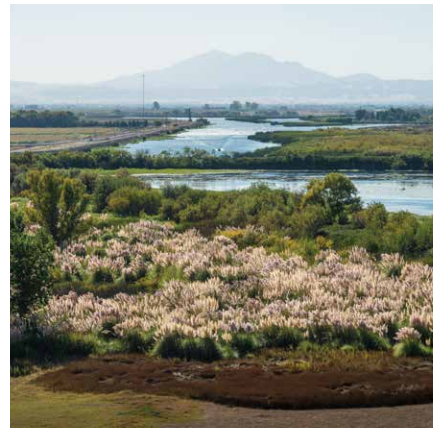
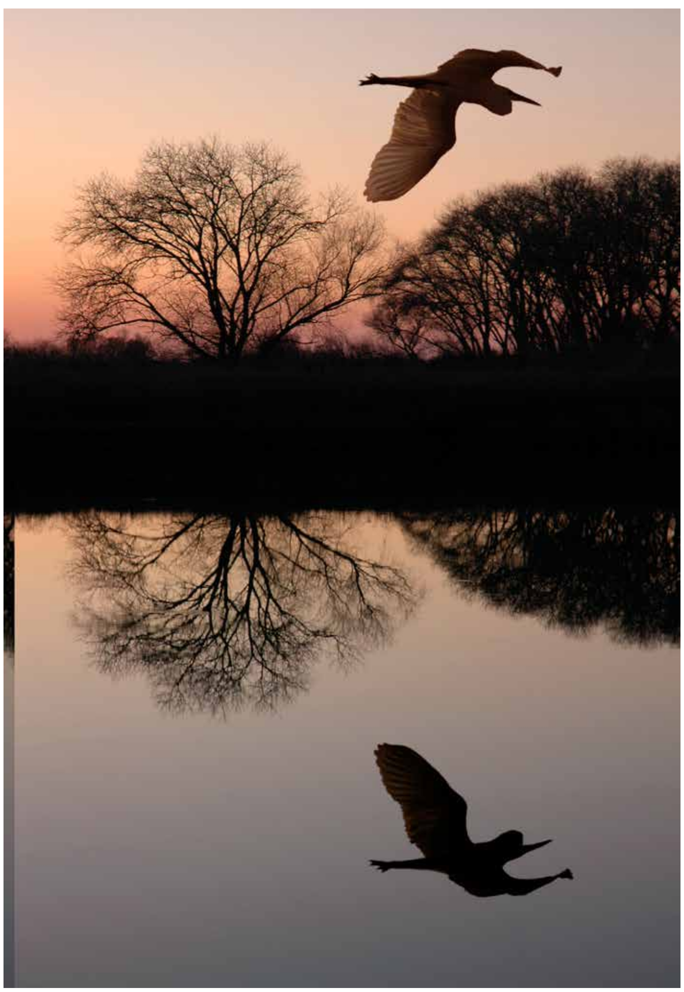
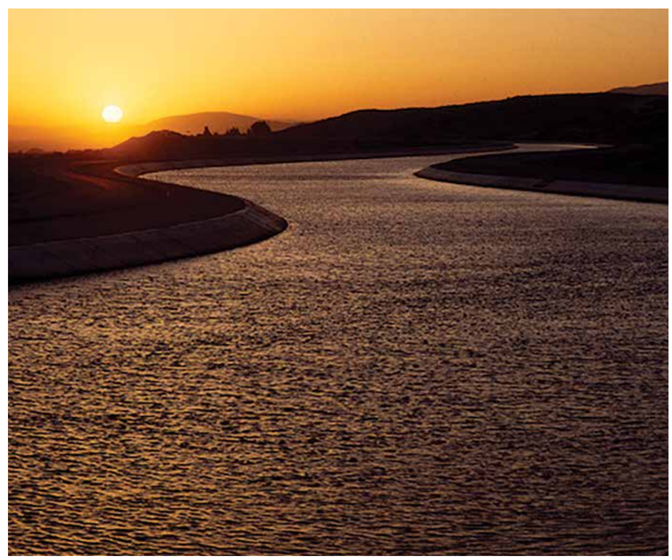
DSM2UG 2014 Summer Newsletter

DELTA SIMULATION MODEL 2 USER GROUP

DSM2

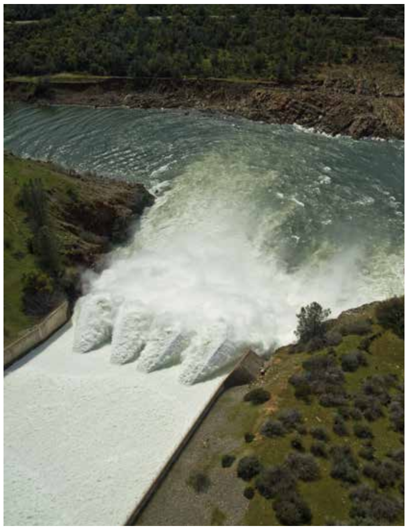






10TH ANNIVERSARY

Special Edition



If you have any questions or comments regarding this issue of the Newsletter, please contact the facilitator of the DSM2 User Group:

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This newsletter can be accessed at the DSM2 User Group website:

http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/dsm2usersgroup.cfm

DSM2 DELTA SIMULATION MODEL 2 USER GROUP

NEWSLETTER SUMMER 2014

California Department of Water Resources | Delta Modeling Section

2014 Annual Report

Min Yu, Senior Engineer WR, DWR and Ralph Finch, Senior Engineer WR, DWR

The following are brief summaries of modeling work conducted during 2013, which will be presented in the 2014 Annual Report to the State Water Resources Control Board.

Chapter 1 - Channel Volume Correction in DSM2-Qual Version 8.1

DSM2-Qual calculates volume of a channel by starting with the initial channel volumes read from the DSM2-Hydro tidefile at the beginning of a run , and then using flows from the Hydro tidefile to calculate the volume into or out of a channel at every time step. This calculation determines the water volume left in the channels (represented by parcels). The channel volumes at other time steps are available in the Hydro tidefile but not used.

This method would be accurate if water mass balances in channels are perfect. However, when there are water mass balance errors in Hydro, the errors will accumulate in Qual. In rare situations, the errors may accumulate significantly and stop Qual from running. This chapter describes a correction procedure that has been added to Qual and tested for accuracy.

Chapter 2 - Quantitative Calibration of DSM2

For the first time in its use, DSM2, the 1D hydrodynamic and water quality simulation model of the Sacramento-San Joaquin Delta, is being calibrated in a quantitative manner with mathematically-based techniques. This chapter describes the background, motivation, goals, and status of the project, as well as preliminary findings.

Projects Update

DSM2UG People

Ask a Modeler

10th Anniverary Special Feature

Chapter 3 - DSM2 Version 8.1 Time Step Sensitivity Test

This chapter gives the update on DSM2 version 8.1.2 time step sensitivity test results. The sensitivity tests are important because relatively small changes in time steps should not result in large changes in water quality results. If there are large differences in results due to differences in time step size, this reflects a problem in the model's ability to converge. Time steps for Hydro (the DSM2 hydrodynamic module), the tidefile (output from Hydro), and Qual (the DSM2 water quality module) have been tested. Sensitivity tests were done to evaluate the effects of different time steps on simulated EC. These results suggest DSM2 converges well. Time steps for the version 8.1 (v8.1) calibration were chosen based on these results.

Chapter 4 - DSM2-GTM

DWR's Delta Modeling Section is developing a new DSM2 transport module, the General Transport Model (GTM). The mesh for GTM is fixed (Eulerian) rather than moving with flow (Lagrangian), and this should make it easier to interact with other models, georeferenced data and visualization as well as to couple to Hydro. It is also based on a more flexible software framework that is easier to adapt to new groupings of constituents -- mercury and sediment are of particular interest. The algorithm is a second order upwind solver developed in a prior collaboration with UC Davis with low numerical diffusion and an elaborate verification framework covering tough problems.

This chapter describes some of the practical issues of embedding such a model in a looped network or in a DSM2 grid with many intermediate junctions (nodes) along a single physical channel reach. We demonstrate the effect the DSM2-Qual schema can have on numerical diffusion, and make some preliminary comparisons with DSM2-Qual on advection problems in which GTM appears to be less diffusive in more complex flow fields or on more intricate grids.

Chapter 5 - Automation of Spatial Map with Temporal Data from DSM2-QUAL Output using ArcGIS

This chapter presents a new post-processing tool for DSM2-QUAL output which enables generation of ArcGIS geo-referenced contour maps and time-varying animations to visualize water quality distributions in the Sacramento-San Joaquin Delta area.

Chapter 6 - Delta Modeling for Emergency Drought Barriers

This chapter is a summary of work and documentation completed by several staff members from the Department of Water Resources' Bay-Delta Office and Operations and Maintenance office. It summarizes the modeling processes used to determine the potential water quality and water supply impacts of Rock Barriers in Sutter Slough, Steamboat Slough, and False River.

Chapter 7 - Bay-Delta SELFE Calibration Overview

The Delta Modeling Section and Virginia Institute of Marine Sciences are completing an initial calibration of the semi-implicit Eulerian-Lagrangian finite element (SELFE) 2-D/3-D model on the Bay-Delta domain. This chapter describes the project scope and the SELFE model and also gives some preliminary results representative of the forthcoming calibration document. SELFE is open source, uses a second-generation semi-implicit algorithm and has been used in a variety of cross-scale contexts on estuary problems around the world. Results for the Bay-Delta suggest the model is able to accurately reproduce the most important transport processes in this domain. Greater emphasis will now be placed on usability and applications, although the chapter also identifies areas of uncertainty or potential improvement.

Quantitative Calibration of DSM2

Ralph Finch, Senior Engineer WR, DWR

For the first time in its use, DSM2 is being calibrated in a quantitative manner with mathematically-based techniques. This describes the background and status of the project.

Background

In the past DSM2 has been calibrated using only channel friction (Manning's "N") values and dispersion coefficients as calibration parameters, e.g. (Liu & Sandhu, 2012). This approach implicitly assumes that other inputs are either perfect (and therefore their values should not change), or to add more parameters would render an already complex process nearly impossible to perform by hand. The comparison-adjustment cycle is done manually, perhaps using automatically prepared graphs of observed and computed values, which is time-consuming and subjective.

Poor data of Delta agricultural diversions and drainage remains as a problem and certainly affects our ability to develop a calibrated model. Until considerably more accurate estimates are available (unlikely in the near future for drainage flows and qualities), they are legitimate candidates for calibration parameters. However to add these to a traditional manual calibration would overburden an already difficult process.

The PEST software package (S.S. Papadopulos & Associates, 2014) was chosen to calibrate DSM2 after a lengthy search through academic literature and the Internet. Coincidently it has already been used in the Modeling Support Branch to calibrate the Integrated Water Flow Model groundwater model.

The best description of PEST comes from its manual (Doherty, 2010):

The purpose of PEST (which is an acronym for Parameter ESTimation) is to assist in data interpretation, model calibration and predictive analysis. Where model parameters and/or excitations need to be adjusted until model-generated numbers fit a set of observations as closely as possible... PEST should be able to do the job. PEST will adjust model parameters and/or excitations until the fit between model outputs and laboratory or field observations is optimized in the weighted least squares sense. Where parameter values inferred through this process are nonunique, PEST will analyze the repercussions of this nonuniqueness on predictions made by the model...a model does not have to be recast as a subroutine and recompiled before it can be used within a parameter estimation process.

Connection to DSM2

PEST must be able to start the forward model in batch (unattended) mode, read all the model output as text files, and adjust parameters and create new text input files for the model. DSM2 is nearly ideal for these broad requirements, with the exception of its output, which is in the form of HEC-DSS files. To deal with the DSS-text file issue, is post-processor is used immediately after every DSM2 run, to convert the necessary DSS model timeseries to text files.

The individual DSM2 (Hydro and Qual) runs are typically one year in length, which takes only a few minutes on a modern desktop computer. However, because thousands of runs are done for a single calibration run, it is necessary to parallelize the runs. We use HTCondor (University of Wisconsin-Madison, 2014) to queue, run, and manage several dozen simultaneous runs on the network of multi-core desktop machines in the Delta Modeling Section. The creation of the several input files and batch files necessary to run DSM2 under HTCondor and PEST was automated with Python, awk, and Windows command scripts.

Status

As of this writing, we have confirmed that DSM2 is a suitable candidate for calibration using PEST. Nearly all of the setup is automated with Python and Windows Batch programs, and some analysis is automated with awk programs to read and reformat PEST output to a style convenient for Excel and ArcMap. Statistical analysis is performed by the contractor using R programs.

We have made the following informal findings:

Manning's N is the dominant parameter. DSM2 output is much more sensitive to Manning's than to dispersion coefficients.

Starting from uniform values for Manning's N and dispersion coefficients, we can reliably obtain validation results as good as or better than the existing manually-calibrated values. It is desirable to highly automate the entire process, as it then becomes almost trivial to try different numerical experiments. Incremental computing power comes at essentially zero cost so a highly automated process reduces elapsed time to only the parallel running time of DSM2.

Future Work

At this time we have used just a few of PEST's many calibration features; we plan on experimenting with several more, including uncertainty analysis.

A separate effort (Wang & Ateljevich, 2012) has developed good quality bathymetric Digital Elevation Maps of the Delta. Concurrent with the calibration project, another project with a GIS contractor is developing a modern, GIS-based cross-section development and editing program for use with DSM2. This project should be finished before the calibration project and will be used with the bathymetry DEMs to develop new cross sections for DSM2.

Much better ET estimates for the Delta have been developed (DiGiorgio, 2009); (Kadir, 2006). They will be incorporated for the final calibration of DSM2.

References

DiGiorgio, C. L. (2009, June). Chapter 2 Data Quality Associated with EC Values in the DICU Model. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh, 30th Annual Progress Report.

Doherty, J. (2010). PEST; Model-Independent Parameter Estimation. 5th.

Kadir, T. (2006, October). Estimates for Consumptive Water Demands in the Delta using DETAW. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh, 27th Annual Progress Report.

Liu, L., & Sandhu, N. (2012). DSM2 Version 8.1 Recalibration. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh, p. Chapter 3.

S.S. Papadopulos & Associates. (2014). PEST. Retrieved April 2014, from S.S. Papadopulos & Associates, Inc.: http://www.sspa.com/software/pest.html

University of Wisconsin-Madison. (2014). HTCondor. Retrieved April 2014, from Department of Computer Sciences, University of Wisconsin-Madison: http://research.cs.wisc.edu/htcondor/

Wang, R.-F., & Ateljevich, E. (2012, June). Chapter 6 A Continuous Surface Elevation Map for Modeling. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta, 33rd Annual Progress Report.

DSM2 Boundary Extension with GIS

Ines C. Ferreira, Engineer WR, DWR

DSM2 is frequently run in planning mode, where the objective is to estimate the impact of proposed facilities or policies on water supply and water quality. While the upstream boundary conditions are obtained from hydrologic planning models such as CALSIM, the downstream boundary conditions at Martinez are not known a priory and must, therefore, be generated before running DSM2. For historical runs, on the other hand, DSM2 benefits from the existence of observed stage and salinity data at Martinez.

Currently, empirical methods are used to generate both tide (stage) and salinity boundary conditions for DSM2 planning simulations. The methodologies used to develop these data are described by Eli Ateljevich in the 2001 DSM2 Annual Progress Report.

There are clear advantages to having the downstream boundary moved to Golden Gate. At Golden Gate there is a reliable, long-term, NOAA water surface elevation gage, EC is relatively constant, it is far enough from potential areas of interest, and it allows for the study of salinity intrusion.

This article describes current efforts in extending the DSM2 western boundary to the Golden Gate using GIS and ArcMap. While an extended grid version of DSM2 exists, the current effort aims at a more refined representation of channel geometry and thus volume. Recently available bathymetry data and improved GIS software tools, make the task of computing cross-sections and volumes considerably easier than in the past. This effort is being undertaken to investigate whether or not a DSM2 grid extension to the Golden Gate would adequately translate the tidal signal and the transport of salt to Martinez. If this effort proves to be successful, empirically derived boundary conditions at Martinez may be abandoned in favor of running DSM2 with a western boundary condition at the Golden Gate.

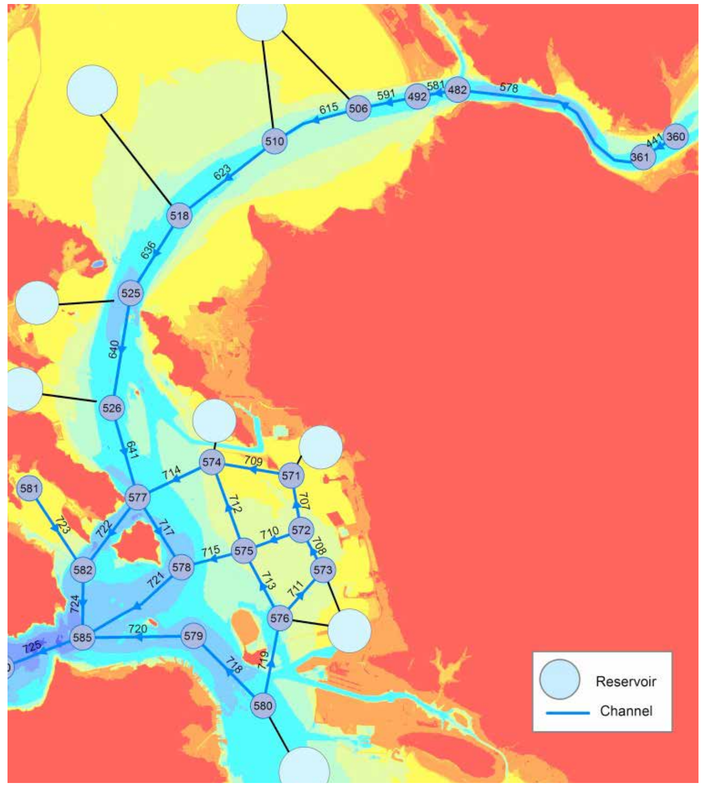


Figure 1 - DSM2 Extended Grid

Initial attempts of extending the boundary from Martinez to the Golden Gate used a combination of a network of arcs and reservoirs for the various embayments with San Francisco Bay.

Comparison of simulated and observed tide values at Richmond Bridge (node 525) show remarkably close results, both in amplitude and phase (Figure 2, blue line=observed, red line=simulated). Comparison of stage at Martinez, on the other hand, displays a distinct phase difference of approximately 45 minutes. Preliminary testing indicates that this is likely to be a result of the use of reservoirs to simulate the embayments, particularly San Pablo Bay.

The next phase of this study is to substitute reservoirs representing San Pablo Bay with a network of arcs allowing multiple paths between Golden Gate and Martinez. Once we have succeeded in reproducing stage at Martinez, we will proceed to the QUAL portion of the model.

