local search (LS) by the reduced gradient method. Supporting modules as well as testing cases are under-development. The linked simulation-optimization process may conduct in the mode of steady-state, transient, linear, nonlinear conditions. A Graphical User Interface (GUI) is also under-development to facilitate the users to create HydroGeosphere model, to visualize the model responses to decision variables, to link the model with an optimizer, as well as to evaluate the uncertainty in the decision-making process.

Session 16. Development and Application of Sediment Transport Models in California

1.2 MB

Numerical Morphological Modeling of the Sacramento River

2.9 MB

Andrey Shvidchenko (Northwest Hydraulic Consultants), Brad Hall (Mobile Boundary Hydraulics), Rene Leclerc (Northwest Hydraulic Consultants), Bruce Cruey (Northwest Hydraulic Consultants), Ron Copeland (Mobile Boundary Hydraulics), and Lea Adams (U.S. Army Corps of Engineers)

This numerical modeling study is concerned with geomorphic trends and sediment transport processes in a 98-mile long reach of the lower Sacramento River between Colusa and Freeport. The study was undertaken to support ongoing bank protection and flood control programs. The channel of the river has a meandering pattern and is closely bordered by flood control levees. Bed material is predominantly composed of sand. Major tributaries include the Feather and American Rivers. The river network includes a system of leveed bypasses designed to convey overbank flows during high water periods.

The Sacramento River system has been significantly affected by historic human activities over the last century and a half. Uncontrolled hydraulic mining for gold in the 1800s caused a massive influx of sediment, which caused rapid aggradation (up to 10-25 ft) of the river channel. In the 1900s, sediment loads started to decline and the river began to incise into the mining debris as hydraulic mining was stopped, upstream dams were built that captured sediment and reduced flood flows, levees were constructed which confined flows to the river channel and overbank bypasses, and water diversion facilities were constructed that reduced flows and affected sediment transport pattern. In-channel sediment dredging for levee construction and navigation purposes contributed to channel degradation of the lower Sacramento River. The transportation of residual mining debris through the Sacramento River probably continued until the mid-1900s. Present sediment loading is generally believed to be approaching its pre-gold rush value.

A one-dimensional HEC-6T sediment transport model of the lower Sacramento River was developed to evaluate future trends in bed profile evolution for existing hydrologic and sediment inflow conditions. The model includes sediment routings through the river channel as well as inflows and diversions to the river from the flood bypass systems. The calibrated model provides good agreement to measured sediment loads, bed material gradations, measured bathymetric changes, and stage-discharge rating shifts. The developed model was used to simulate long-term morphological changes over the next 50 and 100 years. Simulated results show high seasonal variability in bed elevations (up to 3-5 ft), with overall slight degradational trend over the long-term period. Simulated reach-average degradation ranges from 0.02 ft for the 50-year period to 0.1 ft for the 100-year period. The simulated future channel degradation is rather insignificant which indicates that the river channel is generally stable and approaching a state of dynamic equilibrium.

Sediment Transport during Drawdown of the Copco 1 Reservoir on the Klamath River under Dam Removal Scenarios Yong Lai and Blair Greimann (USBR) **3 MB**

Four dams, Iron Gate, Copco 1, Copco 2, and J.C. Boyle on the Klamath River in Oregon and California, are under consideration for possible removal. About 10 million cubic meters of deposits are stored within the four reservoirs. A proposed removal alternative consists of two stages. First, Copco 2 dam is removed as it contains negligible deposits. Second, a concurrent drawdown of the remaining three reservoirs (JC Boyle, Copco 1 and Iron Gate) would commence in late fall or early winter in preparation for the removal of the dams. The deposits have a high water content (~80% by volume) and the majority of the sediment particles are fine-grained (silt and clay). When the deposits are released downstream, high suspended sediment concentrations and their associated biological impacts will be the most likely major concern, while concerns for downstream sediment deposition should be minor. Therefore, a reasonable estimate of the amount of suspended sediment released downstream during drawdown is critical in determining the timing and duration of the drawdown, as well as the drawdown rate selection. There is also interest in determining the best strategies for re-vegetating the reservoir area and recovering a functional riparian corridor in the reservoir area.

