RECLAMATION *Managing Water in the West*

Real-time Forecasting of Salt Assimilative Capacity in the San Joaquin River

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ABSTRACT

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

INTRODUCTION

Agricultural and wetland return flows, mostly from the west-side of the San Joaquin Basin, introduce salinity to the San Joaquin River that occasionally exceeds the river's assimilative capacity, measured as a 30-day running average electrical conductivity (EC) objective at the Vernalis compliance monitoring station multiplied by the daily mean river flow. The River's assimilative capacity for salt loads is significantly greater than the salt load allocations prescribed in the Total Maximum Daily Load (TMDL) published by the Central Valley Regional Water Quality Control Board in 2002. Hence the Board wrote into the Basin Plan for Water Quality a provision that allowed stakeholders to utilize more of the River's salt assimilative capacity if they could implement and operate a real-time salinity management program. This program would, for the first time, engage stakeholders on both east and west-sides of the San Joaquin Basin and induce them to improve scheduling of west-side salt loads with periods of high salt assimilative capacity, mostly generated by Sierran water released from east-side reservoirs on the major San Joaquin River tributaries. This coordination would be catalyzed through the creation and dissemination of real-time salinity forecasts among Basin stakeholders discharging to the San Joaquin River.

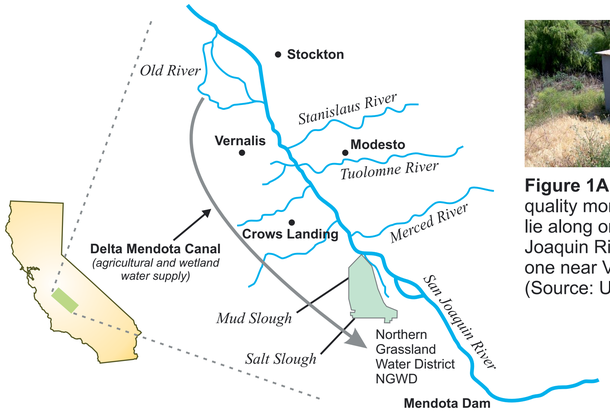

Figure 1. San Joaquin River Basin

Figure 1A. Many water quality monitoring stations lie along or near the San Joaquin River, such as this one near Vernalis, CA. (Source: USGS)

Reclamation and the HEADS group at Lawrence Berkeley National Laboratory in collaboration with program developer Systech Water Resources and data visualization experts 34-North are developing a decision support system for salt load management centered around the Watershed Analysis Risk Management Framework (WARMF) model of the San Joaquin Basin – WARMF-SJR - a comprehensive water quality forecasting model designed to simulate and predict river flow, salinity concentrations and salt loading. The new data and output visualization initiative is known as WARMF-Online. The predecessor to WARMF-SJR is the San Joaquin Daily Input-Output (SJRIODAY), a more primitive river model that considers only the main stem of the River, largely ignoring the dynamics of the contributing watersheds. It is currently used by the Department of Water Resources to make water quality forecasts in the San Joaquin River. With an improved model, forecasted salt load allocations can be made with increased accuracy and disseminated to stakeholders as an aid to improving compliance with water quality objectives.

METHODS

- Generate fourteen-day WARMF forecasts of flow and electric conductivity (EC) once weekly on the same schedule as the Department of Water Resources SJRIODAY forecasts. Follow WARMF forecasting protocols described in technical support manual (Systech, 2011).
- Develop heuristics to improve skill of daily flow and EC forecasts using knowledge of watershed salinity management.
- Use forecasted flow and EC from each model to calculate salt load and salt assimilative capacity at Vernalis.
- Case study: San Joaquin River forecast discrepancies during June 2014.

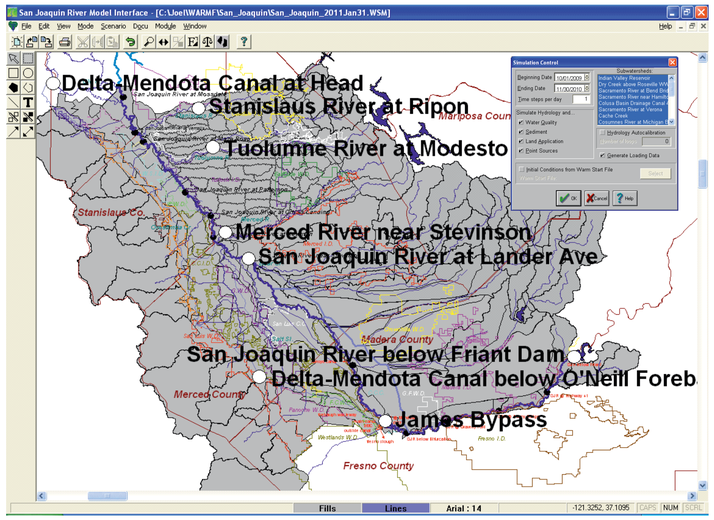

Figure 2. The WARMF model user interface

RESULTS

In a short-term comparison of model accuracy over a seven week period, WARMF-SJR was found to provide more accurate flow forecasts than SJRIODAY but less accuracy of EC and salt load numeric predictions (Table 1 and Figure 3). The SJRIODAY model is adjusted to match measured flow and EC on the day the forecast is made, whereas WARMF relies on volume and bass balance without being adjusted to match measured data.