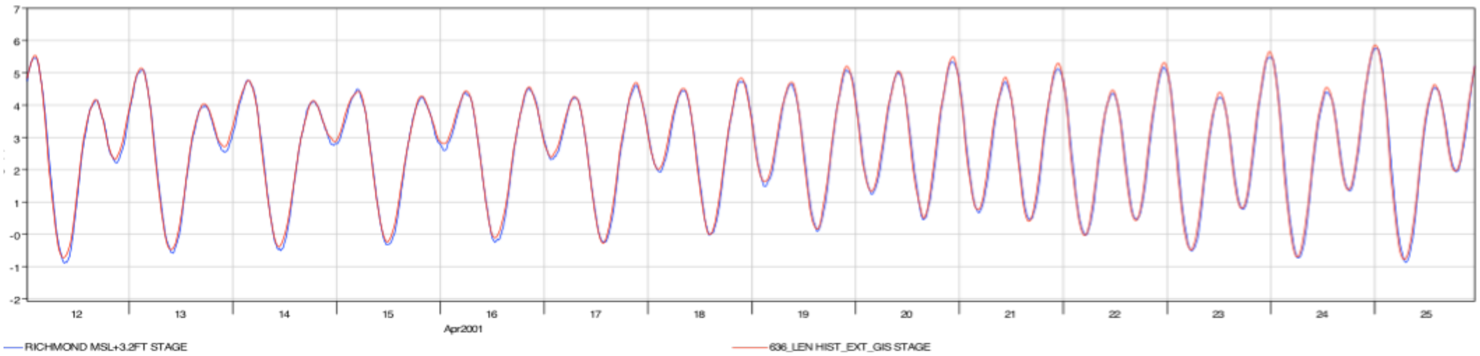


Figure 2 - Stage at Richmond Bridge

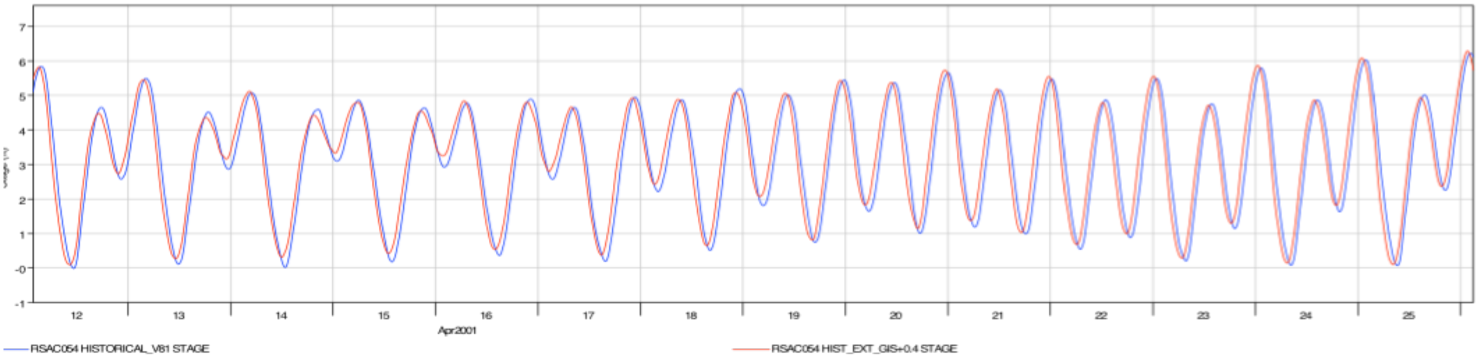


Figure 3 - Stage at Martinez

10 Tidbits about the DSM2 Mercury Modeling Project

Jamie Anderson, Senior Engineer WR, DWR

Why does DWR want to model mercury?

Due to high levels of mercury contamination in Delta fish, in 2010 the Regional Water Quality Control Board adopted amendments to the Sacramento River and San Joaquin River Basin Plan that created the Delta Mercury Control Program and established Total Maximum Daily Loads (TMDL) for methylmercury in the Delta. Developing mercury models is part of the Dept. of Water Resources' response to complying with the TMDL requirements.

What is the mercury modeling project?

This project aims to create mercury cycling models for the Delta and Yolo Bypass. The completed models will be calibrated and validated using field data. The tuned models will then be used to evaluate the potential impacts of management alternatives on the potential for mercury methylation in the Delta and Yolo Bypass. Although mercury accumulation in organisms is the concern for mercury toxicity, this project is focused on the mercury in the water column, and the potential for mercury methylation will be used as a measure of how much mercury is available to organisms.

Who is involved in the mercury modeling project?

This project involves staff from DWR's Division of Environmental Services, DWR's Delta Modeling Section and a consulting firm specializing in mercury cycling, Reed Harris Environmental Ltd. The project is managed by Environmental Services staff. The Delta mercury model work is a collaborative effort with the Delta Modeling Section and Reed Harris. The Yolo Bypass field data collection and model development is being done by Environmental Services and Reed Harris.

Why is mercury a concern in the Delta?

Human exposure to mercury can occur by eating contaminated fish and seafood. A recent study shows that mercury levels in Delta fish are among the highest in the state. Mercury can affect a person's nervous system and harm their brain, heart, kidneys, lungs, and immune system. For unborn and young children, exposure to mercury can lead to developmental and learning problems.

Where does Delta mercury come from?

Most of the mercury in the Delta is from external sources. The major sources of mercury in the Delta are from historic mining activities. In the Sierra watersheds, mercury was used during the hydraulic mining era in the late 1800's to extract gold from the ore. Mercury itself was mined from coastal mountain watersheds to the West of the Delta. Runoff, especially during storms, continues to wash mercury from these watersheds and bring it into the Delta.

What is mercury methylation and why is it important?

Methylation is a process by which anaerobic bacteria convert inorganic mercury into methylmercury. Methylmercury can be consumed by organisms such as algae, which can then be eaten by other organisms. Mercury is readily absorbed into body tissues, where it accumulates (bioaccumulation). When people or other organisms eat a mercury contaminated organism, they accumulate the mercury into their own bodies. Thus the concentration of mercury can be up to million times higher in species at the top of the food web than the amount of mercury in the water (biomagnification).

Is the mercury in the Delta a liquid like the mercury in old glass thermometers?

The mercury in the Delta can be dissolved in the water column or bound to particles such as sediments or organic particles.

Why was DSM2 selected for this project?

For this project it was decided that it would be most efficient to add mercury to an existing Delta model, thus the Delta Simulation Model 2 (DSM2) is being extended to include mercury cycling. DSM2 was selected due to its long history of application in the Delta, model development staff, large user base and user group support.

What new processes need to be added to DSM2 to represent mercury?

The mercury modeling project will be building off of another project to replace the water quality module in DSM2 with a modernized General Transport Model (GTM, see article in this newsletter). Once GTM is complete, mercury specific modules will be added. In order to represent the complete mercury cycle, sediment transport (inorganic and organic particles), additional water quality constituents (pH, sulfates, etc), and possibly bed interactions will be added to DSM2.

When will the DSM2 mercury model be done?

We are targeting the end of 2016 for completing the model development and the end of 2017 for initial model calibration, validation and sensitivity/scenario analysis.

DSM2 General Transport Model (GTM) Development Update

En-Ching Hsu, Engineer WR, DWR and Nicky Sandhu, Senior Engineer WR, DWR

DWR's Delta Modeling Section is developing a new DSM2 transport module, the General Transport Model (GTM). The mesh for GTM is fixed (Eulerian) rather than moving with flow (Lagrangian). This should make it easier to interact with other models, georeferenced data and visualization as well as to couple to Hydro. It is also based on a more flexible software framework that is easier to adapt to new groupings of constituents. Mercury and sediment are of particular interest.

Current accomplishments are:

- Made modifications to hydro tidefile to allow a lossless hydrodynamic representation;
- Designed I/O system for GTM interface;
- Preformed unit-test and system test for Eulerian transport scheme;
- Added components, such as boundaries, junctions, reservoir, external flows, to simulate delta network.

DSM2-Hydro has already been modified to provide more detailed output in the Hydro tidefile:

Hydrodynamic state information is output at every computational point instead of at coarser DSM2 nodes;

Hydrodynamic state information is output as instantaneous values instead of theta averaged quantities;

Other state variables that can be derived from the hydrodynamic state such as flow area are no longer output to the tidefile as they can be calculated using geometric information which is available as virtual cross sections in the tidefile.

GTM uses the same common DSM2 code as Hydro for reading and processing data such as the input system and boundary data. The input system is based on a text reader using keywords that will seem familiar to users of DSM2-Qual. GTM reads in time-varying data from HDF5 and HEC-DSS. The status updates for GTM development are summarized as below.

DSM2-GTM accomplishments thus far include integration of GTM into DSM2, accommodating special features (boundaries, junctions, etc.), and simulation of advection over a full Delta using a full cycle of DSM2-Hydro and DSM2-GTM. Further calibration and performance evaluation are needed.

Preliminary results for a Delta-scale problem without reservoirs indicate GTM is comparable to DSM2-Qual in giving reasonable results. Tests indicate DSM2-Qual exhibits significant numerical dispersion when a plume travels through a reach with many intermediate nodes, yet an artificial tradeoff exists whereby such intermediate nodes are required for flow field accuracy. DSM2-GTM is less impacted by such nodes.

Test results indicate GTM simulates transport well for either uniform or tidal flow. Eulerian spatial referencing offers convenience and extensibility.

We have implemented diffusion and generic reactions in GTM. These processes have been unit tested in prior work. System test and adjustment for special features are required to accommodate the delta network.

Once the testing results for conservative constituents are reasonable, the effort will be moved on to developing dissolved oxygen (DO) module and conducted on coupled mercury and sediment interaction.

New Reservoir Implementation in DSM2 V8.1.3

Lianwu Liu, Engineer WR, DWR and Nicky Sandhu, Senior Engineer WR, DWR

Introduction

This memo describes a modification for DSM2 open water areas that reflect changing areas of inundation due to bathymetry and tidal effects. Previously open water areas were treated as a constant area with a bottom elevation. This change will help in better modeling Liberty Island in addition to other open water areas in the Delta. The elevation-area-storage curves for reservoirs can be calculated using GIS tools like ArcMap. The model has been tested and new results evaluated.

Description

Originally, DSM2 implemented reservoirs with constant area and bottom elevation; reservoir volume can be easily calculated as product of area and depth. A more realistic implementation of reservoirs using elevation versus area and volume relationship is described here and added to version 8.1.3.

The mass balance equation for a reservoir can be written as $\frac{dV}{dt} = \sum Q = Q_{source} - Q_{connection}$

Where V is the reservoir volume; Qsource is external flow into or out of a reservoir, including transfer flow, DICU or pumping; Qconnection is the flow between the reservoir and connected channel (out of reservoir is positive).

Following the FourPt hydrodynamic model procedures, numerical integration in time can be written as:

$$V_{t_2} - V_{t_1} = \left(\theta(Q_s)_{t_2} + (1-\theta)(Q_s)_{t_1}\right)\Delta t - \left(\theta(Q_c)_{t_2} + (1-\theta)(Q_c)_{t_1}\right)\Delta t$$

Linearization with truncated Taylor series in terms of incremental changes of variables Q and Z:

$$V_{t_2}^* + \frac{\partial V_{t_2}^*}{\partial Z}\Delta Z - V_{t_1} = \left(\theta(Q_s)_{t_2} + (1-\theta)(Q_s)_{t_1}\right)\Delta t - \left(\theta Q_{c_{t_2}}^* + \theta\Delta Q_c + (1-\theta)(Q_c)_{t_1}\right)\Delta t$$

where the superscript "*" indicates values from the preceding iteration. Rearranging the equation by moving terms known from the preceding iteration to the right-hand side:

$$\theta\Delta Q_c + \frac{1}{\Delta t}\frac{\partial V_{t_2}^*}{\partial Z}\Delta Z = \frac{-(V_{t_2}^* - V_{t_1})}{\Delta t} + \left(\theta(Q_s)_{t_2} + (1-\theta)(Q_s)_{t_1}\right) - \left(\theta Q_{c_{t_2}}^* + (1-\theta)(Q_c)_{t_1}\right)$$

In the old model, a constant area was used, then $\frac{\partial V_{t_2}^*}{\partial Z} = A = constant$

When using the new elevation-area-storage curve, $\frac{\partial V_{t_2}^*}{\partial Z} = A_{t_2}^*$

is the area, which varies with elevation.

Reservoir elevation-area-volume curves can be generated using the 3D Analyst Tools in ArcMap. Table 1 shows the calculated reservoir elevation-area-volume table of Liberty Island at roughly 0.5 meter interval. The table shows the inundated area of Liberty Island changes greatly from low elevation to high elevation, about 3032 acre at 1.64 ft NAVD and 5190 acre at 6.562 ft NAVD. This calculation included some storage areas outside Liberty Island, e.g. Little Holland Tract, as shown in the map. Channels were kept out of the storage area calculation.

Calculation of $A^*_{t_2}$ and $V^*_{t_2}$

Within each layer (between two specified elevations in the table), if we assume the area changes linearly from the bottom to the top, the volume can be calculated as

$$\Delta V = \frac{1}{2}(A_1 + A_2)(Z_2 - Z_1)$$

But this calculated volume is not equal to the real volume as defined in the elevation-area-volume table, i.e. $\Delta V \neq V_2 - V_1$

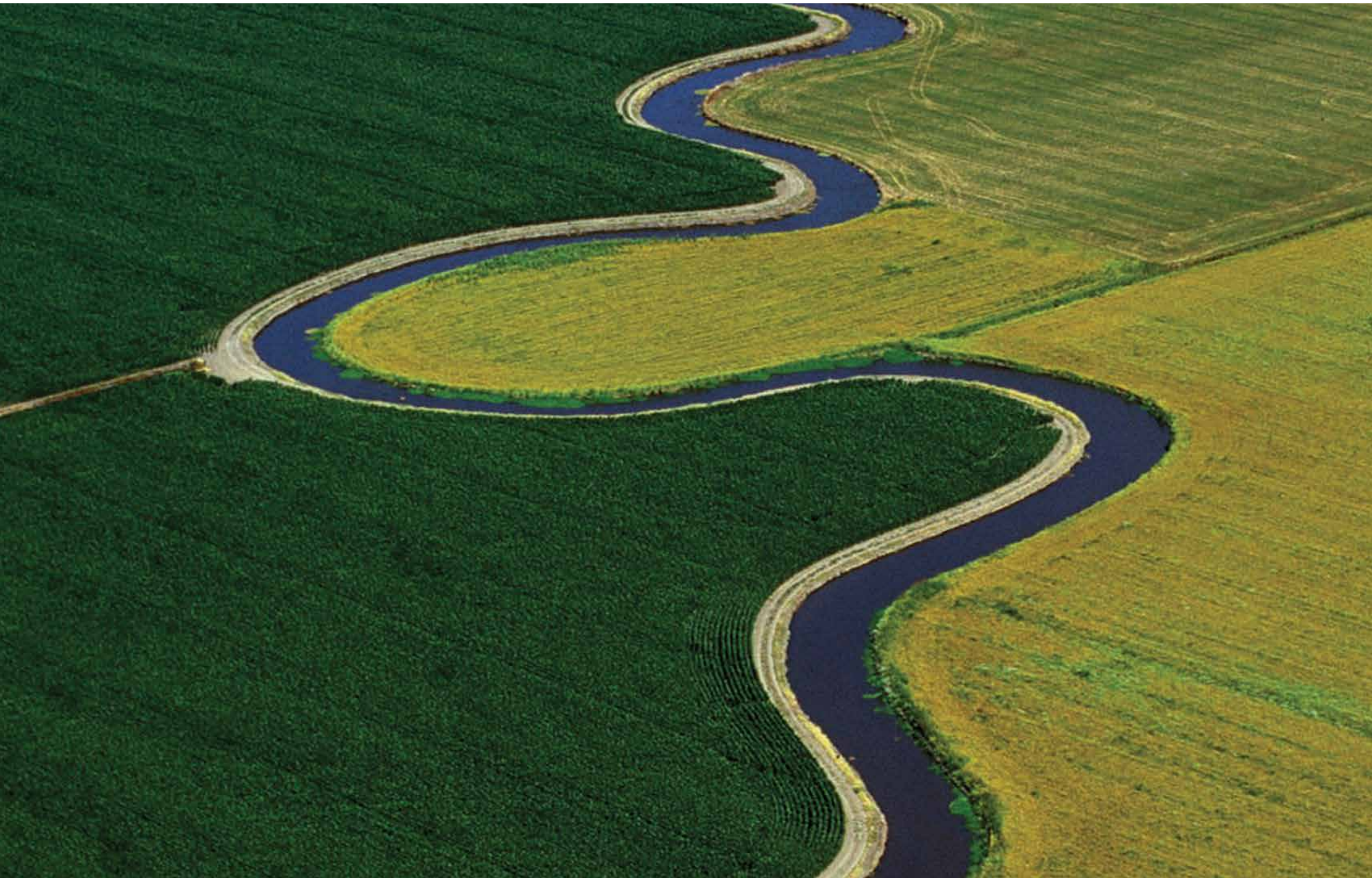
A correction factor is defined as: $\alpha = \frac{V_2 - V_1}{\Delta V}$

At any elevation Z, the area and volume can be calculated as

$$A = \frac{A_2 - A_1}{Z_2 - Z_1}(Z - Z_1) + A_1 \quad \text{and} \quad V = \alpha \frac{A + A_1}{2}(Z - Z_1) + V_1$$

This way, the calculated volume using area exactly matches the specified volumes in the elevation-area-volume table.

$$\frac{\partial V}{\partial Z} = \alpha \cdot A$$



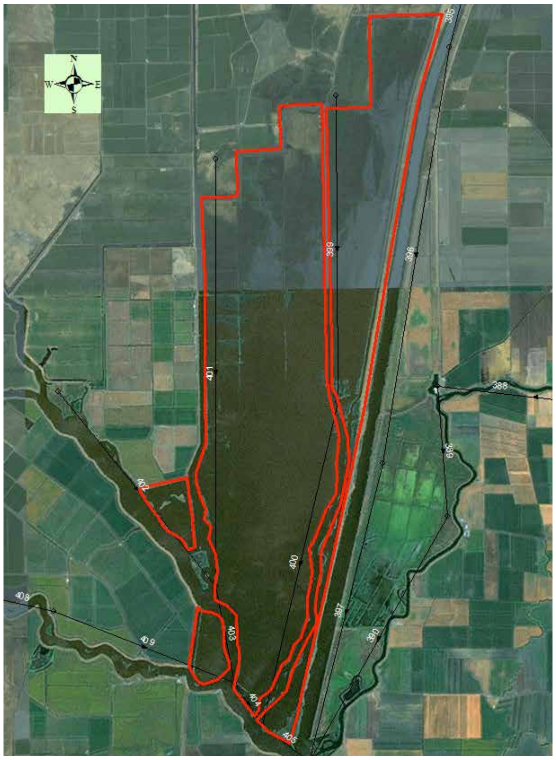


Figure 1 Liberty Island storage area map

Liberty Island		
Elevation(ft NAVD)	Area(acre)	Volume(acre-ft)
-61.975	0.000	0.000
-32.808	2.478	12.020
-16.404	16.220	114.969
-3.281	272.328	1154.224
-1.640	1017.270	2023.584
0.000	1999.522	4448.286
1.640	3031.999	8456.815
3.281	4209.851	14598.662
4.921	4584.028	21795.491
6.562	5190.456	29734.639
8.202	6359.679	39288.629
9.843	6636.050	50043.149
13.123	6731.118	72015.036
16.404	6830.894	94276.839
19.685	6876.916	116780.976
22.966	6890.138	139391.916