In this study, a two-dimensional (2D) flow and sediment transport model is developed to simulate the drawdown process of a reservoir in preparation for dam removal. The model is based on the depth-averaged St. Venant equations with the non-equilibrium and multi-size sediment transport equations. Both cohesive and non-cohesive sediments are modeled. The amount of sediment removed from the reservoir and released downstream during reservoir drawdown, as well as the reservoir erosion characteristics for re-vegetation planning, may be computed using the model. Specifically, the 2D model is applied to the Copco 1 reservoir in an attempt to understand the drawdown process and to determine sediment transport under various hydrologic conditions, ranging from dry to wet years. Copco 1 contains the largest portion of the reservoir deposits and there are a large number of residences surrounding the reservoir. The model determines the amount of sediment released under the proposed drawdown options so that impacts from high suspended sediment concentration may be assessed. The results also provide a basis for the assessment of biological impacts associated with the removal of all four dams.

One-Dimensional Mobile Sediment Bed Modeling for the Klamath River below Iron Gate Dam David Varyu (USBR) **1.6 MB**

The Technical Service Center (TSC), Reclamation, was requested to perform hydrologic, hydraulic, and sediment transport studies to support the Secretarial Determination on Klamath Dam Removal and Basin Restoration. The project reach starts at Upper Klamath Lake in Klamath County, Oregon, with JC Boyle dam in Klamath County, Oregon, and Copco I, Copco II, and Iron Gate dams in Siskiyou County, California. The Klamath River continues flowing through Siskiyou, Humboldt, and Del Norte counties on its way to the Pacific Ocean. In this study, two alternatives were analyzed using the sediment model Sedimentation and River Hydraulics – One-Dimension (SRH-1D) for future conditions. The No Action alternative includes the dams owned by PacifiCorp remaining and continuing to generate hydropower on the Klamath River. The Dam Removal alternative includes the dams being removed by December 31, 2020 with a free flowing river being established by that date. There are two potential causes of sediment deposition downstream of the dams being removed: deposition caused by the release of reservoir sediment, and deposition caused by the natural resupply of gravel to the reach downstream of the dams. The model was run in an unsteady mode for the 2-year reservoir sediment release simulations and in a steady mode for the 50-year gravel resupply simulations.

This study find that the amount of material released from the dams during the first 2 years depends upon hydrology and removal options. A portion of the released material may deposit in the channel, causing a change in average bed elevation. There is no significant change in bed elevation downstream of Willow Creek for the 2-year drawdown simulation. The Iron Gate Dam to Bogus Creek reach is the only reach that displays a significant change in bed composition for the year of – and the year following – dam removal. For this reach, there is little change in the D90, some minor change in D50 depending on hydrology, and a significant change to the D16 during and following drawdown. The wet and median years exhibit a rebound of the D16 to a level close to that which exists before drawdown. The D16 remains low for the 2-year dry hydrology simulation.

The other potential cause of deposition is resupply of approximately 24,000 tons/yr of sediment larger than 0.062 mm (Stillwater, 2010). The significant influence of dam removal for the 50-year simulations extend downstream of Iron Gate Dam to Willow Creek (approximately 5 miles), with minor influence extending downstream to Cottonwood Creek (an additional 3 miles). There is no difference between the alternatives downstream of Cottonwood Creek in terms of bed elevation change, volume of sediment deposition, and median bed material grain size. There is expected to be approximately 2 to 3 feet of aggradation over the next 50 years from Iron Gate dam to Willow Creek for the Dam Removal alternative and no significant bed elevation change for the No Action alternative. There will be less than 1 foot of aggradation from Willow Creek to Cottonwood Creek for the Dam Removal alternative. A decrease in the median grain size of the bed material from Iron Gate to Cottonwood Creek is expected as the result of Dam Removal, whereas the No Action alternative predicts a minimal change. The Dam Removal alternative results in minor differences to the 100-year floodplain compared to the No Action alternative for the Klamath River from Iron Gate Dam to Happy Camp, CA.

***3-D Simulation of Sediment Transport Using the UnTrim San Francisco Bay-Delta Model* - Michael MacWilliams (River Modeling) and Edward Gross (Bay Modeling)**

The UnTRIM San Francisco Bay-Delta model is a three-dimensional hydrodynamic model of San Francisco Bay and the Sacramento-San Joaquin Delta which extends from the Pacific Ocean through the entire Sacramento-San Joaquin Delta. The UnTRIM Bay-Delta model takes advantage of the grid flexibility allowed in an unstructured mesh by gradually varying grid cell sizes, beginning with large grid cells in the Pacific Ocean and gradually transitioning to finer grid resolution in the smaller channels of the Sacramento-San Joaquin Delta. The UnTRIM Bay-Delta model has been used in studies of San Francisco Bay and the Sacramento-San Joaquin Delta for USBR, USGS, the US Army Corps of Engineers, and California DWR.