TABLE 1
Comparison of model accuracy between WARMF and SJRIODAY models

	Flow		EC		Salt Load	
Model:	**WARMF**	**SJRIODAY**	**WARMF**	**SJRIODAY**	**WARMF**	**SJRIODAY**
7-Day error	±4.8%	±8.6%	±14.6%	±2.4%	±30.5%	±11.3%
14-Day error	±0.6%	±4.2%	±14.2%	±2.2%	±28.2%	±8.4%

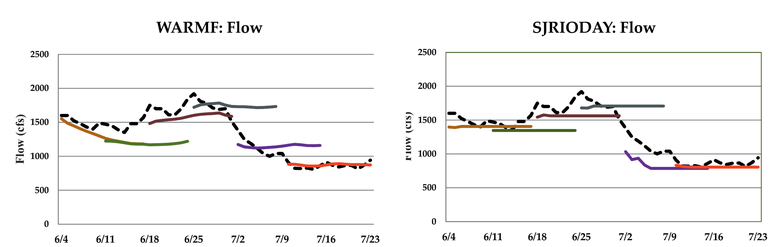

Figure 3. A model comparison; WARMF and SJRIODAY simulations with each colored line segment representing a two-week flow forecast at Vernalis, June through July 2012 (flow data source: USGS, SJRIODAY forecast by DWR).

CASE STUDY

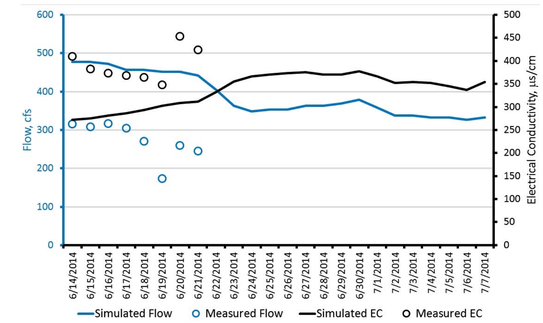

Figure 4. Initial WARMF Real-time Forecast June 21, 2014

San Joaquin River at Vernalis flow ~150 cfs too high, EC ~100 ms/cm too low

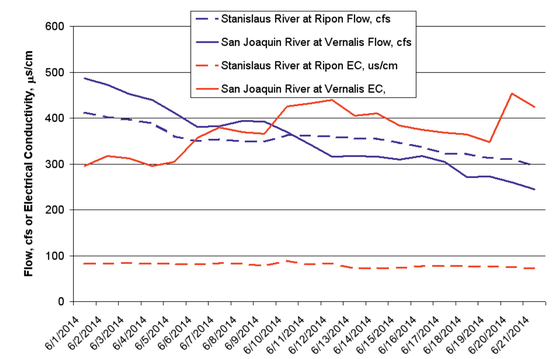

Figure 5. What was happening?

Stanislaus River flow greater than San Joaquin River at Vernalis for first time in at least 38 years

Initial model flow/EC error implied unexpected flow loss from Stanislaus River.

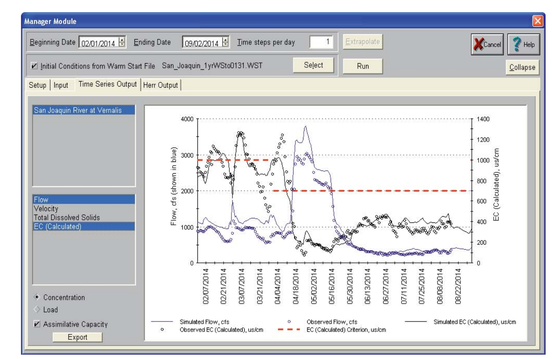

Figure 6. Analysis

Summer WARMF Hindcast/ Forecasts assumed 150 cfs lost from Stanislaus River. 6/1-8/15

DISCUSSION

WARMF simulations can be sensitive to historical meteorological data which is needed to establish sound conditions up to the start of a forecasting season. Meteorological data only runs up to the fifth or sixth day of a forecast, after which historical estimates are used. Refinement of existing models and a forecasters understanding of hydrological trends are key to generating accurate forecasts. Compliance with new water quality objectives will be dependent on accurate salinity forecasting to ensure proper salt load allocations. As a tool used to aid in water management decisions, water quality modeling has a relevant role in salinity management and ecosystem sustainability efforts.

Model forecasts of flow and EC accurate under assumption of 150 cfs loss from Stanislaus River during summer 2014:

- Measured flow losses stopped in August
- Natural cause would have persisted until winter
- Unregulated diversion was likely cause of losses