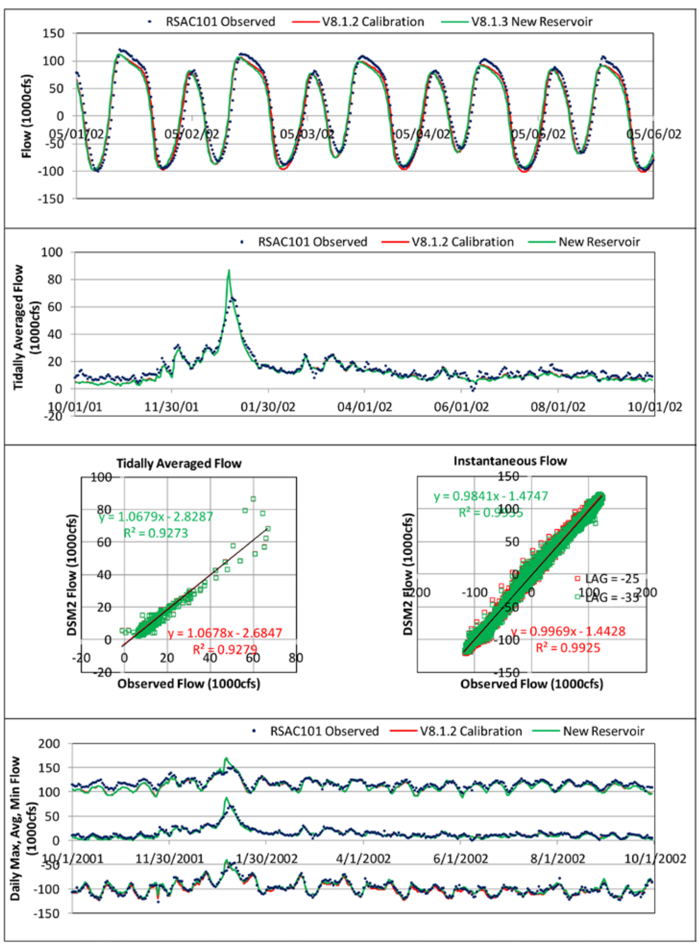


Figure 2 Flow at Sacramento River at Rio Vista

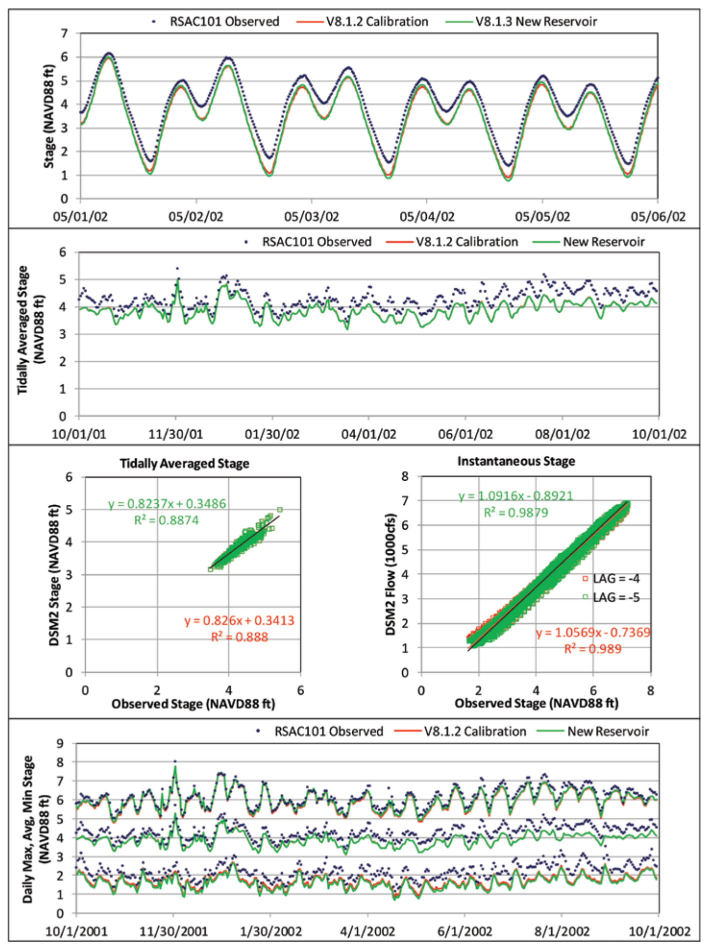


Figure 3 Stage at Sacramento River at Rio Vista

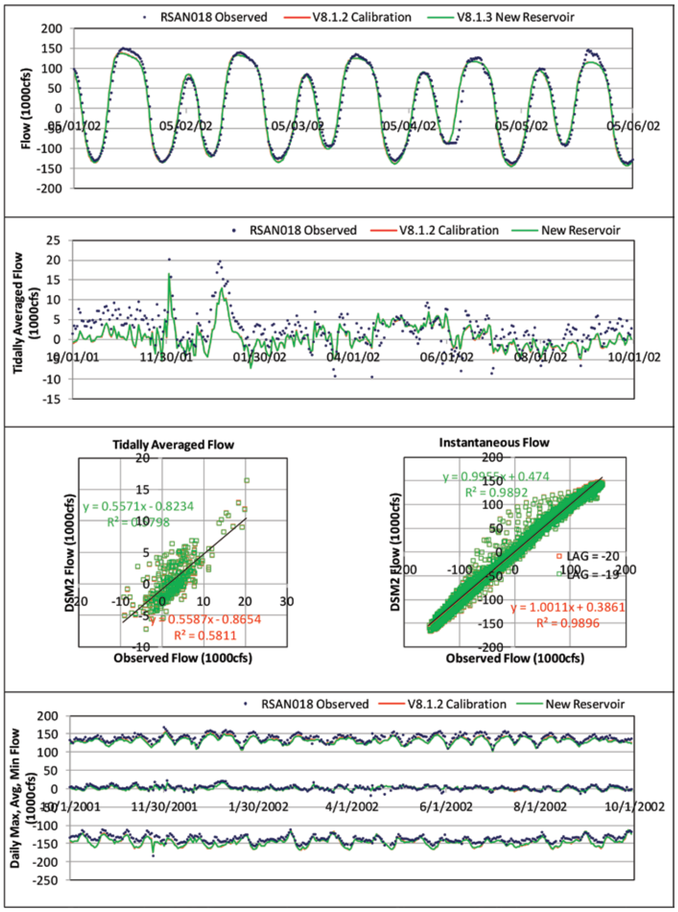


Figure 4 Flow at San Joaquin River at Jersey Point (RSAN018)

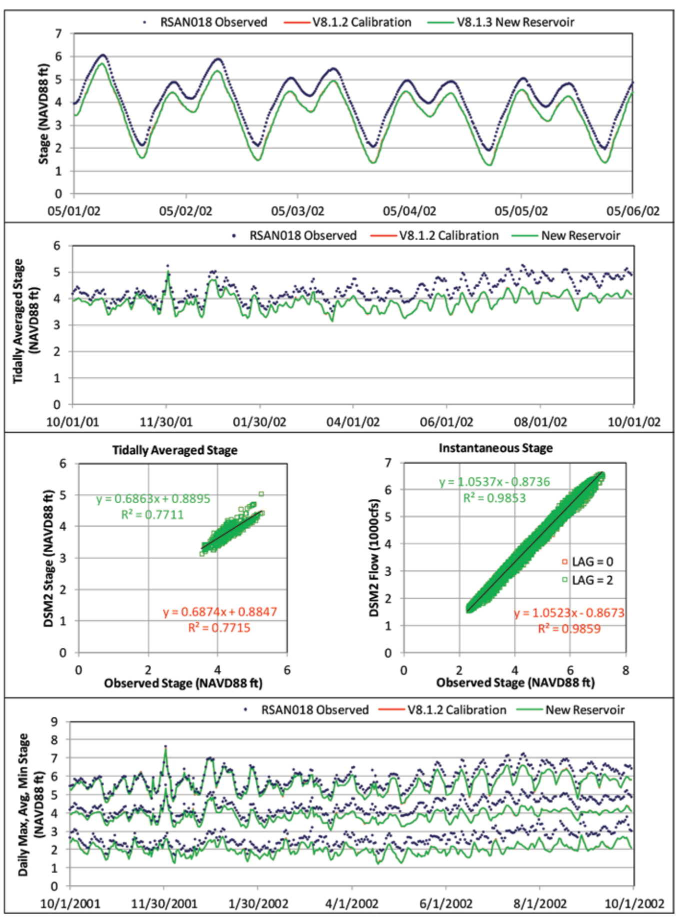


Figure 5 Stage at San Joaquin River at Jersey Point (RSAN018)

Discovery Bay		
Elevation(ft NAVD)	Area(acre)	Volume(acre-ft)
-7.612	0.000	0.000
-3.281	379.378	855.693
-1.640	409.827	1494.922
0.000	436.020	2180.971
1.640	460.503	2909.906
3.281	485.850	3683.030
4.921	516.216	4499.517
6.562	588.874	5395.956
8.202	649.454	6408.017
9.843	696.445	7502.144
13.123	906.898	10038.752
16.404	1134.594	13533.369
19.685	1141.429	17278.161
22.966	1141.429	21023.010

Bethel		
Elevation(ft NAVD)	Area(acre)	Volume(acre-ft)
-10.433	0.000	0.000
-3.281	220.520	386.621
-1.640	274.450	804.670
0.000	286.141	1264.891
1.640	293.217	1740.520
3.281	296.166	2224.650
4.921	297.149	2712.450
6.562	297.198	3199.959
8.202	297.230	3687.516
9.843	297.252	4175.117
13.123	297.268	5150.659
16.404	297.268	6125.948

Franks Tract		
Elevation(ft NAVD)	Area(acre)	Volume(acre-ft)
-37.664	0.000	0.000
-32.808	0.077	0.097
-16.404	15.458	81.712
-3.281	2863.623	6347.693
-1.640	3053.221	11229.356
0.000	3108.659	16289.292
1.640	3135.313	21414.532
3.281	3148.853	26569.405
4.921	3157.061	31739.000
6.562	3162.805	36920.426
8.202	3167.736	42112.172
9.843	3173.686	47313.134
13.123	3179.422	57750.586
16.404	3179.431	68181.904
19.685	3179.431	78613.118

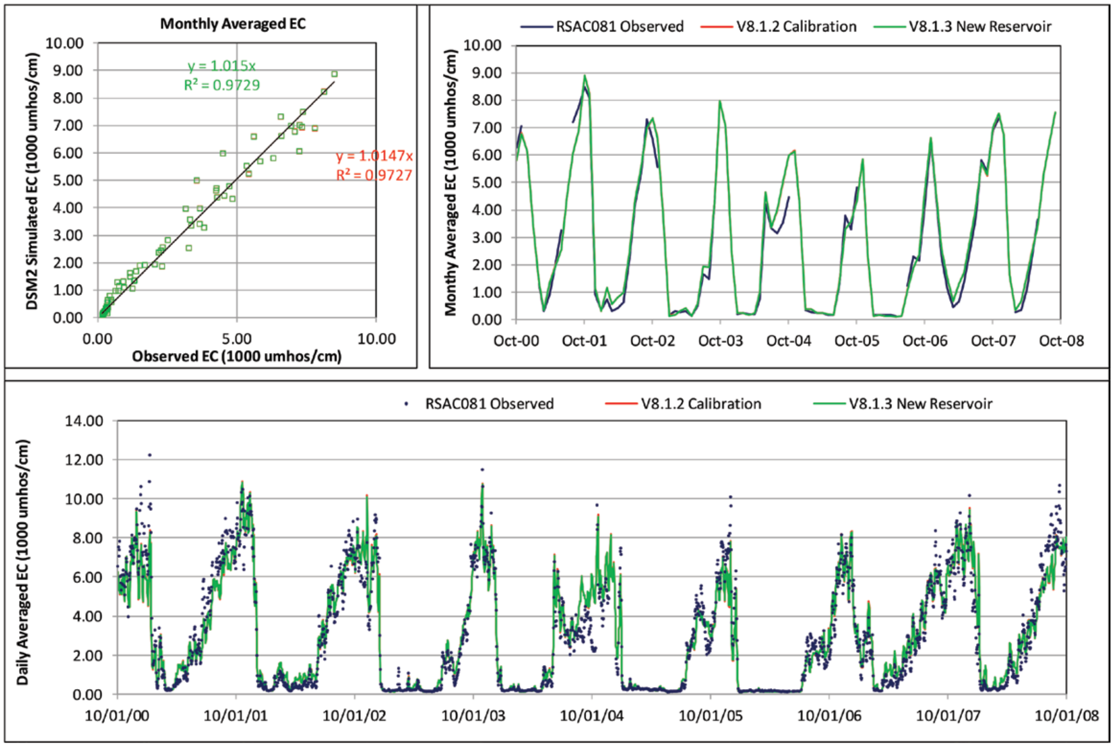


Figure 6 Simulated EC at Sacramento River at Collinsville (RSAC081)

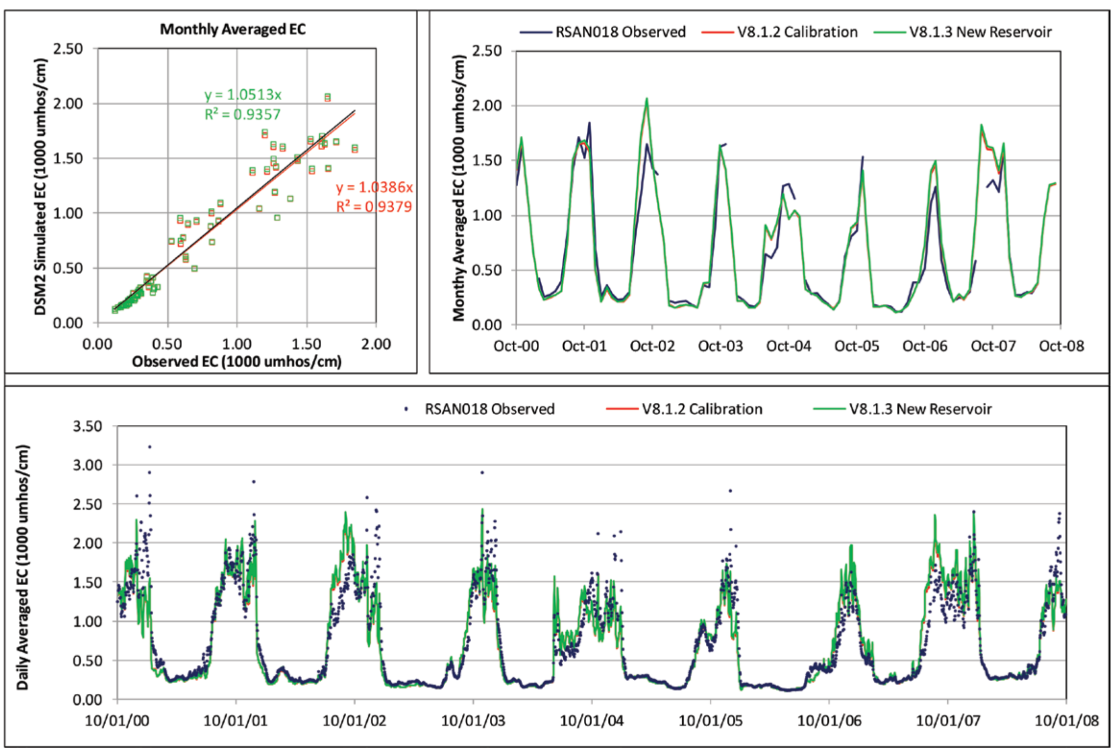


Figure 7 Simulated EC at San Joaquin River at Jersey Point (RSAN018)

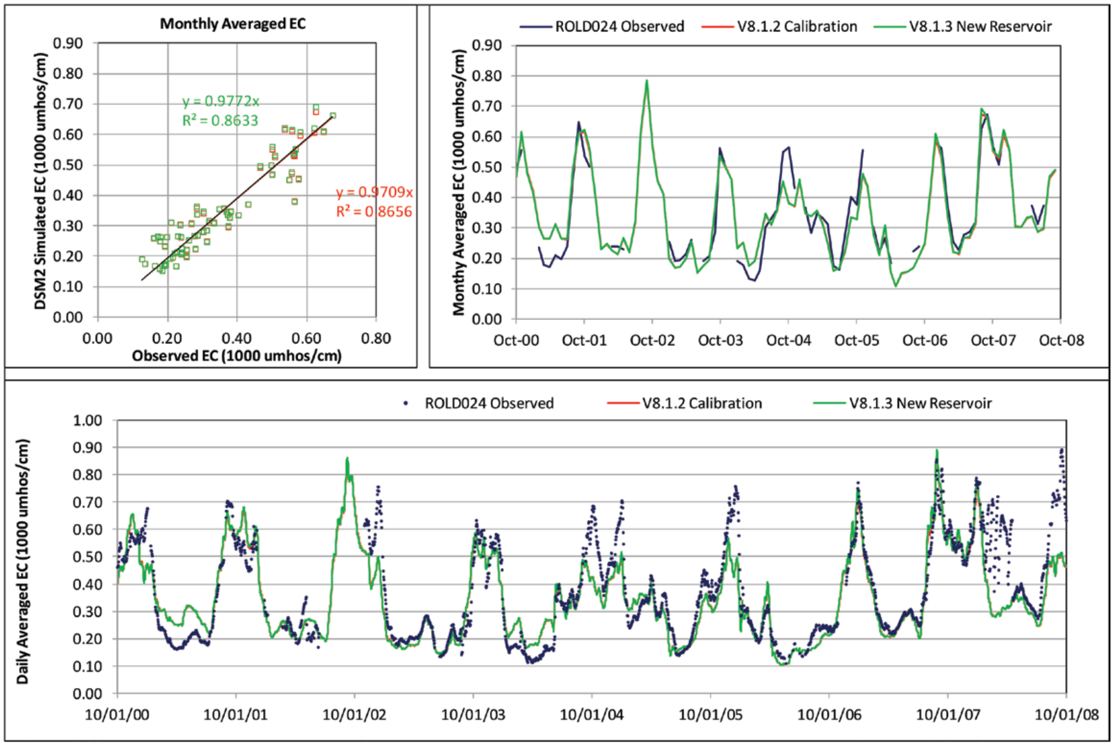


Figure 8 Simulated EC at Old River at Bacon Island (ROLD024)

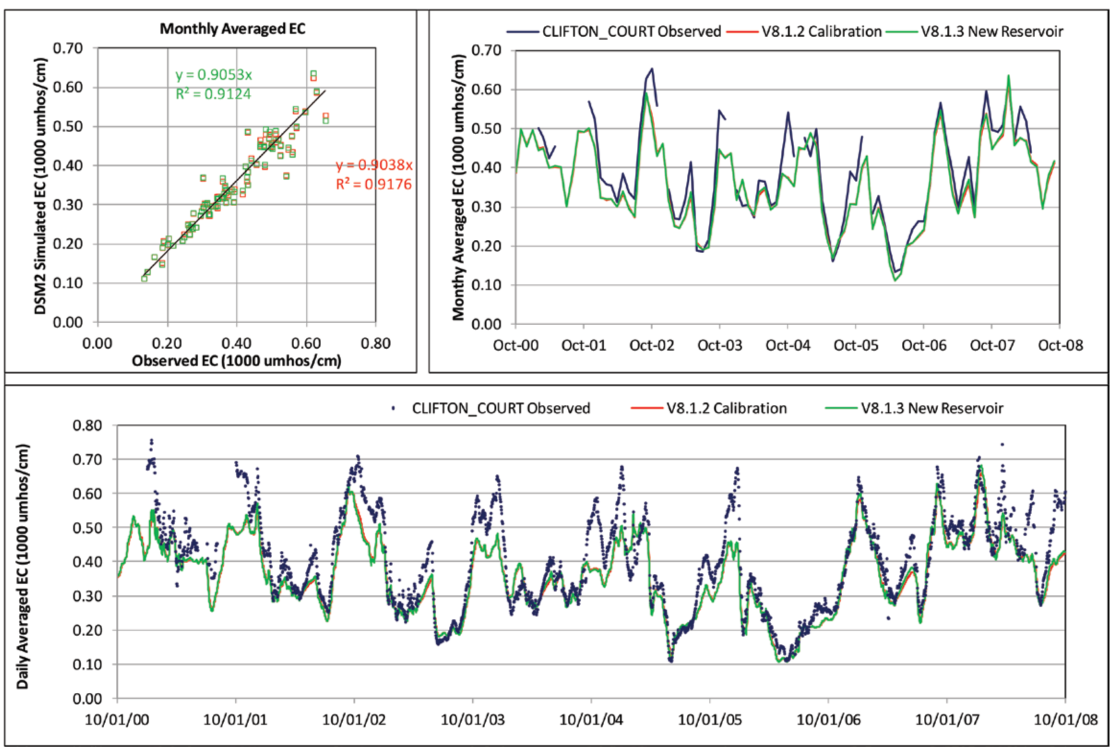


Figure 9 Simulated EC at Clifton Court Forebay

OTHER RESERVOIR ELEVATION-AREA-VOLUME TABLES

Clifton Court Forebay		
Elevation(ft NAVD)	Area(acre)	Volume(acre-ft)
-41.864	0.000	0.000
-32.808	0.232	0.685
-16.404	2.641	19.749
-3.281	1721.648	3634.879
-1.640	2060.266	6766.577
0.000	2167.212	10261.804
1.640	2189.206	13837.950
3.281	2202.368	17439.877
4.921	2213.733	21063.314
6.562	2222.305	24701.898
8.202	2228.793	28350.774
9.843	2233.958	32007.171
13.123	2243.772	39346.372
16.404	2255.195	46730.970
19.685	2258.395	54155.385
22.966	2258.395	61564.824

Mildred		
Elevation(ft NAVD)	Area(acre)	Volume(acre-ft)
-27.592	0.000	0.000
-16.404	30.433	43.056
-3.281	955.409	7648.080
-1.640	960.074	9217.757
0.000	964.188	10794.926
1.640	967.400	12377.913
3.281	969.247	13966.830
4.921	971.128	15559.504
6.562	972.641	17157.774
8.202	973.281	18755.206
9.843	973.874	20353.688
13.123	974.667	23553.121
16.404	974.977	26754.369
19.685	974.979	29953.415
22.966	974.979	33152.168

From the tables, it can be seen that other reservoir areas are fairly constant over the tidal range, and very close to the constant area values used in V8.1.2.