Sediment transport simulations have been made using the UnTRIM Bay-Delta model with multiple different approaches. As part of the Hamilton Wetlands Restoration Project Aquatic Transfer Facility (ATF) study, predicted shear stress from the UnTRIM model was combined with erosion rates and critical shear stress from Sedflume cores analyzed by Sea Engineering to predict erosion rates at potential project sites. In a subsequent analysis, the UnTRIM model was applied with the FISH-PTM particle tracking model to estimate suspended sediment concentrations and deposition patterns for a range of dredged material placement scenarios. The UnTRIM Bay-Delta model has recently been coupled with the SediMorph morphological and sediment transport model and the SWAN wave model. This coupled 3-D hydrodynamic, wind wave and sediment transport model is being applied to provide insight into several applications in support of the San Francisco Bay Regional Dredged Material Management Plan (RDMMP).

Coupled Wave-Current Modeling of Sediment Dynamics in San Francisco Bay using the SUNTANS Model Yi-Ju Chou and Oliver Fringer (Stanford University) 1.8 MB

We develop a coupled wave-current model to simulate suspension and transport of cohesive sediment in San Francisco Bay. Based on the unstructured hydrodynamics model, SUNTANS, the model integrates a wind-wave model to calculate phase-averaged properties of high-frequency waves induced by winds and a multiclass sediment transport model. Hydrodynamics is calculated by solving the phase-averaged

Navier-Stokes equation that is coupled to the wave field through the radiation stress along with enhanced turbulent mixing in the oscillatory boundary layer. Cohesive suspended sediment transport is modeled with the transport equation with a settling term using results from observations and this suspended sediment interacts with a multilayer bed model that accounts for mud consolidation on the bed. With the thickness of the mud layer obtained from the multilayer bed model, a mud flow model that is based on the theoretical two-layer flow formulation enables calculation of wave attenuation in the presence of the high-viscosity mud-flow layer. We demonstrate the behavior of the combined hydrodynamics-sediment-wave model and focus on comparisons to observations in South Bay. Sensitivity of the results are demonstrated with respect to the relative effects of tides and wind-waves.

Session 18. Multi-Dimensional Modeling from San Francisco Bay through the Sacramento-SanJoaquin Delta

High-Resolution,Three-Dimensional Hydrodynamic Modeling of San Francisco Bay
Oliver Fringer (Stanford University) **1.8 MB**

I will discuss progress in the development of an open-source, three-dimensional hydrodynamics model of San Francisco Bay using the unstructured-grid SUNTANS model. The long-term goal is to have a San Francisco Bay model that is linked to the Pacific Ocean via coupling with the ROMS ocean model. The SUNTANS model incorporates a wind-wave model and a cohesive sediment transport model and is designed to run efficiently on parallel computers using 50 m grid resolution throughout the Bay. The focus of the talk will be on numerical issues related to obtaining correct salinity predictions in North and South Bay and on the physics of low-frequency currents throughout the Bay.

***San Francisco Estuary SaltFlux Analysis for Sea Level Rise Scenarios* - Edward Gross (Bay Modeling)**

The salt flux analysis presented quantitatively estimates the contributions of individual transport processes to predicted increased salt intrusion resulting from sea level rise. The primary transport processes are tidal dispersion and gravitational circulation. Distinguishing the relative contributions of individual processes responsible for salt intrusion has several practical benefits. First, it improves the conceptual model of how salinity is expected to change with different modifications to the Delta, including sea level rise. Second, the analysis provides insight to the effectiveness of potential management actions to address salt intrusion. Third, the salt flux analysis provides guidance to the representation of salt intrusion processes in one-dimensional and two-dimensional models for sea level rise scenarios.

The salt fluxes are analyzed over a spring-neap period with unsteady tributary inflows. In addition to the baseline scenario, the results of 5 different sea level rise scenarios are analyzed as well as an additional scenario with maximum sea level rise and a 5% increase in tidal amplitude. Salinity increases with sea level rise and both tidal dispersion and gravitational circulation contribute to increased salinity at some locations. However, the contributions of individual processes are strongly variable spatially and vary with sea level rise.

***3-D Hydrodynamic and SalinitySimulations Using the UnTRIM Bay Delta Model* - Michael MacWilliams (River Modeling)**

The UnTRIM Bay-Delta model is a three-dimensional hydrodynamic and salinity model of San Francisco Bay and the Sacramento-San Joaquin Delta, which extends from the Pacific Ocean through the entire Sacramento-San Joaquin Delta. The UnTRIM Bay-Delta model has been used in studies of San Francisco Bay and the Sacramento-San Joaquin Delta for California DWR, USBR, USGS, and the US Army Corps of Engineers. The model calibration and validation conducted as part of these studies demonstrate that the UnTRIM Bay-Delta model is accurately predicting flow, stage, and salinity in San Francisco Bay and the Sacramento-San Joaquin Delta under a wide range of hydrologic conditions.