Results Comparison

Historical simulations from 2000 to 2008 were done with the new reservoir specifications and results compared to the V8.1.2 calibration. The change of the Liberty Island storage affected flow around the lower Sacramento River and even San Joaquin River. Small adjustments of Manning's coefficients were made to a few channels for calibration. The recalibrated flow and stage results were generally very close to V8.1.2 calibration. Obvious differences were only seen at Rio Vista; the phase difference for flow changed from 25 minutes to 35 minutes (Figures 2); and stage amplitude became larger (Figures 3). There were almost no differences at Jersey Point and the whole South Delta (Figures 4 to 5). EC results are almost identical to the V8.1.2 calibration. EC results at key stations: RSAC081, RSAN018, ROLD024, and Clifton Court are shown from Figures 6 to 9.

Summary

A new input table that uses elevation-area-volume curves for reservoirs was added. The modifications were tested for stability and accuracy. This feature is useful in better modeling Liberty Island and other potential tidal marsh restoration areas where the inundated area changes significantly with tidal elevations. This change prompted a recalibration in the region of Liberty Island and the resulting differences using the new reservoir specifications were not significant.

A new information message was added for accumulated volume balance errors of reservoirs at the end of a Qual run and listed in the end of the output file (*.qof).

Rating Clifton Court

Eli Ateljevich, Senior Engineer WR, Ming-Yen Tu, Engineer WR, and Kate Le, Engineer WR, DWR

Summary

With the help of staff at DWR Operations and Maintenance(O&M), Delta Field Division (DFD) and North Central Regional Office (NCRO), we have developed a new rating for the Clifton Court radial gates – a formula for estimating flow into the Forebay based on gate heights and water levels inside and outside the gates. The new rating is suitable for operational and modeling purposes. The development of the rating has been presented several times before – here we will give some background then concentrate on conclusions.

The original operational rating for the Clifton Court gates was devised by Edward Hills in 1988, based on a few dozen observations with hand-held velocity meters with gate heights in the common range of the day: 12-15ft. There were no examples of the much lower gate heights (say 5-8ft) that are common nowadays. An optimistic assessment was published in the Delta Modeling Section Annual Reports in 2004, but this validation was based on a misunderstanding concerning quantities stored in DWR databases. We have found to the contrary that the Hills rating performs poorly even in its design range, with sustained errors of thousands of cfs (or 30-40%) common over a wide range of flows. Figure 1 shows a comparison of daily averaged Hills flow with daily Dayflow estimates based on daily flow balances, which are thought to be fairly accurate. Significant overestimation and underestimation are evident. Figure 1 implies persistent errors of thousands of cubic feet per second, and this portrayal is misleading. In a dynamic model of Clifton Court, a surplus or deficit of 1000 cfs would be unsustainable – it would drain or overtop the Forebay within a few days. Instead,what happens in any reasonable model is that Forebay water levels provide negative feedback, resisting further accumulation of error. For instance, if inflow is overestimated, water levels go up in Clifton Court Forebay and this increase acts through the gate rating to slow the water coming in. Long term flows are likely to be accurate, matching exports. However, water levels may drift unrealistically and instantaneous flow may be significantly wrong.

DSM2 uses a submerged gate equation to model the Forebay gates. The formula and coefficients were developed independent of the Hills Equation. As we will show later, the existing DSM2 gate equation has some problems reproducing Clifton Court water levels. The potential of the existing gate formulation is marred by simplifications made in typical modeling practice. For instance, in historical mode, gates are typically regarded as fully closed or open which is very unrealistic under the "sipping" regime employed often in recent years. It is not possible to model flows or water levels accurately under this constraint.

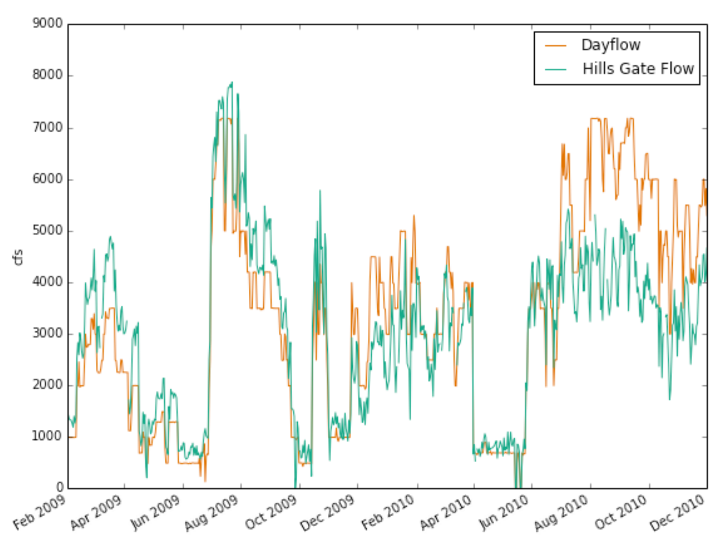


Figure 1: Comparison of daily gate flow calculations from Dayflow (SLP is gate inflow) with daily averages of flows from the Hills Equation.

In an 2013 publication studying residence time in Clifton Court using UnTRIM, Ed Gross and Michael MacWilliams proposed a two step procedure to estimate flows, using daily CDEC flows to scale data from the Hills Equations. The scaling constrains the flow to agree volumetrically over each calendar day, while the Hills Equation provides disaggregation in time. If we understand this approach correctly, the gate flow is calculated offline and applied directly as a transfer rather than using a gate equation inside the model. We have tried this during the calibration of the 3D model SELFE and found it to be a high quality but brittle solution for long term simulations. The method lacks the negative feedback we cited earlier, and a small (say 2-5 cfs) systematic discrepancy between Banks pumping and the gate flow will fill the Forebay over just a few months. The method also is based on historical data and hence has no analog in planning or real-time operational work.

THE NEW RATING:

The Clifton Court radial gates in DSM2 are based on the following submerged gate formulation: $Q = nCA\sqrt{(2g)(z_{up} - z_{down})}$

Where:

- Q is the gate flow
- n is the number of gates operating (with non-zero heights)
- C is the dimensionless state-dependent gate coefficient described below
- g is gravity
- z_{up} is the stage upstream of the forebay (assessed by DFD at Clifton Court Ferry)
- z_{down} stage inside the forebay and
- A is the average area of the gates in operation, based on width and limited from above either by the free surface or by the average gate height :

  The new rating retains the old form. However, adapting some advice from Tony Wahl of the USBR we made the gate coefficient linearly dependent on the ratio of gate height to upstream depth from the sill (-15.5ft NGVD):

Where d and s are parameters to be fit.

$$C = d + sR$$

$$R = \min\left(\frac{G}{z_{up} - z_{sill}}, 1.0\right)$$

The new rating does not assign individual coefficients to the five Clifton Court Gates but has been tested over periods where the gates are operated in mutually different positions.

CALIBRATION:

We originally intended to use direct flow observation to calibrate the new gate equation. With the aid of Dave Huston of NCRO and his crew, downward-looking ADCP campaigns were made at the intake channel and collated with interior and exterior elevation and gate height. We used two collections by DWR NCRO in 2004-2005, two in 2012, as well as one collection by Cathy Ruhl of the USGS in 2008. While our data set has more variety than some of its predecessors, the ADCP data span mostly small-medium gate heights. We had a tough time filling this area of the rating – in 2012 the winter "sipping" season was declared two days before our proposed outing and in 2013 one of the gates fell off its hinges in the week before our second attempt.

To make up for the lack of data covering large gate openings, we calibrated the rating in this range using a flow balance around Clifton Court. The use of volume changes in Clifton Court has been used to estimate daily gate flows for years. The method is thought to be inappropriate for instantaneous flows because stage differences of a few millimeters in Clifton Court Forebay represent a relatively large flow over 10 minutes. This critique is pertinent if differencing is used to convert volume changes to flows.

We considered a variety of formulas of varying complexity. The existing DSM2 gate equation proved too restrictive. When the DSM2 gate equation was coupled with correct historical gate heights, it underpredicted stage but tracks daily flow well on a daily basis (Figure 3). The rating proposed in Equations (1-3) with variable coefficient was more successful, as shown in Figure 4.

We also fit the ADCP data. In this case we fit the two parameters governing the flow equation directly with nonlinear least squares. Outliers in this fit (see Figure 6) were mild and generally due to startup transients when gates were initially open. The two methods agreed well enough to speculate an accuracy of 3-500cfs, and no formal effort was made to reconcile the fits from the different types of datasets.

We have reproduced the same quality of fit on other normal years. Mindful of the importance of drought, we also sought to validate the rating using flow balance in 2008, a critical year with long periods of low inflows. The rating works less well in

this flow regime. Tidal fluctuations are approximately correct, but we see episodic overestimation of several tenths of a foot in water levels (Figure 5). This problem is most likely attributable to the smaller gate heights, but evaporation and higher relative errors in Banks pumping data are also likely to contribute.

Our method does not use differencing in time to produce flows. Instead we calculate flows with the proposed rating and integrate over time. Figure 2 shows the domain of our conceptual model. Interior water level is the state variable we integrate and compare to observed values. The other inputs are Banks and Byron-Bethany exports, interior and exterior water levels and gate height (we used 10-minute values except at Byron-Bethany where we used daily). Flow into the Forebay was assumed to be governed by the trial rating equation, and we tuned the coefficients until the subsystem reproduces Clifton Court water level variations accurately.

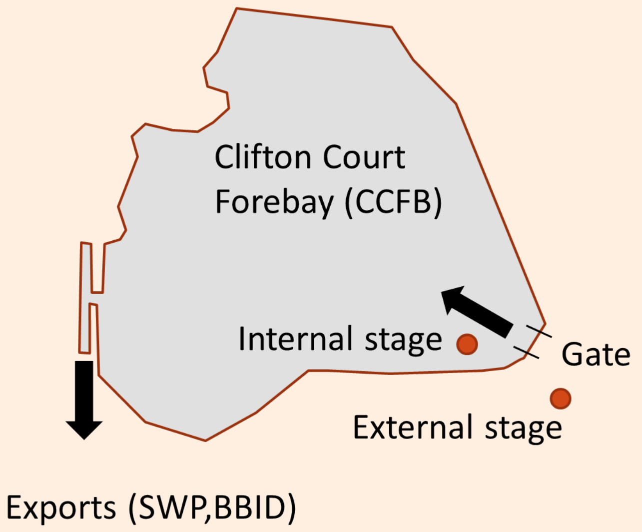


Figure 2: Components of flow balance used to calibrate the gate rating.

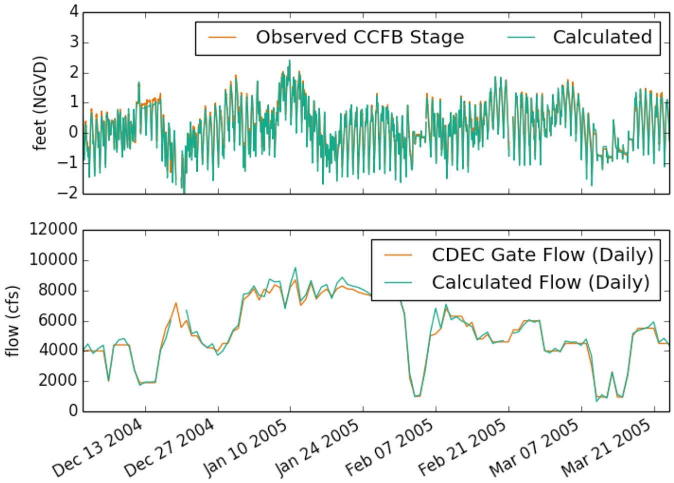


Figure 4: Forebay water level fluctuations and gate flows from the new rating compared to field data.

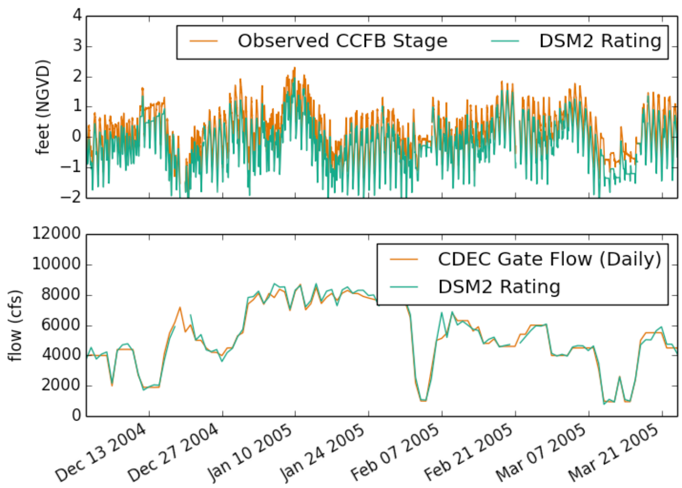


Figure 3: Forebay water level fluctuations and gate flows from the DSM2 gate equation, assuming correct use of gate heights.

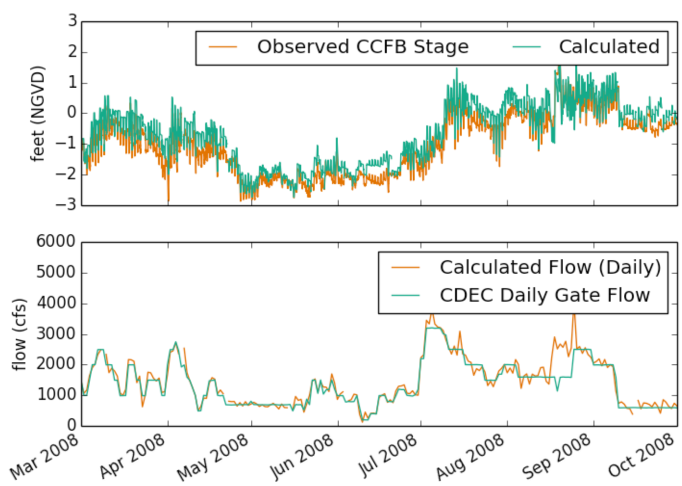


Figure 5: Rating validation in 2008 under low flows.

We did not reconcile the ADCP and flow-balance based methods formally. The two agreed well.

CONCLUSIONS

The gate rating presented here is sufficiently accurate for our purposes and appears to be robust. Typical errors in flow for the rating are 5-10%, and any tendency for Clifton Court water levels to wander appears to be self-correcting.

The bad news is that the new rating requires more preparation. We have noted appreciable loss of accuracy if any of the pieces are missing or daily averaged. Banks pumping and Clifton Court gate heights are both needed at fairly high time resolution and subtidal water level variation at the outside of Clifton Court must be correct (ie, astronomical forecasts are not sufficient). Finally, large errors are introduced in planning studies when modelers assume that the gates are open during the entire period (usually Priority 3 or 4) when they are allowed to be open under operational agreements, without considering that in practice they are often closed much earlier because allocations for the day are satisfied.

Some approximations are possible, though. For historical periods when explicit gate heights or Banks pumping data are not available, we have had some luck converting target gate flows to gate heights using the following method:

Obtain daily gate flow from Dayflow (SWP) or CDEC (CLC) and distribute this volume evenly over the period the gate is open (which is part of the DSM2 standard inputs and usually comprises a subset of the Priority 4 period).

Determine a gate height by inverting this simplified rating based on gate heights only:

Since the costs of preparation are not insignificant, we intend to confirm how important this all might be on dynamics throughout the South Delta. Our main conclusion at this point is that correctly modeling fluctuations inside Clifton Court requires not only an improved rating, but also gate heights and Banks pumping data on an hourly or better basis. These are data that have been publically available in the past, but on a sporadic basis.

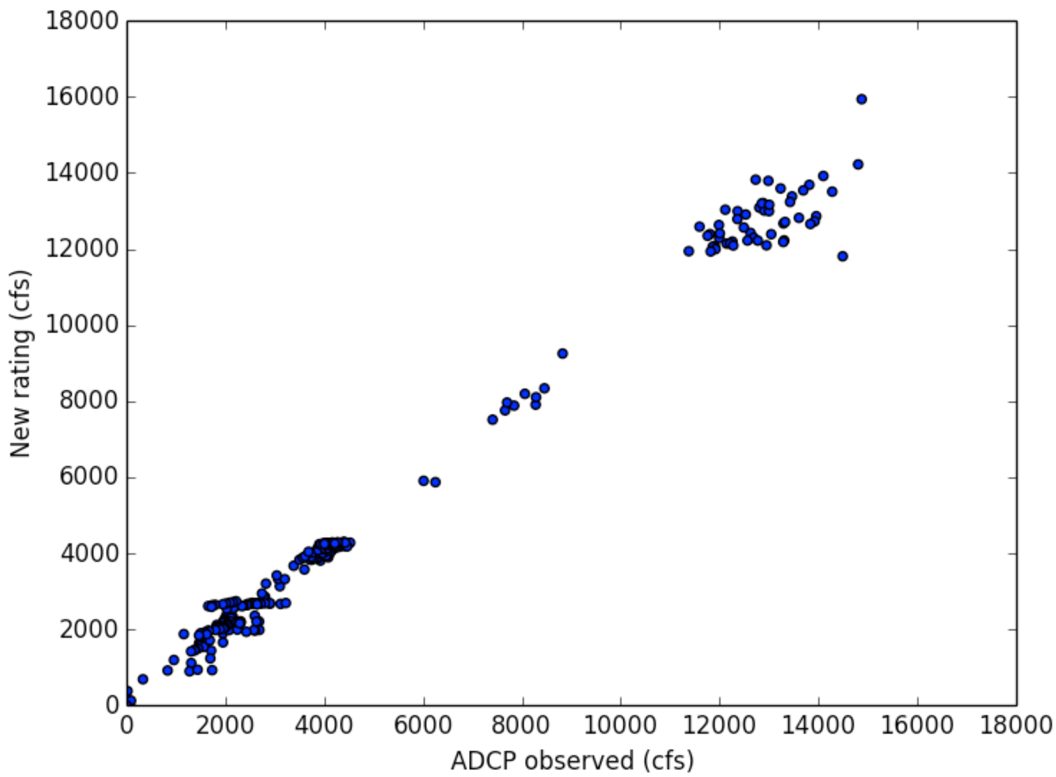


Table 1: Parameter fits for coefficients and comments from drought modeling.

Coefficient	value	comment(drought)
d	0.75	Range 0.7-0.75 OK.
s	0.08	Range 0.6-0.8 OK.