The high resolution UnTRIM Bay-Delta model simulates 3-D hydrodynamics and salinity from the coastal ocean near Point Reyes through all of San Francisco Bay and the Sacramento-San Joaquin Delta at more than 30 times real time on a single desktop workstation computer, allowing for feasible year-long simulations. However, future conditions simulations for the Delta which incorporate sea level rise, flooded islands, and marsh restoration may require even faster 3-D modeling tools.

By specifying high resolution bathymetry on a coarser computational grid using a sub-grid approach developed by Vincenzo Casulli (Casulli, 2009), the tools now exist to develop even more efficient 3-D Delta models using UnTRIM. A sub-grid model of San Francisco Bay and the Sacramento-San Joaquin Delta developed using this approach runs at more than 750 times real time in 3-D and almost 5,000 times real time in 2-D on a single desktop workstation computer, while still providing accurate results. These computational speeds allow for feasible simulation of decadal or longer analysis periods.

This presentation will give an overview of the high resolution and sub-grid resolution UnTRIM Bay-Delta models. In addition, the results of several future conditions simulations that demonstrate the need for better incorporation of three-dimensional modeling into the development of accurate operational response predictions for sea level rise scenarios will be presented.

Analysis of the Distribution of Tidal Prism in the Sacramento-San Joaquin Delta **37 MB**
John DeGeorge (Resource Management Associates)

Over the last several years the RMA Bay Delta Model has been used to simulate a wide variety of potential large scale changes in the Sacramento-San Joaquin Delta related to tidal marsh restoration and levee failure events. One of the interesting observations resulting from these simulations is that, for a given mean sea level elevation, the change in tidal flows at Martinez is much less than might be expected given the large changes in flooded area associated with the restoration and levee breach scenarios. It follows that there will be a limit in the total acreage of active tidal marsh and that planning for large scale restoration should take this into account. This talk will present an analysis of model simulation results examining the distribution of tidal prism in the Delta under the current channel configuration and a variety of restoration and levee breach scenarios. In particular, results are presented on the regional distribution of tidal flows, tidal prism, and tidal range with a discussion of how conveyance in the system affects the distribution.

Session 19. IWFM & IDC 2010 Enhancements and Applications

IWFM v4.0: A New Version with an Improved Root Zone Module **1.9 MB**
Can Dogrul (CA DWR)

Version 4.0 of IWFM is a new numerical engine with new and improved features. One of the most prominent improvements is the inclusion of a root zone module that simulates root zone and land surface flow processes at finite element level. It is also capable of simulating rice and refuge operations. The agricultural water demand calculations are performed using similar methods employed in irrigation-scheduling-type models. IWFM v4.0 also includes a new solver that is shown to speed up the execution times as much as 7 times compared to the previously employed Successive Over Relaxation (SOR) method. This presentation will detail the new and improved features of IWFM v4.0.

[Evaluating the Feasibility of Artificial Recharge in the Walla Walla Basin Using the Hydrological Model IWFM](#) 3.1 MB

Aristides Petrides (Oregon State U.), R. Henry (Walla Walla Basin Watershed Council), R.H. Cuenca (Oregon State U.), and J.S. Selker (Oregon State U.)

The Walla Walla River Basin is a bi-state watershed in northeast Oregon and southeast Washington. Since 2004, the Walla Walla Basin Watershed Council and Oregon State University have developed a regional hydrological simulation model using the Integrated Water Flow Model (IWFM) of the California Department of Water Resources. The Walla Walla River Basin model was structured to evaluate the impacts of surface-water irrigation conservation practices on aquifer and river processes. Model results showed that lining the irrigation canals with the purpose of water conservation significantly reduced groundwater recharge, resulting in sharp declines in aquifer levels. The model predicted that these declines would result in cessation of flow in several springs that provide critical summer habitat for endangered salmonid species. To mitigate these unintended effects, the feasibility of artificial aquifer recharge, which is currently being implemented in the basin on a pilot scale, was evaluated with a more advanced IWFM-based model. The model domain of 231 km^2 was structured with a detailed resolution of the areal water resources utilizing an average node spacing of 100 m. The Walla Walla River Basin model presents the largest scale application yet to be developed for IWFM in terms of the number of nodes and water features definition. The model provides a rational and transparent approach to the selection of the quantity and locations of recharge projects. Model Features: Total number of nodes: 18,520, Number of elements: 36,484, Aquifer layers: 2, Artificial aquifer recharge model as IWFM-lakes: 3, Total length of irrigation canals model as streams: 220 km, Stream nodes: 2,015