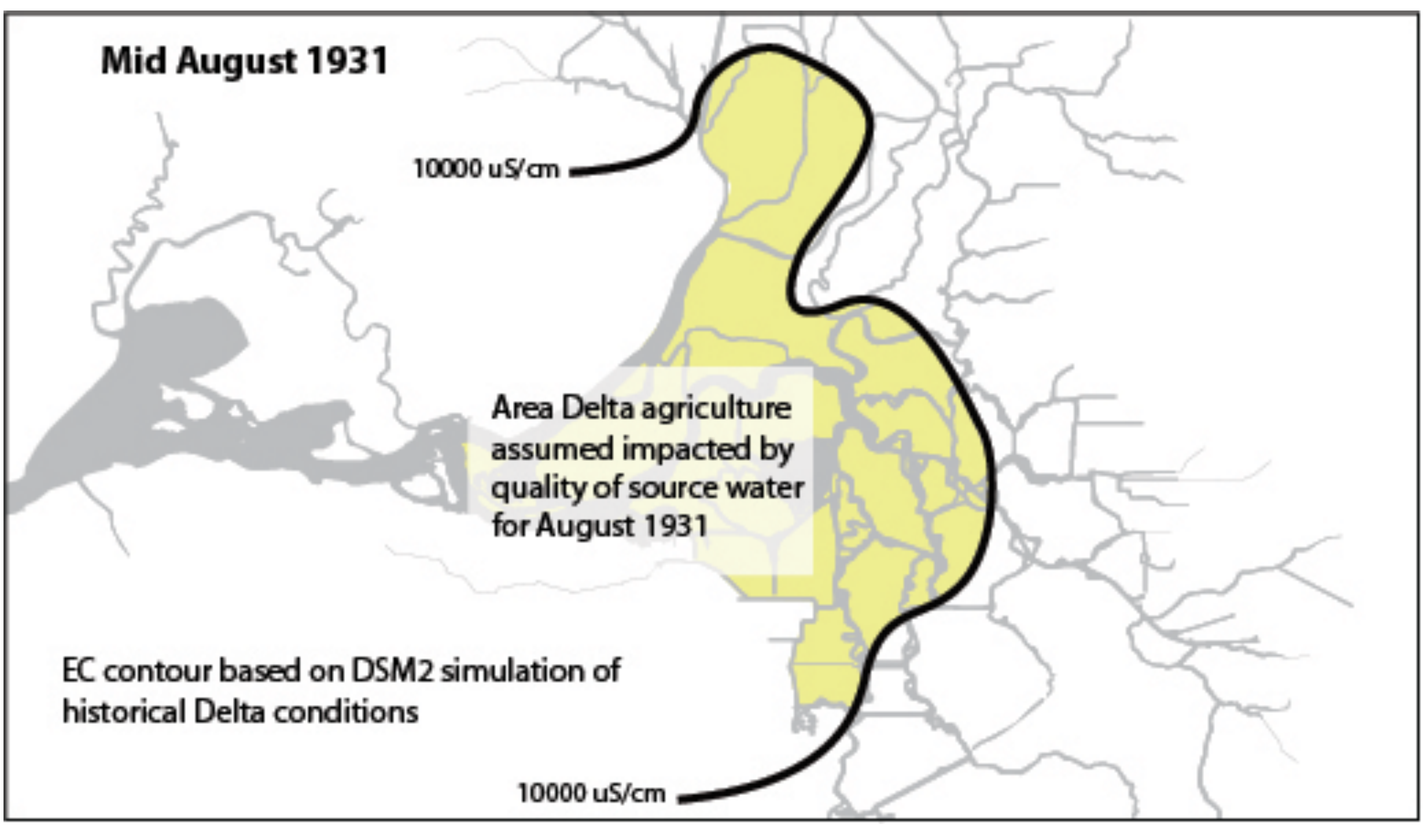
Modifying Delta Consumptive Use for Extreme Low Outflow Events

Lan Liang, Engineer, DWR and Bob Suits, Senior Engineer, DWR

DWR forecasts of Delta conditions in early 2014 included a "worse case" scenario which yielded very low summer and fall Delta outflows. This scenario included two key factors: low Delta inflows reflecting certain reservoir release strategies and high Delta consumptive use. The resulting Delta outflows for this scenario were lower than estimated outflows since the droughts of the 1920s and 1930s.

Such extreme event poses two problems for modeling. First, the boundary EC at Martinez needs to be estimated using the G-model under hydrologic conditions outside of those used to develop and calibrate it. Second, Delta consumptive use should be modified to account for reduced agricultural diversions considering crop salinity tolerance for significant salinity intrusion. These two modeling issues are not independent. Modified boundary EC depends in part on the assumed modifications to consumptive use and reductions in consumptive use depends upon the salinity intrusion which in part is based on the boundary EC. Accounting for these issues should make future significant drought forecast simulations more realistic.

As a proof-of-concept for modeling Delta EC under extreme low-flow conditions, historical 1931 conditions were simulated through several iterations of boundary EC and Delta consumptive use estimates. This year was an historical extreme event, for which some analysis was conducted at the time of salinity intrusion and crop yields.

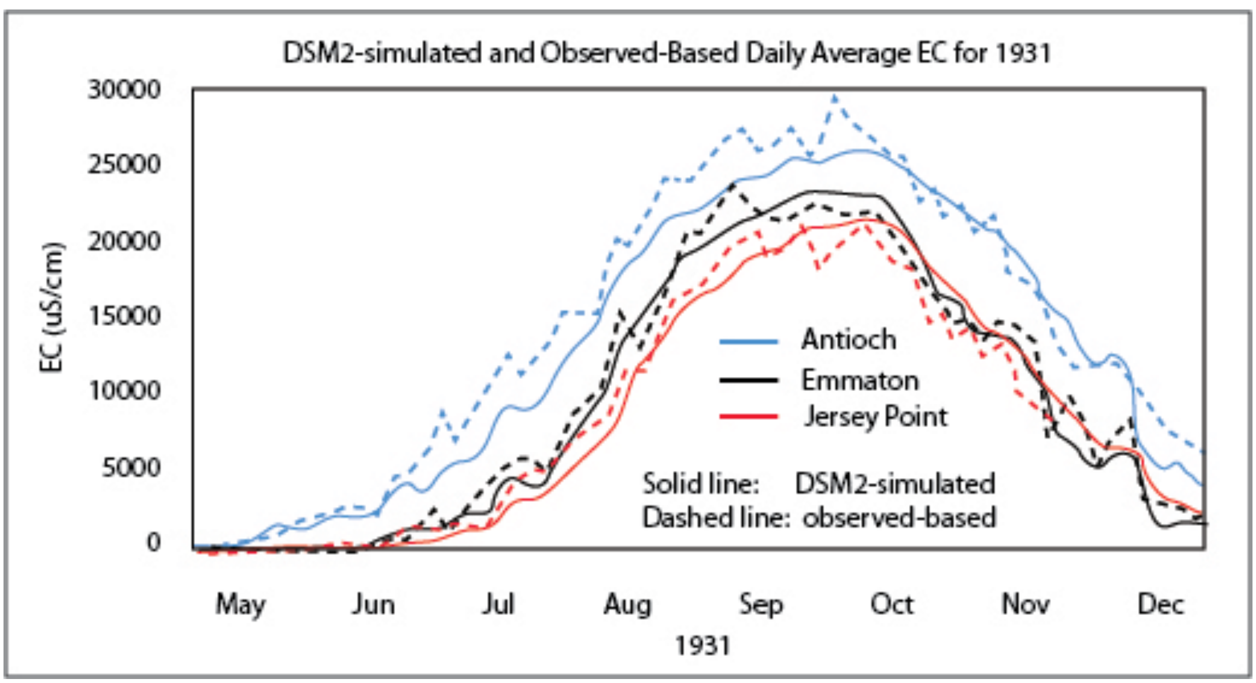


Initial consumptive use was determined using DETAW for historical conditions. Initial Boundary EC values were generated by first using the G-model and then adjusting EC until simulated EC nearest to Martinez matched observed values.

Consumptive use was reduced based on: portions of Delta islands falling within a mid-month EC contour of 10000 µS/cm (based on DSM2-simulated EC). The 10000 µS/cm level is the salinity associated with averaged crop yield of the crop categories in the Delta being reduced 50% according to crop salinity tolerance published by Food and Agriculture Organization. Resulting changes to consumptive use for 1931 are shown below. An example contour for August of 1931 is shown along with graphs of simulated EC at several locations follow. These results are preliminary and work may continue in the future to more directly link channel EC at actual diversion locations and crop acreage serviced by each diversion to modifications to consumptive use.

unit: cfs	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DETAW_initial	2953	3557	5129	4188	2438	1392	783	-4153
DETAW_modified	2953	3557	5013	3650	2121	1367	783	-4153
reduction	0	0	-117	-538	-317	-25	0	0
reduction in percent	0%	0%	-2%	-13%	-13%	-2%	0%	0%

Modification of 1931 Delta-wide consumptive use based on salinity intrusion



Particle Entrainment Study for 2014 Spring Drought Forecast using DSM2-PTM

Joey Zhou, Engineer WR, DWR

The United States Fish and Wildlife Service (USFWS) requested California Department of Water Resources (DWR) Modeling Support Branch perform a DSM2-PTM modeling study to investigate the impacts of SWP pumping on particle entrainment in the Clifton Court facility under the 2014 spring drought forecasted conditions and under an assumed storm event. The study has been completed and the report and data were transferred to USFWS.

Model setup

Two hydrodynamic scenarios representing the current (baseline) and an assumed high export condition were simulated: The hydrodynamic conditions and particle insertion locations are described below:

Inflows and Exports

Baseline Scenario: The forecast of 4/9/2014 – 7/31/2014 Delta inflows and exports (including SWP, CVP, North Bay Aqueduct, and Contra Costa Water District) is used. The forecast is based on the 90% annual exceedance probability.

High Export Scenario: For Sacramento (SAC) and San Joaquin Rivers (SJR), the forecast of 4/9/2014 – 5/22/2014 inflows are replaced by 2/1/2014 – 3/16/2014 inflows, which include a rain storm event. The inflows before 2/19/2014 are historical data and after the date are forecast data. The other Delta inflows are the same as the baseline.

All exports except for SWP and CVP are the same as the baseline. SWP and CVP exports will be generated so that maximum exports (with an upper limit of OMR = -6250 cfs) can be achieved and D1641 standards will not be violated. The adjustment rules are listed below:

- Set Net Delta Outflow (NDO) = 4200 cfs (to meet D1641 salinity objectives);
- Find the south delta export upper limit corresponding to OMR = -6250 cfs using Paul Hutton's regression formula:
- Set the SAC and SJR by replacing 4/9/2014 – 5/22/2014 SAC and SJR inflows with 2/1/2014 – 3/16/2014 inflows;
- Obtain SWP/CVP export time series by calculation using NDO = 4200 cfs and the mass balance formula while making sure the exports not exceeding the above OMR limit:

Tide, Consumptive Use, Gates/ Barriers

For both scenarios, forecasts of 4/9/2014 – 5/22/2014 tides and DICU are used; all south Delta temporary barriers are in place. Clifton Court Forebay is in priority 3 operation schedule. Delta Cross Channel gates are closed. Montezuma Salinity Gate is tidally operated.

Particle Insertion

In both scenarios, 10,000 particles are inserted in the locations indicated in Table 1. The particles are inserted at the beginning of the PTM simulations with duration of a day. The fates of particles are analyzed at both PTM standard output locations (major boundaries) and USFWS specified locations.

River Region	DSM2 node	20mm station
San Joaquin River	34	906
	38	815
	42	812
	469	809
	46	804
Sacramento River	334	Close to Sacramento, above DCC/Georgiana
	316	723
	350	711
	352	707
	354	704
	465	513

Table 1 - Insertion locations for PTM simulations

Hydrodynamic simulation outputs:

Figure 1 shows the major boundary inflows of the first 44 days in the Delta: scenario 'baseline' (solid lines) utilizes Apr-May 2014 forecast hydrograph; scenario 'mod' (dash lines) utilizes Feb-Mar 2014 rain storm event and the adjusted exports. (Please refer details to the technical report written for USFWS).

Sacramento River (GREEN): scenario 'mod' has the rain storm flow surge in day 8-18, and another higher flow period in day 29-44, with flow much higher than scenario 'base'.

San Joaquin River (RED): scenario 'mod' has a little lower flow than scenario 'base'

Exports (CVP + SWP + fixed CCC) (blue): scenario 'mod' adjust exports according to the rain storm flows, to reach its high capacity within OMR limit (6250 cfs). Figure 1 shows scenario 'mod' has much higher exports than scenario 'base'. Some key flow indices (NDO, QRIO, QWEST, OMR) are generated using DSM2-HYDRO outputs to investigate the interior Delta hydrodynamic conditions (Figure 2, Figure 3). Part of their definitions are extracted from DAYFLOW *http://www.water.ca.gov/dayflow/documentation/dayflowDoc.cfm*

PTM simulation outputs

PTM output is in the format 'percentage, %, of total insertion', which depicts the relative destination possibility of inserted particles. Results are primarily analyzed at the end of the first 44 days, since it concludes the period of the designed hydrodynamic comparison conditions. Meanwhile, differences between scenarios are also investigated at the end of 113 days, since it's the time most particles reach their final destinations and hydrodynamic conditions are the same for the latter period. For details, please refer to the technical report written for the USFWS.

Particles final fates at the Delta boundaries are the major concern of the study. Three boundary outputs are examined in this study: particles passing Martinez, particles entrained by exports CVP+SWP, and particles staying in the Delta. They are the three primary constituents of the output pie charts (Figure 4, Figure 5).

Particles final fates at USFWS specified stations in the south Delta are also investigated. And their patterns are in accordance with boundary outputs (Figure 6).

To compare the 2 scenarios 'mod' and 'base', 'mod-base' differences of boundary outputs, USFW specified station outputs for all the insertions are investigated for both after 44days and 113 days (Figure 7, Figure 8).

Residence time represents how long particles stay in the Delta (Figure 9, Figure 10). Travel times to Martinez and CVP, SWP are also investigated.

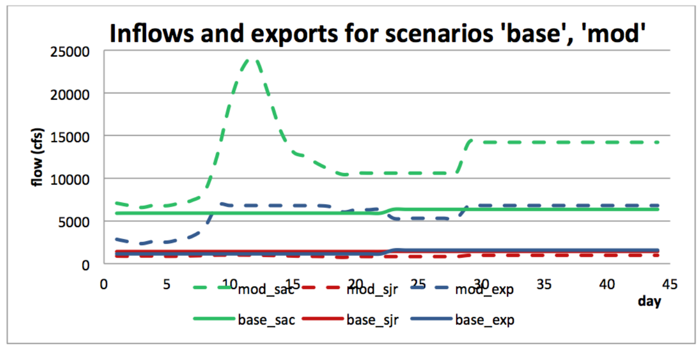


Figure 1 Major boundary flows and exports (CVP+SWP+CCC) for scenarios 'base' and 'mod'

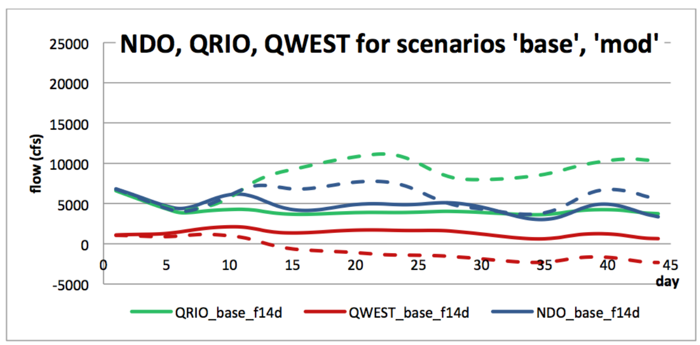


Figure 2 QRIO, QWEST, NDO from DSM2 outputs for scenarios 'base' and 'mod'

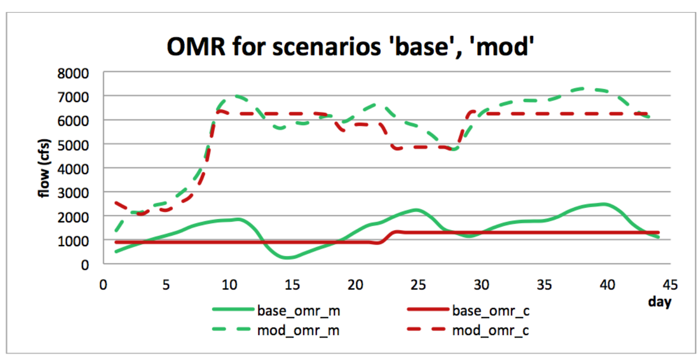


Figure 3 OMR from DSM2 outputs for scenarios 'base' and 'mod'

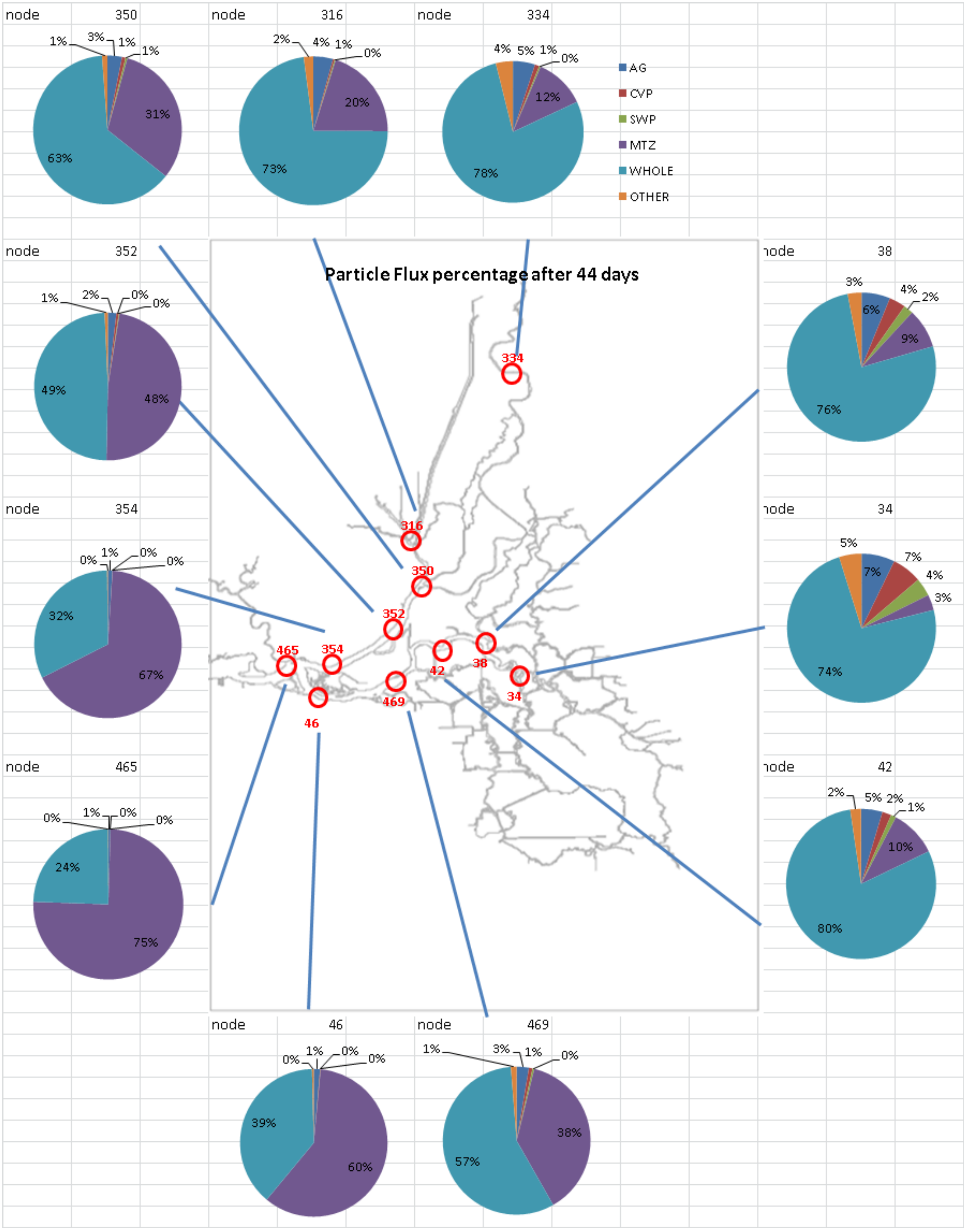


Figure 4 Pie chart of PTM boundary outputs after 44 days for scenario 'base'

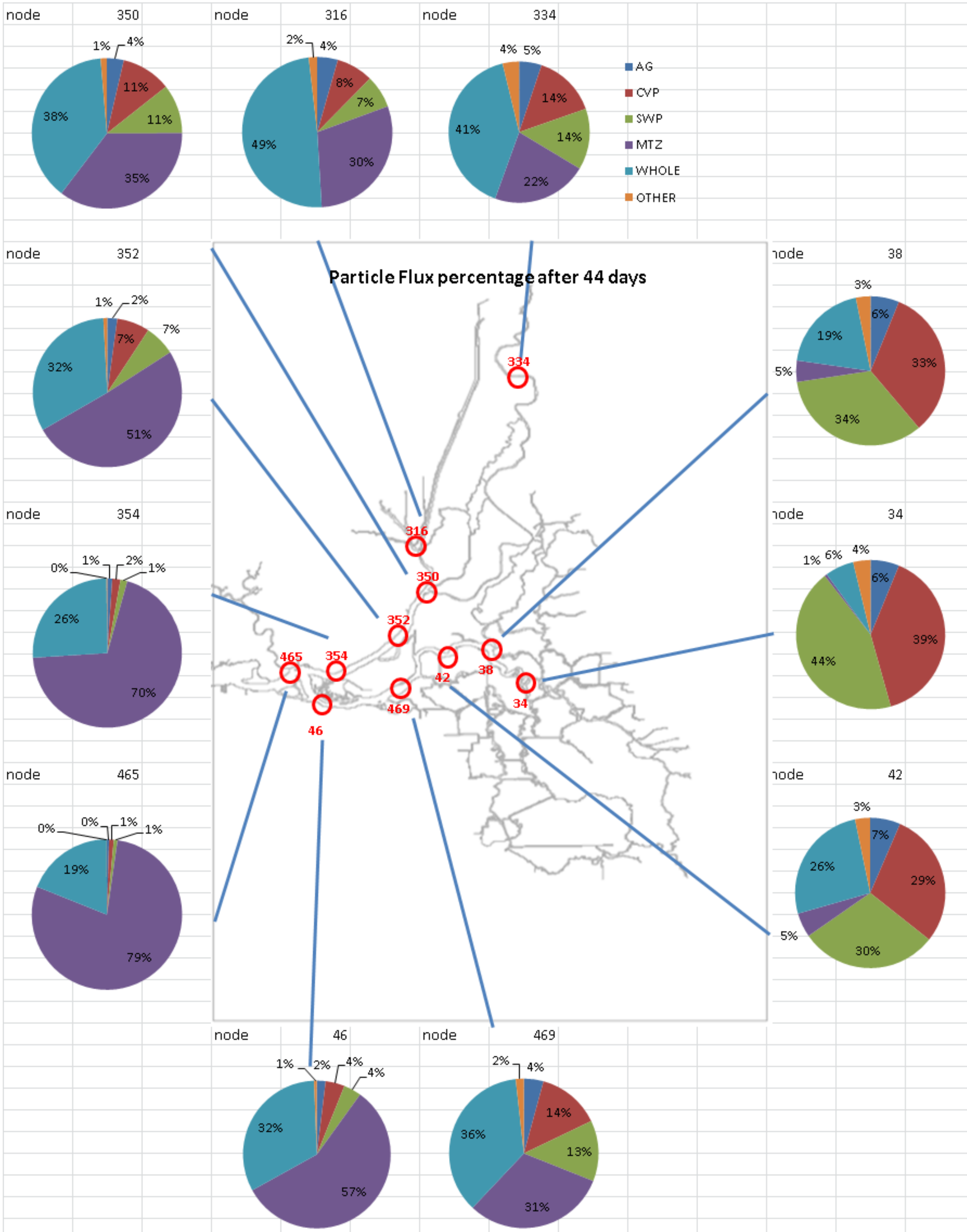


Figure 5 Pie chart of PTM boundary outputs after 44 days for scenario ‘mod’

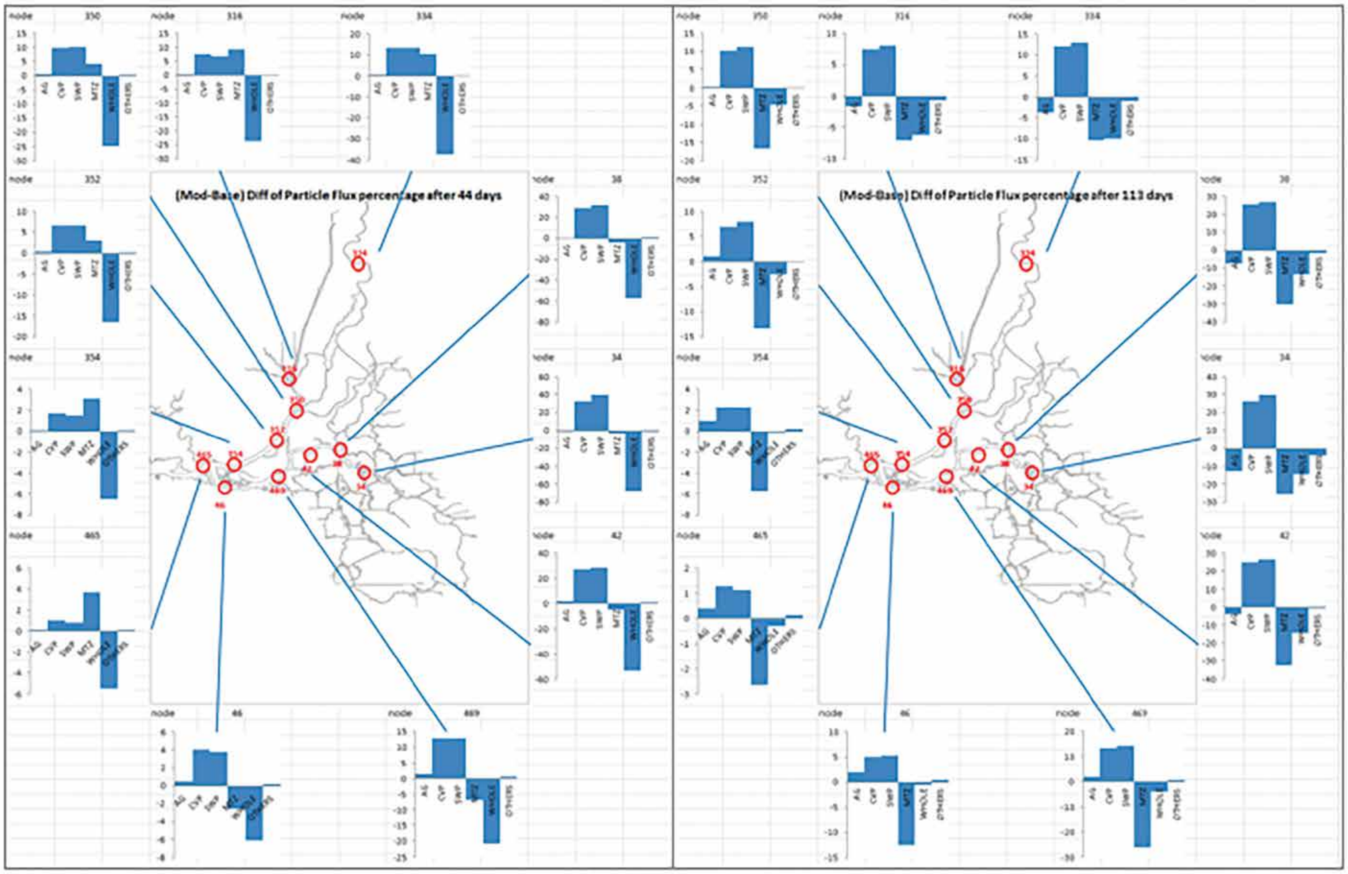


Figure 6 Difference of PTM boundary outputs between scenario 'base' and 'mod', after 44 day and 113 day

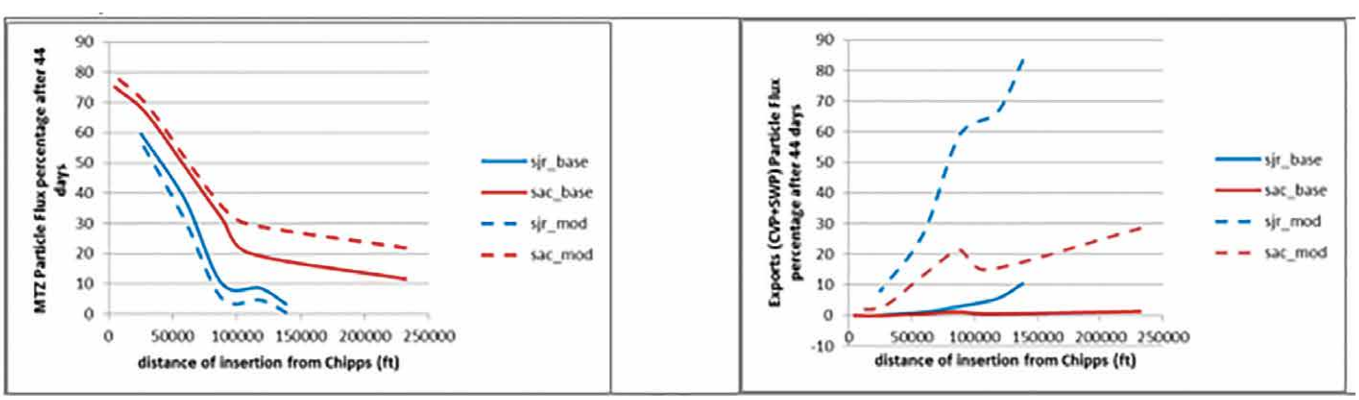


Figure 7 Particles passing Martinez for scenario 'base' and 'mod' after 44 days

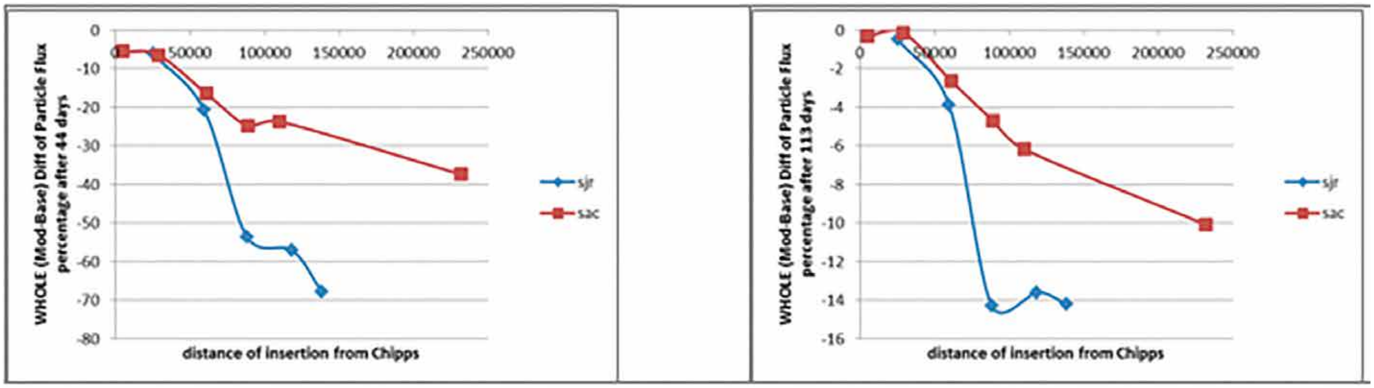


Figure 8 Difference of particles staying in the Delta between scenario 'base' and 'mod' after 44 days and 113 days

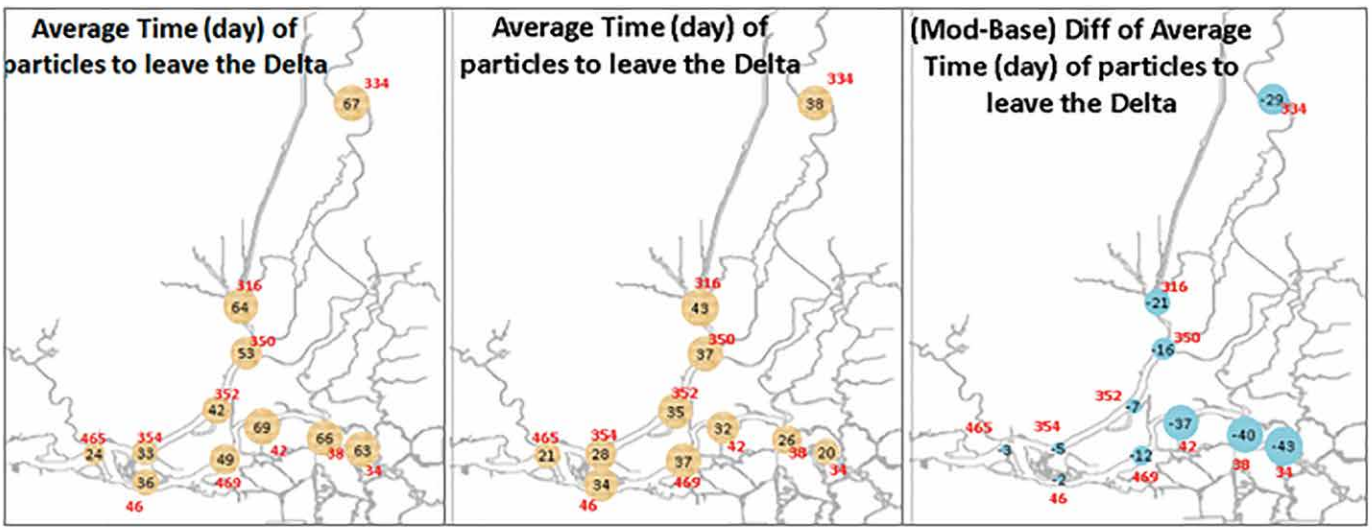


Figure 9 Residence time of scenarios 'base', 'mod', and their differences

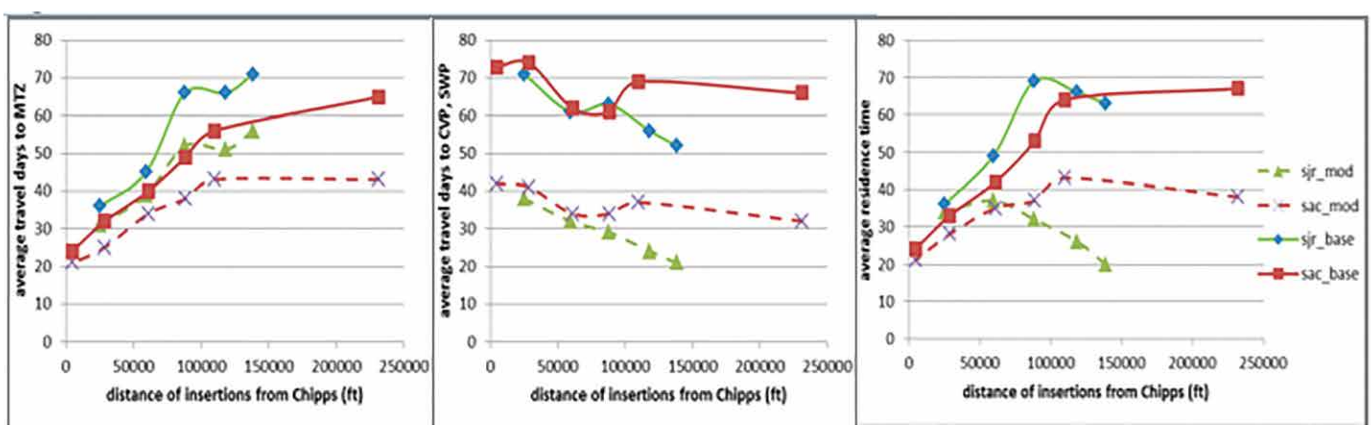


Figure 10 Average travel time to Martinez, exports, and out of Delta

Summary

In summary, this study consisted of the modeling of two scenarios, one with drought conditions of forecasted low flows and one with storm conditions of high flows and its higher derived exports. It is obvious that the latter scenario has higher Sacramento flows and Old and Middle River flows, with a little bit lower San Joaquin River flows for the first 44 simulation days.

Usually insertions farther inland from the ocean have less particles passing Martinez and more particles entrained at the Central Valley Project and State Water Project exports. These patterns correspond to more particles passing locations in the south Delta with increased travel time to Martinez and decreased travel times to the exports.

Insertions on the Sacramento River usually have more particles passing Martinez and less particles staying in the Delta. Insertions on the San Joaquin River usually have more particles entrained at the State Water Project and Central Valley Project exports, which corresponds to more particles passing locations in south Delta due to their closer proximity to the exports.

Scenario 'mod' with high Sacramento flows and high exports could be viewed as adversely affecting particle flux destinations in the Delta. It decreases particles passing Martinez and increases particles entrained in exports. On the other hand, scenario 'mod' facilitates the movement of particles out of the Delta, which corresponds to shorter travel time to Martinez, exports, and out of the Delta. Usually both patterns increase as insertion locations move upstream.

Insertions on the San Joaquin River are more affected by the higher exports. Insertions on Sacramento River are more affected by high flow inflow conditions.

The influence of the exports is delayed compared to the higher Sacramento inflows due to the storm, e.g. scenario 'mod' has 3-10% more particles passing Martinez at the end of 44 days, though it turns to be 3-16% less at the end of 113 days.

Some locations, like upstream of the Delta Cross Channel on Sacramento River, or upstream of Threemile Slough on San Joaquin River require more detailed investigation, since their neighbor channel networks are complicated.

DSM2 Delta Modeling in Support of Drought Planning Activities

Bob Suits, Senior Engineer WR, DWR and Tara Smith, Supervising Engineer WR, DWR

In response to increasing concerns about a possible severe drought developing in California this past year, the installation of emergency rock barriers to prevent salinity intrusion at Delta exports was studied. Delta modeling was conducted to assess:

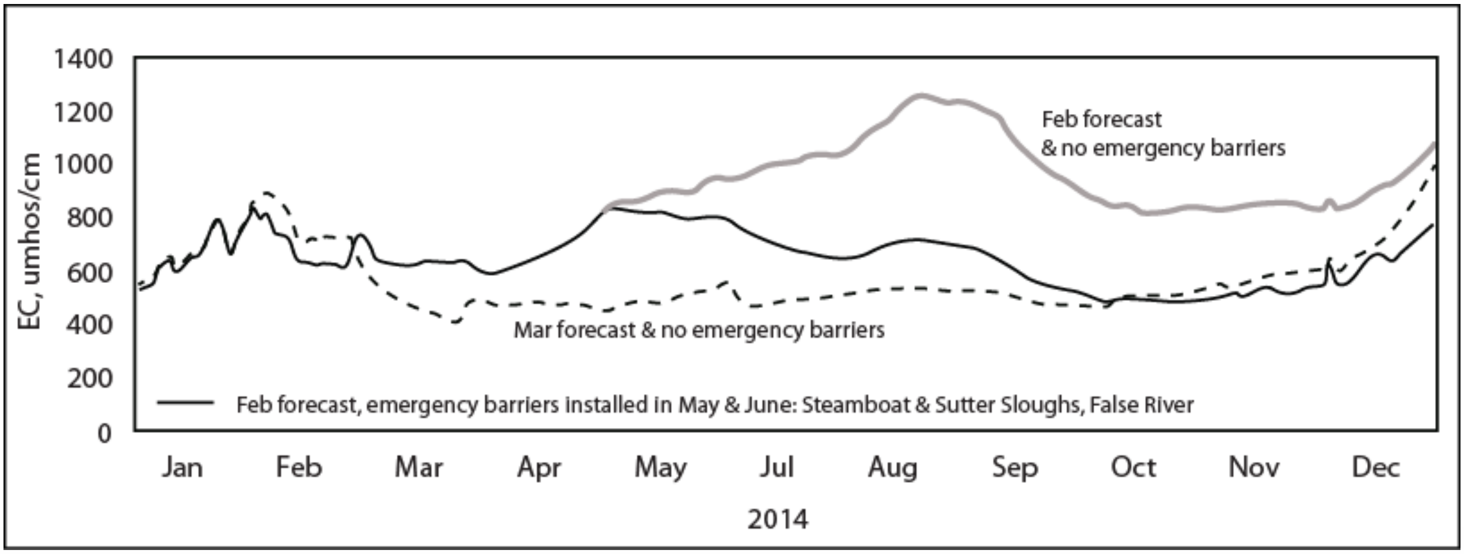
- The drought's possible impact on water quality in the Delta, given various drought forecast scenarios.
- Water quality benefits from installing rock barriers to reduce salinity intrusion and to meet D-1641 water quality objectives.
- Emergency barriers' possible local impacts on water level, flow and velocity.
- The amount of potential water savings from installing emergency barriers.

Assessment of potential salinity intrusion used historical observed data and results from computer modeling of forecast conditions. Monthly long-term Delta water quality forecasts are routinely generated as part of the MWQI program. Forecast Delta inflows and exports are generated by the Delta Coordinated Operations (DCO) model that DWR's Division of Operation and Maintenance runs to determine allocations to water contractors. Information that is fed into DCO includes hydrology data (development by the Flood Management Division), contractor delivery requests (compiled by State Water Project Analysis Office), and regulatory and court restrictions on exports. The DCO allocation forecasts used for the 2014 drought analysis assumed a 90% hydrology which assumes that only one in ten years would be drier than this particular forecast.