[IDC, Uniquely Positioned for Diverse Applications](#) 4.8 MB

Reza Namvar, MesutCayar, Jon Traum, Elias Tijerina, SaquibNajmus, and Ali Taghavi (RMC WRIME)

The Integrated Water Flow Model Demand Calculator (IDC) has been developed by the California DWR, Modeling Support Branch, as a stand-alone module for calculation of monthly agricultural demands, soil moisture accounting, and deep percolation.. The IDC has become a versatile analytical tool that has applications ranging from preparation of monthly recharge rates for most groundwater models to development of agricultural demands for purposes of planning and management of a watershed and/or basin. This presentation provides information on two applications of the IDC (i) recharge calculation for a MODFLOW application; (ii) agricultural demand calculation for basin planning.

The Riverside-Arlington Model is a saturated groundwater flow model that was developed using the U.S. Geological Survey (USGS) groundwater flow code of MODFLOW-2000. The IDC program was used for estimation of deep percolation from rainfall and irrigation. The model area and the surrounding small watersheds are divided into 113 subregions based on land use types and hydrologic soil characteristics. Monthly deep percolation rates were calculated by the IDC program for each subregion. The soil characteristics and acreages of agricultural, urban, native, and park areas of the subregions were determined from the latest soil surveys and several land use coverage sources. Monthly deep percolation rates for the subregions in the model area, as calculated by the IDC program, were processed outside MODFLOW and then mapped onto the applicable model cells. The groundwater flow model was calibrated to the historical groundwater levels, and any changes to the recharge estimates as a result of calibration were looped back through the IDC program to ensure consistency between the IDC parameters and recharge estimates, and those used in the groundwater model. The baseline model data sets were also developed using historical hydrological conditions and baseline level of development. As part of this process, the IDC was used to estimate the baseline level of recharge for each model subregion.

A second application of the IDC was to the water demand study in Treasure Valley, Idaho. The purpose of the water demand study was to evaluate the historical and current land and water use conditions, and to develop appropriate time series data for forecasting future agricultural and urban land use categories and water demand conditions in the Treasure Valley. The water demand study was part of a series of other studies that include evaluation of alternative water supplies, data collection and analysis, groundwater studies in North Ada and Eastern Ada, and update of the Treasure Valley groundwater model. The results of this analysis are used to support the Comprehensive Aquifer Management Plan (CAMP) for the Treasure Valley. The study area, covering 1,685 square miles of Treasure Valley of Idaho, consists of major urban areas including the metropolitan Boise, Meridian, Nampa and Caldwell area and several municipalities and major irrigation districts. Historical land use, historical crop acreage data, irrigation efficiency and agricultural water demand data were collected from local, regional, state, and federal agencies for the 1980–2008 historical conditions, current conditions, and future conditions over a 50 year period. Spatial data was organized and presented using ArcGIS. The IDC model was used estimate the agricultural demand. The results of IDC model were compared to two earlier reports for historical water demand analysis and the results were compatible for the overlapping time periods. Historic and future analyses of water demand in the Treasure Valley region indicate that irrigation efficiency, hydrology, and distribution of crops have significant effects on the water demand estimations, and that the IDC is a suitable tool for estimation of agricultural water demands for historical and/or projected conditions in Idaho.

Current Status of the California Central Valley Groundwater-Surface Water Simulation Model C2VSIM **Charles Brush (CA DWR)** **1.8 MB**

The California Central Valley Groundwater-Surface Water Simulation Model (C2VSim), a groundwater-surface water simulation of the alluvial portion of California's Central Valley, was developed using the Integrated Water Flow Model (IWFM) application (v.3). C2VSim simulates groundwater flow, surface water flow and land surface processes on a monthly time step from October 1921 through September 2003. C2VSim is being calibrated in four phases. In the first phase, tools were developed to link IWFM and the PEST parameter estimation suite. The second phase involved refining the conceptual model and calibrating regional values of horizontal and vertical hydraulic conductivities, specific yield and stream-bed conductances for 1975-1999 using the PEST pilot point framework with 139 regional pilot points. In the third phase, the model framework was improved and the remaining hydrologic parameters were calibrated using 398 local pilot points and an expanded observation data set. In the current phase, input data are being thoroughly reviewed, and parameters are being calibrated for each model node and element. The calibrated C2VSim model will provide robust estimates of ungaged water resources properties such as groundwater pumping rates, changes in groundwater storage, and flows between groundwater and rivers. The groundwater simulation portion of C2VSim has been linked with the CalSim 3.0 reservoir simulation model, and has also been used to study the impacts of groundwater pumping on stream flows, and the impacts of reductions in surface water flows (for example due to climate variability) on the Central Valley's streams and aquifers.

Session 20. Development Progress on the Multi-Dimensional Model REALM

REALM Project Overview and Progress **Eli Ateljevich (CA DWR)** **0.2 MB**

This talk is an overview the REALM model development effort. The River Estuary and Land Model is a 1D-2D model of the Bay-Delta system under development by the Department of Water Resources and Lawrence Berkeley National Laboratory. The model targets a range of Bay-Delta problems, and incorporates high performance, adaptive technologies and accurate solvers. The beta release in 2011 will include hydrodynamics, water quality and a particle solver. This talk describes project progress in the model, our integrated bathymetry and incipient testing and applications.

2D Adaptive Mesh, Embedded Boundary Modeling for Shallow Water 1.3 MB
Phil Colella (Lawrence Berkeley National Laboratory)
Abstract not available.

Embedded 1D Modeling 0.65 MB
Peter Schwartz (Lawrence Berkeley National Laboratory)

We present a Cartesian grid, embedded boundary algorithm for solving the two-dimensional shallow water equations in under-resolved channel geometries. In particular, we describe an explicit algorithm, in which the time step does not depend on the channel width. Coupled with the algorithms in Realm for solving the shallow water equations in resolved geometries, this work facilitates simulations on large, complex domains.

Test Application of REALM Hydrodynamics near Threemile Slough 0.9 MB
QiangShu (CA DWR)

This talk describes a limited application of REALM to describe the flow splits near Threemile Slough. Mixing and velocity patterns are illustrated over a limited portion of the Delta domain.

Particle Tracking Model in REALM, 2D Shallow Water Model with Adaptive Mesh Refinement and Embedded Boundaries **Kijin Nam (CA DWR)** 2.4 MB

This talk describes the particle tracking algorithm and capabilities of REALM. Kinematic particle tracking is often combined with surface water models for flow visualization and for estimation of sediment, chemical and biological transport. In some applications, a stochastic diffusion process is added to advection to simulate sub-grid dispersion. Parallel, adaptive hydrodynamic models promise to enhance the accuracy of simulated flow fields, but also complicate the implementation of particle models. The presentation will discuss the algorithm, verification techniques, and sample application near Threemile Slough.

Session 21. Estimating in-Delta ET and Municipal Uses

Advances in Evapotranspiration Measurement in California 4.3 MB
Tom Shapland (U.C. Davis)
Abstract not available.

Consumptive Water Demands in the Sacramento-San Joaquin Delta for Water Year 2007: Simulated (DETAW) vs. Remote Sensing 1 MB
Tariq Kadir, Lan Liang, and Bob Suits (CA DWR)

Estimating the consumptive water demands is a significant component of the water budget computations in the Sacramento – San Joaquin Delta, and impacts CVP-SWP exports, Delta outflows, and diversions/return flow estimates affecting salinity modeling in the Delta channels. Using the Delta 2007 land use survey conducted by DWR, estimates of consumptive water demands in the Delta using the DETAW planning tool are compared to remote sensed measurements from SEBAL and MODIS. Results from remote sensing are also used to develop "stress coefficients" that allow modification of DETAW "potential" water demands to reflect actual field conditions.

[A Simulation Approach for Capturing and Coping with Demand Uncertainty in South-of-the-Delta Water Management]() 1.5 MB

Michael Tansey (USBR), David Yates (NCAR), and Chuck Young (SEI)

South-of-the-Delta water management must contend with numerous uncertainties arising from both physical conditions and regulatory requirements. Using model based simulation, the goals of this study were to develop an adaptable approach to capture major uncertainties affecting agricultural water management and to provide a basis for making collaborative risk based management decisions. To accomplish these objectives, an agricultural water management model of Central Valley Project (CVP) districts on the Westside of the San Joaquin Valley and Tulare Lake Basin was developed. This model referred to as the Westside Water Management Simulator (WWMS) allows for explicit representation of surface water, groundwater or other sources of supply as well as factors affecting agricultural demands including infrastructure, crop acreages, irrigation practices, soil properties and evapotranspiration. In order to account for other demands affecting the operation of San Luis Reservoir, non-agricultural and State Water Projection (SWP) demands are also represented in the WWMS model. A calibrated version of the model was developed.