A key issue in the drought forecasts was the forecast of Delta consumptive use through 2014. Knowledge of how Delta agricultural practices might change during prolonged low Delta outflow during the irrigation season is particularly lacking. This is important because Delta-wide net consumptive use differences of 500 to 1000 cfs can dramatically affect simulated Delta salinity intrusion during low outflow events. Thus, several consumptive use scenarios were assumed in generating drought scenarios via the Delta Islands Consumptive Use model, including a "worse case" condition.

Analysis of the impact of installing various combinations of emergency barriers was based on DSM2 simulations of forecast hydrology for with and without barrier conditions. Interpretation of simulated results was aided by comparing forecast salinity with historical Delta salinity during the past droughts of 1976 – 1977 and 1987 – 1991. Some early worse case drought forecasts indicated prolonged, very low Delta outflow which resulted in extreme salinity intrusion. Such forecasts were compared to the historic pre-project droughts during the 1929 – 1934 period in order to assess the reasonableness of these DSM2 simulations.

As 2014 progressed, significant precipitation in the late winter-early springtime moderated the drought forecasts to the point of deferring the installation of emergency barriers. The figure below is a sample of the water quality analysis and shows both how the forecast changed as the year progressed and the kind of improvements to water quality possible due to the installation of three emergency barriers.



February 20th and March 21st Forecasted EC at Clifton Court Forebay

DSM2UG People

Francis in Cairo

FRANCIS CHUNG 20 Things You Don't Know About Me

Francis, a Principal Engineer, and Chief of the Modeling Support Branch of DWR, shares with us 20 tidbits about himself

1 My first name Francis is my catholic baptized name. My first name in Korean, Il Whan, means daily shine.

2 Right after graduating college in Korea I joined the Korean Army and served there for 30 months. It is mandatory to do the military service in Korea. I happened to enjoy this experience and learned quite a bit from it. As an engineering unit lieutenant, I enjoyed the interesting dynamics of young male soldiers. Also as an engineer, I designed and built bridges, bunkers, barracks, and military roads—the type of construction work. Of course, I did not know then that my career in civil engineering would not involve much of design and construction work afterward. So the engineering experience of design and build was unique and fun.

3 I started working at DWR around Christmas in 1980. My first assignment was to develop a simulation model for the SWP and CVP.

4 I like people at DWR. They are nice and professional. I also like the diverse nationality and cultural diversity of DWR people especially within the Modeling Support Branch. Without traveling the world, you get to have a good exposure to various cultures and national traditions in the MSB. For instance, I like our potluck party when I get to taste the great food from all over the world!

5 My favorite assignments/projects are mathematical modeling in general. A model represents a number of real world water problems in a tractable fashion. With luck some solution paths of difficult and complex water problems can be explored. This work can be challenging, and time-consuming, but can also be rewarding, and satisfying.

6 My hobbies include hiking, cross country skiing, going gymnasium, golfing, and partying.

7 I watch TV news, some Korean soap opera, and some comedies. My main goal of watching TV is to get my mind off work. So I don't recall much once I turned off TV. I also prefer watching DVD movies at home. The last DVD that I recall watching was Lincoln.

8 I do quite a bit of reading or at least try to since I enjoy being exposed to different minds and thinking processes. I recall being impressed by certain books like; Guns, Germs, and Steel by Jared Diamond; 1491; World History of Salt; The Swamp; Communist Manifesto by Marx and Engel; recently read three books on Mao; books on theology and science; a lot of books on world rivers and water resources.

9 I like listening classical music and watching musicals. One of my favorite musicals is 'Phantom of Opera,' which I replayed a few times.

10 I like dogs and always have one except at the moment. My last dog was Bok-Jol, a Korean pure bred.

11 My favorite exercise is golf, if it can be qualified as an exercise. I played golf for about 30 years. I try to play at least once a week these days. I like a number of things about golfing:

- It is a good exercise in a nice ambience; outdoors, greeneries, varying and beautiful surroundings like mountains, hills, and rolling mounds, trees in a distance, water, and clean air.
- The game requires focus and naturally helps me forget all other thoughts while at play.
- I get to spend quality time with loved ones like my wife, family members, and good friends.
- I like meeting strangers and talk about stuff in life. I discover that people tend to loosen up with strangers perhaps thinking that their secrets are safe.
- It is a challenging game and humbles many. I learn to be patient and not to declare victory too soon.
- There is always the next chance; there is a next hole and if you are on the last hole—18th, there is a next game.

12 I don't have a favorite number. I like all numbers. I think my career is built on numbers; building, slicing, or mixing them.

13 The best gift I have ever received is a Kindle White from my son.

14 My ideal vacation would be at some mild weather place with some nice hiking courses, good golf courses, and clean environment. Good company certainly adds to the pleasure.

15 My favorite trip was my visit to Cairo for watching different people and visiting big structures like pyramids.

16 I have been living in Carmichael and like the area and neighbors.

17 The most important person in my life is my father.

18 I met my wife through my older sister. She set us up for a blind date.

19 I have two sons. One is a high school teacher and the other is a lawyer.

20 If I could make one wish, that would be for Otto Jae-Man Chung, my first grandson. He is due for delivery on August 25, 2014. I hope and pray that the kid comes to this world safely and on time. (He did arrive safely at the end of August.)

Bangalore, 2013

SUJOY ROY the Real McCoy

Min Yu, Senior Engineer WR, DWR

While Dr. Sujoy Roy, a Principal Engineer at Tetra Tech Inc., is a relative newcomer to the DSM2 User Group, he is by no means a greenhorn among DSM2 users. In fact, Sujoy is very familiar with the model and his group has been using DSM2 while working on a very interesting and highly-visible project the past few years.

Sujoy originally comes from New Delhi, India. He graduated with a Bachelor of Technology degree in Civil Engineering from the Indian Institute of Technology in 1990. That same year he came to Carnegie Mellon University in Pittsburgh to pursue his Master's Degree in Civil and Environmental Engineering. His focus was water quality and water resources computer modeling. After receiving his degree in 1992, Sujoy continued in graduate program at the same university, receiving his Ph.D. Degree in 1995.

In 1996, Sujoy joined Tetra Tech Inc. In the last 18 years, he has worked on a variety of water resources and environmental projects at different levels in establishing his expertise among the California modeling community.

Sujoy's current position at Tetra Tech is Director of the R&D Department. He has been developing, overseeing, and managing large scale water resources projects with a team of three engineers and staff across different offices. These projects are all dear to his heart and he speaks about them with great passion—go ahead and ask him about them and you'll see for yourself. One project that Sujoy has been working on for the last five years is a TMDL project led by the San Francisco Bay Regional Board that addresses selenium toxicity in North San Francisco Bay. Sujoy and his team have developed a numerical model using ECoS, an estuary chemistry model, to use DSM2 QUAL output as the input to simulate the fate, transport and biological uptake of selenium in the bay. Another recent project that Sujoy has greatly enjoyed is leading the effort to assess salinity trends in the Delta using data over the past nine decades. The project was contracted by Metropolitan Water District (MWD). Sujoy had the opportunity to work closely with Dr. Paul Hutton, a Principal Engineer at MWD and a long-time participant and strong supporter of the DSM2 User Group. While the project was demanding because of the high importance of the analysis and the logistics of generating a very large database, Sujoy admitted that the experience was nevertheless very rewarding. After all, the final product was critically important to California water community. Sujoy humbly credits Paul's clear vision on the project's direction for the success of this undertaking.

Sujoy with his family, Mt Cotopaxi, Ecuador, 2013

Ecuador 2013

In addition to a successful career at Tetra Tech, Sujoy has served on a couple of National Science Academy panels and on the Science Advisory Board of the U.S. Environmental Protection Agency. In his spare time, Sujoy enjoys home life in Walnut Creek. His wife majored in Finance and is a Risk Analyst at a bank. They have two boys, ages eight and eleven. The family loves to travel, making several trips back home to India, but also exploring exotic places including the Ecuadorian Amazon. Besides coaching his son's soccer teams, Sujoy is fascinated with history, leading him to study human evolution and all things related to World War II. In our phone interview, Sujoy told me he always strives to learn new things, both professionally and personally. He appreciates those projects that require synthesizing information across different fields. While his work can be challenging, the possibility of learning something new always motivates him. While the next two destinations on his family's travel itinerary are Peru and Germany, Sujoy is looking forward to tackling his next project coming on the horizon—Salton Sea and renewable energy. Yep, he is the real McCoy.

Passion Rewarded with Success Jamie Anderson's Story

Min Yu, Senior Engineer WR, DWR

I have known Jamie for more than ten years. When she joined the Delta Modeling Section (DMS) in 2000, I worked next to her in the South Delta Improvements Program. My first impression of Jamie could be simply summed up in one word: WOW! Here was a petite young lady with a pony tail, who looked just like someone right out of college with her diploma still warm right off the printer, and yet she was already a seasoned modeler with an impressive resume. Jamie had earned her Ph.D. in Civil Engineering from UC Davis, and completed some of her post-doctoral work under her adviser Dr. Gerald Orlob, one of the most renowned professors at UC Davis. She was cheerful, bubbly, warm, sweet, and accomplished. I knew instantly that this Jamie 'girl' would be one of the DMS's shining stars. Well, ten plus years later, Jamie is still the same person (sans the pony tail though), but she has mingled her passions for teaching, writing and engineering in her career and given all new dimensions to the DSM2 modeling world.

Jamie was born and raised in Colorado. Her childhood dream was to become a teacher, a Spanish teacher to be specific, or an author. But then during high school she attended a weekend engineering camp at the University of Colorado-Boulder and thought that putting buildings on springs to protect them from earthquakes would be a cool thing to do. So she decided to major in Civil Engineering at Colorado State University where they had a technical exchange program to Mexico to combine her interest in engineering and Spanish. However when Jamie took a structures class, she decided it wasn't as fun as she had originally thought. Luckily for us, that semester she had a great hydraulics class that planted a seed in Jamie's heart that blossomed into a lifelong passion for water resources engineering. After obtaining her BS degree, Jamie spent 3 months on a technical exchange program in Argentina before arriving in Davis California, and spent the next nine and half years there pursuing her Master's and then Ph.D. in Civil Engineering.

selfie: Jamie, Nick (10), Emily (7) and Mike selfie 2014

Now Jamie, an overachiever by her own admission, couldn't have just settled for one major. During her graduate studies, not only did Jamie take a whole slew of Spanish classes for fulfilling her childhood dream (her favorite class at UCD was Latin American Film), she also minored in Ecology and Environmental Science in continually expanding her horizons. In addition to her studies, she was a Research Assistant and participated in the UCD Ecotoxicology Graduate Group and the Center for Ecological Health Research. Jamie is a true planner by heart and trade and the most organized person I have ever met. While Jamie achieved excellence in every class and each project she undertook, she even timed the completion of her dissertation in December 1999, right before the new Millennium hit.

A year later, Jamie was part of the Delta Modeling Section family. When I asked her why she chose DWR, her answer reminded me of the popular adage 'behind every success man is a woman.' Jamie's career decisions involved her husband Mike Anderson (as a little tidbit, Jamie's maiden name is also Anderson). Mike, who is currently the State Climatologist and works for DWR's Flood Management, was looking for a faculty position at that time. With that uncertainty factored in her planning 'equation', Jamie was looking for a temporary part time engineer position in the Sacramento area until their long term plan became clearer. It must have been fate or some incredible coincidence, because when Jamie began attended Interagency Ecological Program Particle Tracking Workgroup meetings for her doctoral work on a particle tracking model of juvenile chinook salmon, she crossed paths with Tara Smith (Chief of the Delta Modeling Section), who was a Senior Engineer back then. Tara Smith was also a former student of Dr. Orlob's, and he had been encouraging Jamie to meet Tara since he was sure that they would get along (and he was right). One thing led to another and by October 2000 Jamie was on board working on her first DSM2-related assignment as a part-time Water Resources Engineer. As it turned out, the Delta Modeling Section was a perfect fit for Jamie, and a few years later she encouraged her husband Mike to join the department as well.

Jamie's first assignment for Delta modeling put her writing and teaching skills to work on developing the DSM2 Tutorial (http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/models/dsm2v6/dsm2tutorialv122502.pdf). The tutorial is one of the most downloaded documents on the DMS website and was literally my DSM2 'Bible' in the old days for learning how to run studies. Jamie envisioned that there would be Volume 2 and 3 for the tutorial series; however, she was then assigned to work on the South Delta Interim Program studies for the next few years.

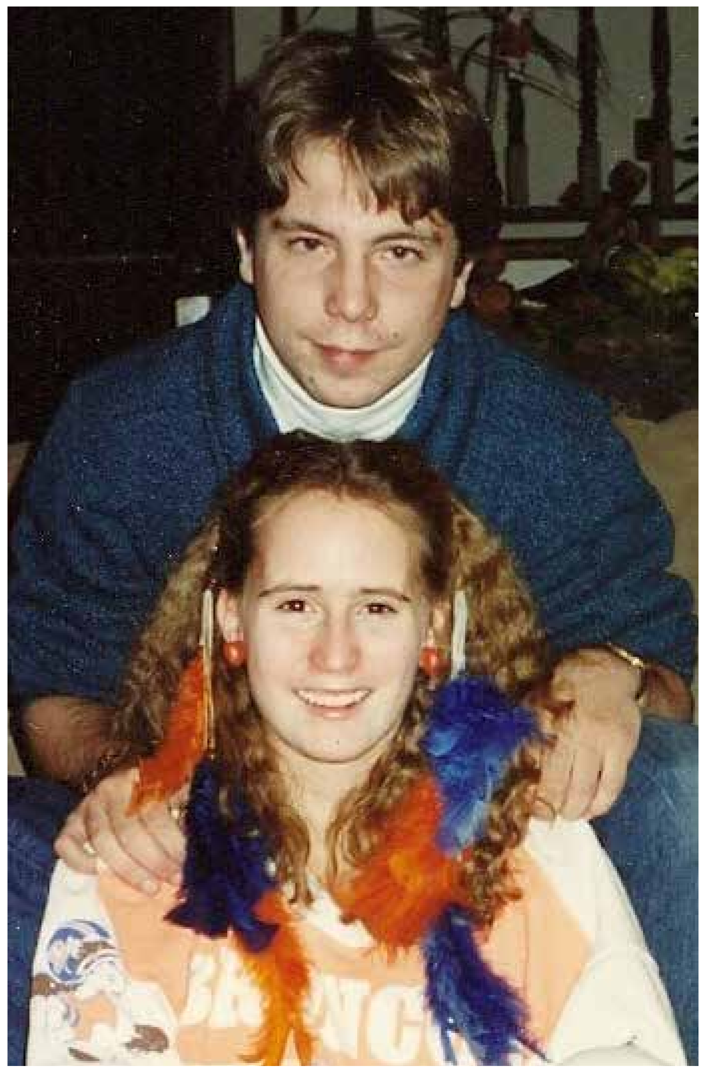
In 2005, Jamie was chosen to lead the Climate Change Work Team, a joint effort between DWR and US Reclamation Board, to respond to Governor Arnold Schwarzenegger's Executive Order on reducing greenhouse gas emissions. Jamie coordinated and collaborated with more than twenty engineers and scientists from different State and federal agencies and other public entities to provide decision makers updates on potential impacts and risks of climate changes. The team also produced a technical memorandum report in 2006 to describe progress made on incorporating climate change into existing water resources planning and management. The report was a

Jamie with her friend's horses Mac and Jake 2013 huge success. In addition to be well-received by the California water community, the report drew international attention as a landmark publication for its qualitative and quantitative information on climate change's potential effects and threats to California's water resources. Since then, Jamie has been serving as a liaison between DWR's Climate Change Technical Advisory Group and our Modeling Support Branch helping to develop appropriate modeling scenarios and coordinate climate change studies. She also serves as an instructor for a class called Climate Change Literacy 101 at the DWR training center. For Jamie, this is a perfect blend of her passions: engineering, writing, and teaching.

Jamie's biggest professional challenge came in 2011 when she served as DWR's technical representative on the Jones Tract levee failure trail. In addition to conducting modeling studies, collecting field data and testifying as an expert witness in hydrodynamics, Jamie attended the entire trial as the technical assistant to the State's attorney. Jamie continues to embrace projects that stretch outside her comfort zone by working on a project to extend DSM2 to include sediment transport and mercury cycling.

As Jamie triumphs in all aspects of her career, her dedication to her work hasn't slowed down her personal life. Jamie and Mike Anderson live in Davis and they are proud parents of two beautiful and brilliant children, a 10 year old boy and a 7 year old girl. Their children are in essence like Mike and Jamie, sharing strong traits in problem solving and leadership. Jamie has been working part-time so that she can be more involved in her children's lives. She has been volunteering ever since her kids started school, helping with learning stations, serving as a Garden Parent for the last three years, and even becoming a Girl Scout Troop Leader last year. Although a group of 7 year old Girl Scouts can be an energetic handful, Jamie appreciates the opportunity of being with her daughter and her daughter's friends, and teaching them vital skills for life and helping them to give back to the community.

In her free time, Jamie enjoys horseback riding, making jewelry and traveling. Jamie has visited 14 countries and looks forward to continuing to explore the world with her family. Besides being an avid Denver Broncos fan and often has orange and blue finger nails during football season, Jamie plays fantasy football including two leagues with folks from DWR. She is also proud of a recent personal triumph, learning how to swim. Yes, she was a water resources engineer who was afraid of the water. In looking to the future, Jamie looks forward to continuing to develop her skills in both real water and virtually modeled water.



Jamie and Mike early 90's: Jamie (wearing her Denver Broncos shirt and feathers) and Mike in the early 90s before they were married

Ask a Modeler

If you have the questions, we have the answers!

Q: I just installed the new version of DSM2 (V8.1.2) and will be re-running some historical simulations. Can you tell me what the most recent year is that can be simulated now and are those input files included with the V8.1.2 download or do I need to get them from you?

(Scott Evans, Electronics Technician, USGS)

A: The input data for DSM2 historical simulations has been updated to March 2013, but it is still under review for QA/QC. The most recent year for historical simulations is till March 2012. And yes, the input files are included with the V8.1.2 downloads.

Answer provided by Lan Liang, Engineer WR, DWR

Q: I'm running v8.1.2, which comes with input files for historical simulations between 1990 and 2012. Are there input files available to run a historical simulation back to 1980?

(Doug Jackson, Computational Ecologist, NOAA)

A: Yes, we have done some pre-1990 historical simulations, and the input files are available. The output results are preliminary and will require further QA/QC for an official release. Please contact Min Yu (Min.Yu@water.ca.gov) for more details.

Answer provided by Yu Zhou, Engineer WR, DWR

Q: Is there a new version of DSM2_Grid2.0.pdf available? From the *.hof file, it appears that some of the internal->external node mappings have changed (e.g., internal node 295 now maps to external node 330 instead of 331), so I assume that either the internal node locations have changed or the external node locations have changed – and in the latter case the grid PDF that comes with v8.1.2, which has a date of August 2002, would no longer apply.

(Doug Jackson, Computational Ecologist, NOAA)

A: We have a GIS version that supersedes the pdf file (which was from an AutoCAD version and not accurate for GIS purposes). Please contact Jane Schafer-Kramer (Jane.Schafer-Kramer@water.ca.gov) for a version for the 2009 calibration version. We have not changed the GIS locations for the nodes for this version.

Answer provided by Nicky Sandhu, Senior Engineer WR, DWR

Q: I'm starting a series of planning DSM2 runs, and there appears to be a missing time series for planning run NAVD stage in the time series directory.

Using study template run "BST_2005A01A_Existing_Daily", I found the time series I believe I need:
"/FILL+CHAN/RSAC054/STAGE/01MAY1987/15MIN/PLANNING-2-SL_NAVD/"
in this subdirectory:

C:\delta\dsm2_v8\study_templates\BST_2005A01A_Existing_Daily\timeseries\Orig

but I expect that time series should be located in a DSS file in here:
C:\delta\dsm2_v8\timeseries

AND, that the preprocessor (prepro_BST_Existing.bat) run should be selecting it because the HYDRO input file "hydro_BST_Existing.inp" is specifying the NAVD grid.
(Marianne Guerin, Associate, RMA)

A: The details were described in the release note under \documentation\ folder. User would need to manually create a NAVD88 series by adding 2.68 ft to the Martinez stage. This is due to the fact that the preprocessing still uses data based on the old NGVD29 datum. We haven't made changes to the scripts to automate this process yet.
Answer provided by Lianwu Liu, Engineer WR, DWR

Q: Could you please provide me a copy of the DSM2 boundary conditions corrected for day light savings?
(Chandra Chilmakuri, Water Resources Engineer, CH2M HILL)

A: Yes, the DSS file is available for downloads at the DSM2UG Portal https://dsm2ug.water.ca.gov/library/-/document_library/view/183510.
Answer provided by Min Yu, Senior Engineer WR, DWR

Delta Modeling Section Alumni: **Where Are They Now?**

Min Yu, Senior Engineer WR, DWR

Have you ever wondered what happened to your favorite former DSM2 modelers who left the Delta Modeling Section (DMS) in the past years?