To demonstrate how the WWMS model might be used to inform a risk based decision making process, a hypothetical example with two alternative scenarios involving changing only the timing of the use of the surface water and groundwater supplies was developed. The sensitivity of these management alternatives to uncertainties in potential evapotranspiration (PET) was also assessed by incorporating multiple realizations of PET in the WWMS model. These realizations were obtained from an ongoing collaborative research and development effort by the National Center for Atmospheric Research (NCAR) and Reclamation to supplement the retrospective PET data available from the California Irrigation Management Information System (CIMIS) stations with future PET estimates at lead times ranging from 8 to 180 days. The 180 day seasonal outlooks used in the WWMS simulations are based on the K-Nearest Neighbor (K-NN) methodology conditioned by probabilistic seasonal climate forecasts available from Columbia University's IRI. A website that provides this information was developed.

To illustrate how probabilistic outlooks of seasonal ET might be used in a risk based decision framework for managing San Luis Reservoir, multiple realizations of daily ET from April through September were generated for the CIMIS stations used in the WWMS model assuming that the April 1st 180 day seasonal outlook was for a 50% chance that temperatures would be "above normal", a 30% chance of "average" and a 20% chance of "below normal". Precipitation was assumed to have equal chances of being "above normal", "average" or "below normal". Twenty PET ensemble members were generated and used as inputs to the WWMS model. For each management alternative, the model was run repeatedly to simulate the effects of demand uncertainty on storage in San Luis Reservoir. The results were captured in the form of a performance measure that can be used to quantify risk.

[Prospects for Automation of Regional Evapotranspiration Estimation]() 7.5 MB

Nigel Quinn (LBNL/USBR)

Abstract not available.

Session 22. Development Updates of CalSim 3.0

CalSim 3.0 Highlights **- Hongbing Yin (CA DWR) and Jim Cornwell (USBR)**

The CalSim 3.0 Beta release is tentatively scheduled in next couple of months. This presentation summarizes some major highlights of the CalSim 3.0 model. CalSim 3.0 is a new and improved water resource systems model being developed jointly by the California Department of Water Resources (DWR) and the Mid-Pacific Region of the U.S. Bureau of Reclamation (Reclamation) to simulate much of the water resources infrastructure in the Central Valley of California and Sacramento San Joaquin Delta region. Compared to its predecessor, CalSim-II, one of the major advances in CalSim 3.0 is higher spatial resolution for both water supply and water demand. Other advances in CalSim 3.0 include more input from local agencies on hydrology and facilities operations, improved groundwater representation, model validation to recent historical stream gage flows and diversions, automated rainfall-runoff and water demand calculation, enhanced model output presentation and evaluation, and thorough model documentation. Once the final version is released to the public, DWR and USBR plan to replace its predecessor, CalSim-II.

CalSim User Interface and Web User Interface - Dustin Jones and HaoXie (CA DWR)

The CalSim User Interface and the Web User Interface have been developed for the purpose of visualizing model elements and their connectivity within the model code, and to visualize the output results for a single model and comparison between multiple model results.

CalSimHydro – Hydrology Pre-processor - Ines Ferreira (CA DWR)

CalsimHydro, the Calsim 3.0 Hydrology Pre-processor is an application designed to automate the various steps in the computation of hydrologic inputs for Calsim 3.0. CalsimHydro consists of a five-step FORTRAN based program that runs the individual models in succession passing information from one model to the next and aggregating data as required by each model. The final product of CalsimHydro is an updated Calsim 3.0 SV (state variable) DSS input file.

CalSimHydro is composed of five modules: 1) Rainfall-Runoff model, 2) Soil Moisture Demand Calculator; 3) Rice Water Use Model. 4) Refuge Water Use Model, and 5) Data aggregator and transfer module.

CalsimHydro is flexible enough to be used to generate the input data sets not only for the benchmark CalSim 3.0 model but also for various alternative CalSim 3.0 studies by modifying specific hydrology inputs accordingly. For example, ET and precipitation may be modified based on a Global Climate Model (GCM) to reflect distinct climate change scenarios. Existing level population and land uses may be replaced by projected levels to reflect future water uses.

Model Validation Results - Andy Draper (MWH) and Dustin Jones (CA DWR)

The validation process is an essential part of the CalSim 3.0 development program, and results in a better understanding of the model's capabilities and limitations in modeling the CVP and SWP operations and Sacramento-San Joaquin Delta. A historical monthly water balance has been developed for the major streams in the Sacramento Valley for water years 1922 through 2009. The water balance is based on historical stream gage data, simulated rainfall-runoff, simulated groundwater inflow, historical diversion data and estimated irrigation return flows. Closure errors in the water balance are used to correct any systematic bias in the simulated components. A more comprehensive validation of CalSim 3.0 is being carried out for a recent 10-year period (1997-2006). For this period, simulated stream flows, diversions, and return flows are compared to historical data. Water use parameters are adjusted to refine simulated diversions in the model. Both graphical and statistical methods were utilized for the model validation. The validation methods used and results will be discussed in the presentation.

Comparisons of CalSim 3.0's and CalSim II's Water Balances and Performance Metrics - Erik Reyes and MesseleEjeta (CA DWR)

CalSim 3.0 is the next generation of the CalSim model and has increased the resolution of the Calfornia Water system representation. Establishing thorough Water Balance for land and water uses, surface water inflows, groundwater pumping and recharge, stream-aquifer interactions, and estimated losses is important for an effective evaluation of each model and characterization of the changes between the two models. This exercise also provides system performance metrics for evaluating the similarities and changes between the two models and their impact on typical system performance metrics such as storage, Delta outflow, and export. This presentation will attempt to show and compare the two model's

Water Balances and system performance metrics for water supply and demand of the represented system.

Session 23. San Joaquin River Restoration Modeling 0.35 MB

Interim Flows Monitoring and Reporting 0.2 MB

Erin Rice (USBR) and Heather Shannon (MWH)

The San Joaquin River Restoration Program (SJRRP) is a comprehensive long-term effort to restore flows and a self-sustaining Chinook salmon fishery to the San Joaquin River from Friant Dam to the confluence of Merced River, while reducing or avoiding adverse water supply impacts. The Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.* (Settlement) provides for a period of Interim Flows prior to the release of Restoration Flows. SJRRP is completing monitoring and analysis activities to formulate a scientific basis for Friant Dam operations in preparation for Restoration Flows. SJRRP's Annual Technical Report (ATR) updates the public on Interim Flows results from the previous year. The ATR tracks uncertainties and long-term strategies to implement the Settlement, while providing an adaptive management framework to inform decision making. Numerical representations of conceptual models predict conditions to formulate future operations and rely on Interim Flows data for validation and calibration.

Update on Groundwater Modeling Tools and Future Applications for the San Joaquin River Restoration Program (SJRRP) 3.7 MB

Steven P. Phillips and George L. Bennett (USGS)

SJRRP flows in the San Joaquin River are designed to restore fish populations from Friant Dam to the Merced River confluence. However, increased seepage losses may exacerbate existing drainage problems in adjacent agricultural lands. A spatially refined version of the USGS Central Valley Hydrologic Model (CVHM) is being developed by the USGS to help evaluate seepage-related issues. A key component of the refined CVHM is an improved aquifer sediment texture model for the area within five miles of the river. An understanding of thenatural heterogeneity of the shallow aquifer-system materials is critical to the simulation of historic drainage problem areas and the potential effects of increased river flows on those areas. Towards this goal, 402 high-quality borehole logs were added to the 214 used locally in the CVHM; these data were used to generate multiple equally-probable distributions of sediment textures (gravel, sand, muddy sand, clay) between borehole locations using Transition Probability Geostatistical Software (TProGS; Carle and Fogg, 1996). These texture distributions will be evaluated using the refined CVHM; the distribution that provides the best fit to measured groundwater-level and river-flow histories will be used to simulate seepage and agricultural drainage conditions under various SJRRP planned river flows.

Ecosystems Diagnostics and Treatment 1.6 MB

Chip McConnaha (ICFI) and Bill Smith (MWH)

Abstract not available.

Habitat Modeling for Site-Specific Designs 7 MB

Bob Mussetter (TetraTech) and Blair Greimann (USBR)

A team of scientists and engineers are working on behalf of the Implementing Agencies to plan and design the San Joaquin River Restoration Project. A key part of this work involves one- and two-dimensional (1D and 2D) hydraulic and sediment transport modeling to analyze and design the various project components that include instream and riparian habitat, fish passage structures, bypass channels, and flood protection measures. One-dimensional, steady-state HEC-RAS models of the mainstem (~150 miles) and bypasses (~55 miles) have been developed and calibrated to provide both reach-scale and local predictions of water-surface elevations and cross section averaged hydraulic conditions, and these models have been refined to facilitate unsteady-flow routing of Friant Dam releases through the

Restoration Reach. The 1D models have also been converted into SRH-1D and SRH-1DV format to facilitate sediment routing studies and predictions of the future riparian vegetation growth under restoration conditions. More detailed evaluation of instream habitat, including incipient motion and spawning gravel behavior in the reach immediately below Friant Dam and hydraulic conditions in both the main channel and overbanks in the downstream rearing and passage reaches, is being performed using the SRH-2D model. This presentation will provide an overview of the scope and challenges associated with the habitat modeling.