In honor of the 10th Anniversary of the DSM2 User Group, we have checked in to see what some of the DMS alumni have been up to over the past decade.

GEORGE BARNES

Former Chief of the Modeling Support Branch, DWR

"For those who haven't been around too long, I retired in year 2000. I have had a great retirement. My wife and I have traveled to Europe several times. I was golfing twice a week and bowling twice a week until I broke my leg in 2007. My leg healed just fine but since then I have just been bowling three times a week because the golf was getting too hard on my back. I have been enjoying getting together with family and friends (I have two daughters and three grandsons). I joined SIRS(Sons in Retirement) and the Corvette Club and we keep very busy. I have had a number of health issues but I work out a lot, keep active and enjoy life. My biggest contribution to modeling was probably initiating and directing the development of DWRSIM (I had a lot of help from folks like Price Schreiner, Francis Chung, Sushil Aurora, and Dwight Russell just to name a few). DWRSIM of course was the predecessor to CALSIM. I have many fond memories of directing the activities of the Modeling Support Branch and enjoyed the privilege of working with so many talented and hardworking engineers. Best Wishes to all of you."

Christmas 2013

NIRMALA BENIN (NEE MAHADEVAN)

Senior Engineer, DWR
Water Use Efficiency Branch, DWR

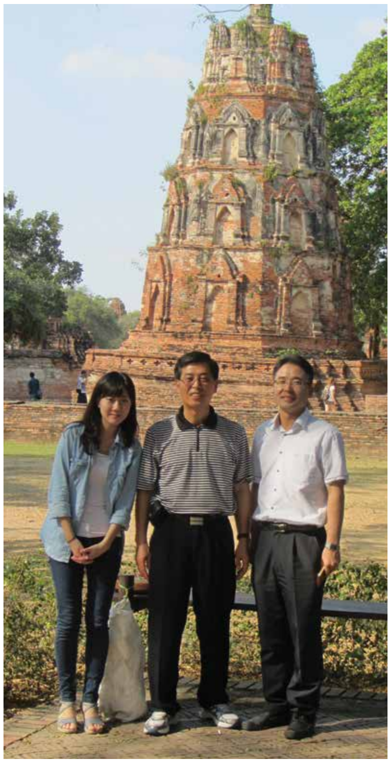
With a friend in Florida. 2010

"I started working as a UCD student assistant with the Delta Modeling Section in 1989. The Section, at that time was led by Francis Chung and I worked directly under Kamyar Guivetchi. I stayed there till 1996 when I decided to get more experience since I only had a BS in Civil Engineering and I wasn't ready to become a lifetime modeler!

After the Delta Modeling Section, I worked at the DWR Joint Operations Center, a private engineering firm (Larry Walker Associates) where I worked on a variety of environmental engineering issues primarily stormwater management, the Drinking Water Program at California Department of Public Health (now under SWRCB) where I regulated drinking water systems and funded and managed projects, a large water system in Maryland (Washington Suburban Sanitary Commission) where I modeled water system hydraulics and managed infrastructure improvement projects, and now I have come back full circle to DWR at the Water Use Efficiency Branch for which Kamyar is the Division Chief.

Looking back to my beginnings, I know now how lucky I was to have worked in Delta Modeling, such a dynamic, supportive group at the time, with managers that were genuinely interested in developing a young engineer. Having coworkers who were well respected by academia was also a privilege. I am so proud that those coworkers have moved on up the ladder within and outside DWR and are more broadly well respected.

Thanks Delta Modeling and especially Francis and Kamyar who hired me! I am a much better engineer because I was molded by you."



Francis in Cairo

FRANCIS CHUNG

Principal Engineer WR, DWR
Chief, Modeling Support Branch, Bay-Delta Office
(Former Chief of the Delta Modeling Section)

"I cannot say that I am not an alumnus of the Delta Modeling Section since I left the Section technically. Neither can I say that I am an alumnus since the Section is an active part of my operation as of today. With that back drop, here I am, sitting not too far from the Section physically, thinking about how best we can invest or divest in our future development of models so that we continue to be relevant, useful, and adding value to the modeling community specific and the water management body in general. I am musing on the current major water issues such as the BDCP, drought management, drought hydraulic barriers, emergency water transfers, real time Delta salt controls, groundwater overdraft, real time inflow forecast, or potential 2015 drought managements AND ways for us modelers to help explore solution paths."

PAUL HUTTON

Principal Engineer, MWD
(Former Chief of the Delta Modeling Section)

"I joined the Delta Modeling Section in 1990 as my first assignment with DWR. The Section, at that time led by Francis, included familiar names such as Tara, Bob, Ralph, Parviz, Kamyar Guivetchi, and Chris Enright. Coming from a background in water and wastewater treatment, these years were instrumental in developing my future career in California water resources management and modeling. In addition to conducting simulations with an enhanced version of the Fischer Delta Model (which we later named the Delta Simulation Model), I provided modeling support for the Municipal Water Quality Investigations (MWQI) program. With guidance from Francis and Jay Lund, I wrote a Ph.D. dissertation based on this work. After several wonderful years with the Section, I proceeded to move around the Department, working for Sushil Arora (in the Hydrology and Operations Section), Jeanine Jones (Bulletin 160-98), and Mark Cowin (CALFED). When Francis was promoted to Principal Engineer in 2000, I jumped at the opportunity to return to work with him and serve as the Delta Modeling Section chief. After an all-too-brief stint, I left DWR in 2002 to work at the Metropolitan Water District in its Sacramento office, where I continue to be active in SWP and Delta operations, Delta water quality and hydrodynamics, and modeling as a Principal Engineer. Although I have been gone for 12 years, I continue to maintain close ties with the Section and take pride in its ongoing accomplishments."

Paul with wife Juliet and his father-in-law Tom in Vacaville 2014

YIGUO LIANG

Senior Engineer WR, DWR,
Chief, Hydraulic Analysis Section, Division of Flood Management

"Since I left in March 2008 from the Delta Modeling Section, I have been working in Division of Flood Management for a program called Central Valley Floodplain Evaluation and Delineation program, which started in early 2008 and is now coming to an end. Topographic data (land and stream), hydraulic models, and floodplain evaluations for the Central Valley are the major products from this program. Ever since I left DMS, I have been doing one thing almost daily that is related to DMS – the tatty mug print can prove it."

Yiguo's favorite DMS tea cup

MICHAEL MIERZWA

Principal Engineer WR, DWR
Chief, Central Valley Flood Planning Office

"Delta Simulation Model 2 Reflections—Today I am the Office Chief of the Central Valley Flood Planning Office, a recent transition from leading the FloodSAFE Program Management Office with CDWR's Division of Flood Management. As the state's lead flood management planner I am looking forward to guiding the development of new tools and approaches that will demonstrate the value to California and the nation associated with investing in flood management actions both in the Central Valley and statewide.

Over the past ten years I have worn a variety of hats (and no, not just baseball caps, though my collection of MiLB caps is as extensive as my list of former projects and titles), including planning and designing large-scale water resources systems; supporting and conducting real-time emergency operations; communicating and coordinating water management issues with a wide-range of audiences; planning program-level finance, budget, and resource needs; formulating and reviewing water management legislation and policy; reporting on program and project-level accomplishments; working with the media; facilitating policy and technical meetings and panels; and continuing to design and lead technical studies.

This September I will be part of the U.S. delegation at the International Commission on Irrigation and Drainage meeting in Korea (my fourth time representing the nation's flood management policies at an international venue). When reflecting on these conferences, I still can remember my first professional presentation in Feburary 2000 in which the California Water and Environmental Modeling Forum (then Bay-Delta Modeling Forum) sponsored a dueling model workshop covering the Nov. 1999 Delta salinity intrusion event. I was extremely nervous and mistakenly referred to an astronomical tide as an astrological tide (about a dozen times).

continued...

Michael in River Cats gear and in front of Devil's Tower Wyoming (amazingly without his sunglasses)

And while I have always embraced new ideas and welcomed (if not advocated for) fast paced change, my experiences using the Delta Simulation Model (2) to inform decisions (as opposed to inspiring more questions) really are as much about the fun of finding new ways to use the model to calculate residence time or source water fingerprints as they were around finding ways to actually share the work of others with decision making groups. My most memorable experiences really are centered around the "Methodologies for Estimating Flow and Salinity in the Sacramento-San Joaquin Delta" annual report series. I was the lead editor / project manager for the report series during my seven year tenure in Bay-Delta Office (1999 – 2006). I appreciated that by having to understand each new model development, study approach, or investigation described in the report that I would in effect share nearly the same knowledge as each chapter author.

I think the greatest challenge that we have as scientists and engineers is finding a method to communicate the knowledge we have in a way that others will actually benefit from our knowledge. Annual reports, technical presentations, code documentation (I hope you are still doing this, I certainly demand it of my team members), and users groups are some of the principle methods we can employ to work smarter together."

AARON MILLER

Senior Engineer WR, DWR
Chief, Delta Export Management Section, Division of Operations and Maintenance

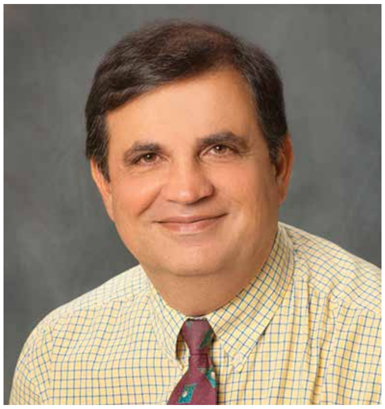
"My first job out of college was in the Delta Modeling Section. I was hired by Tara, Parviz and Hari in November 1998 in what was called the Office of SWP Planning. I have many fond memories working with the many talented people in the Modeling Support Branch. After working in the Delta Modeling Section for about 4 ½ years and experiencing enough of those fond moments, I decided to experience more of DWR. I spent about 1 ½ years in the Division of Environmental Services, Suisun Marsh Planning, working mainly on tidal marsh restoration with the RMA2 and RMA11 models. I spent about 1 ¾ years in the Division of Flood Management, Hydrology Branch where I forecasted river stages during the 2006 floods. In June 2006 I moved to Operations and Maintenance in the Water Management Branch. I initially worked as a Senior Specialist analyzing the impacts to SWP deliveries from various ESA requirements and other proposed projects. Recently I became the Senior Engineer overseeing the Delta Export Management Section, where our primary responsibility is to determine the daily SWP export from the Delta. The experience I gained while in the Delta Modeling Section is REALLY coming in handy these days."


Aaron fly fishing in the Chilean Patagonia, 2013

PARVIZ NADER-TEHRANII

Supervising Engineer WR, DWR
Chief, Delta Water Rights Technical Support Section, Bay-Delta Office

'You know it appears that I never left the Delta Modeling Section. I still work on the same floor. I still work with the same people. I still deal with DSM2. So much for the move! But honestly, I am not complaining. Officially, I deal with a lot of the different modeling that has been (or will be) done in support of BDCP. This includes CALSIM II, DSM2, and a lot of other models. I am also the DWR coordinator for a lot of the activities related to SWRCB. The Board is in the process of updating the Water Quality Control Plan. So my job is to tap into the expertise of our brilliant DWR staff to make sure our voices are heard."



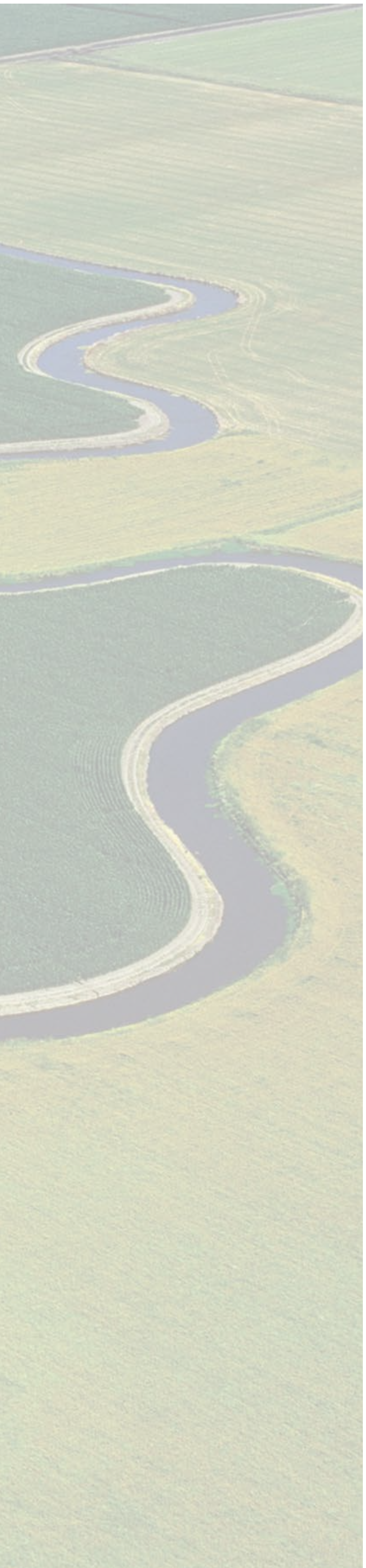
DWR 25-Year Anniversary

THOMAS PATE

Principal Engineer, SCWA,
Director of Engineering Operations and Maintenance

"When I was graduating from Humboldt State University as Environmental Resources Engineer there were two aspects of my education that I wanted to exercise in my career: 1) water resources numerical modeling development, and 2) fisheries engineering. My first DWR assignment was in the Delta Modeling Section under Francis, Sanjaya, Tara, and Paul Hutton. Working in the Delta Modeling Section was my first truly professional experience! My exclusive accomplishment was to extend the DSM2 boundary up the San Joaquin River from Vernalis to the Merced River confluence. After 2 years with the Bay Delta Office I transferred to the Division of Planning and Local Assistance in the Fish Passage Improvement Program. I spent 2 years evaluating fish barriers on Delta tributaries and implementing solution to improve fish migration routes. DWR provided the opportunity to accomplish my primary career goals early on. An opportunity came along with the Solano County Water Agency to combine all my educational skills, work close to home, and serve my local community. My DWR experience and specialized skill set were critical elements in being selected for the position. I have been with the Agency for over 11 years now serving as the Director of Engineering, Operations and Maintenance and Principal Engineer. As a State Water Contractor I still get to work cooperatively with my DWR colleagues from relationships developed during my tenure there."

"The sea is my mistress, the outdoors is my home."
Thomas Pate, 2014



MOHAMMAD RAYEJ

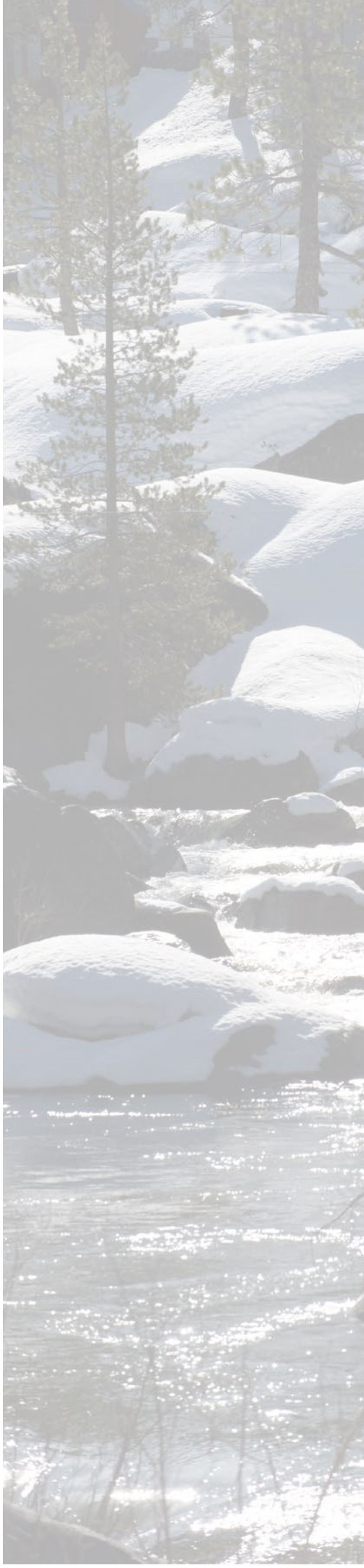
Senior Engineer WR, Division of Statewide Integrated Water Management, DWR

"Below is a summary and update of where I have been and will be ..!!

- Started with DWR (Delta Modeling) in 1988;
- Major job responsibility; DSM1 source code checking/testing/developments/enhancements;
- DSM1 application/model studies of South Delta Barriers, Suisun Marsh planning, CALFED studies;
- In charge of search for new robust hydrodynamic engine for Delta; selected USGS "4-Point implicit" hydrodynamic model; new HYDRO in DSM2;
- Initial checking/testing/application of HYDRO capabilities to Sacramento-San Joaquin Delta;
- Left Delta Modeling in 1998;
- Worked in SWPAO for one year;
- Joined California Water Plan (CWP) in 1999 as Senior Engineer;
- Major job duties in CWP (current); development of WEAP supply/demand model under future population growth, urban development, future Ag land, and climate change scenarios in California;
- Organized WEAP workshop/classes in DWR, UC Davis, CSUS (class projects);
- Collaborated and co-authored with WEAP consultants on a Paper "WEAP: A Climate Driven Model for Sacramento Basin", which won the 2009 ASCE "Best-Practice Oriented" award;
- Travel to IRAN (2011) to conduct/present WEAP Workshops;
- Travel to China conferences (Shenzhen2012, Beijing 2013) to present WEAP applications in California;
- Part-Time Faculty at Sac State (CSUS), Dept. of Civil Engineering, teaching UG/G classes in Hydraulics/Hydrology;

Future plans: Retirement… but probably will keep teaching… some consulting… travel…!!"

Mohammad (left) at a conference in China, 2013



SANJAYA SENEVIRATNE

Senior Engineer WR, Bay-Delta Office, DWR

"I am so old I cannot remember (when I left DMS). Since I continue to run DSM2 on an almost daily basis, I never really left."

BIJAYA SHRESTHA

Senior Engineer WR, Bay-Delta Office, DWR

"After I left the DSM2 modeling group, I joined the Delta Conveyance Branch, Bay-Delta Office as a Senior Engineer, Water Resources and worked on the Franks Tract Project. I led the modeling and technical study needs for the project EIS/EIR and the feasibility design documents. Currently, as the project manager, I am managing the Clifton Court Forebay Fishing Facility Project. My main responsibility is to lead, oversee and coordinate activities within DWR and outside agencies to complete planning and design, obtain regulatory construction permits, and complete construction of the project."

Santa Barbara, 2014

SHENGJUN WU

Senior Engineer WR, Division of Statewide Integrated Water Management, DWR

"After leaving Modeling Support Branch in Feb 2008, I transferred to Conjunctive Water Management Branch of DPLA then (now DIRWM) as Engineer, WR. There I worked as DWR project manager for the projects funded through DWR grants. I also worked as the Subject Matter Expert writing Conjunctive Management & Groundwater (Chapter 8) of 2009 Water Plan Volume II (Resources Management Strategy). Nine months later I was promoted to Senior Engineer, WR in Surface Storage Investigation Branch of DPLA (now DSIWM). For the last 5 years I have been working on System Reoperation study. I have been involved on project initialization and performing system reoperation studies using CalSim/CalLite. After August 2014 I will start my new job as Senior Hydroelectric Power Utility Engineer at Power Planning Branch of SWP Power and Risk Office. There I will perform complex engineering work related to hydropower and SWP operations studies, and hydraulic, hydropower, and financial modeling activities."

Washington DC, 2013

DSM2 DELTA SIMULATION MODEL 2 USER GROUP