Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

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Chapter 15: Short-Term Improvements to Artificial Neural Network Implementation in CALSIM

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15 Short-Term Improvements to Artificial Neural Network Implementation in CALSIM

15.1 Introduction

An Artificial Neural Network (ANN) was recently implemented in CALSIM II to define Delta salinity constraints. The Delta Modeling and Hydrology and Operation Sections are collaborating with the U.S. Bureau of Reclamation (USBR) staff through the CALSIM ANN Refinement Team (CART) to make systematic improvements to the model. This chapter outlines the team's objectives, current status, and future considerations. The team's goal is to implement a refined ANN in CALSIM II by mid-2003.

15.2 Objectives

The short-term objectives for the year 2002 have been identified as follows:

- Identify the best inputs for the ANN that generate the most accurate flow-salinity relationship.
- Identify better training techniques to improve the accuracy of the predicted EC.
- Increase the robustness of the ANN to take into account any variation of hydrology and Delta operations.
- Find a method to simplify the ANN implementation and reduce ANN run time in CALSIM.

15.2.1 Best Input Parameters in ANN

The existing ANN uses Sacramento and San Joaquin flows, exports (including net channel depletions) and Delta Cross Channel (DCC) operation as inputs to estimate EC at any given location. The following inputs will be considered in an attempt to improve the existing ANN:

- Use the Cross Delta Flow (flow through the DCC and Georgiana Slough), instead of DCC operation.
- Use QWEST instead of DCC operation.
- Use net channel depletions as a separate input.
- Use EC at Mallard as a new input (the existing ANN predicts EC at Mallard very well).

- Train the ANN on the differences rather than the absolute values, i.e. use flow differences to predict EC differences.

15.2.2 Better Training Techniques

The existing ANN was trained using the Stuttgart Neural Network Simulator (SNNS version 4.2). The goal is to develop the best training techniques that will yield the best results using the current SNNS. The performance of other ANN models will not be evaluated this year.

- At present, the time period between 1980–1991 is used for calibration and 1975–1979 is used for validation. Instead of a specific time period, 25% of the data will be randomly picked as the validation data set.

- At present all input data are normalized between 0.2–0.8 prior to training the ANN. Different ranges will be tested.

- To increase the accuracy of the predictions, weights in key regions will be increased.

- Different training parameters including the use of different ANN hidden will be tested.

15.2.3 Increase the Robustness of the ANN

The existing ANN performance degrades when the hydrology changes by a significant amount. This observation can be attributed to the following:

- The hydrology is outside the range of the training data set.
- The EC time series pattern in the training data set is very different from the EC time series pattern that is generated by the planning hydrology.

To eliminate these problems the following strategies will be tested:

- Multiply a given hydrology by different factors to generate a wide range of hydrologies. The perturbations should encompass all possible hydrologies that CALSIM will generate.
- Use several different known hydrologies in the training of the ANN. It is important to pick at least two hydrologies that bookend all other hydrologies.
- Synthetically generate a data set to capture all possible hydrologies.

15.2.4 Changes in ANN Implementation in CALSIM

Depending on the final form of the new ANN, the implementation of ANN in CALSIM will likely be changed. This work will begin when the new ANN is finalized.

15.3 Current Status

Most of the planned experiments are ongoing. No definite conclusions have been made. However, an improvement in predicted EC was observed when Cross Delta flow was used instead of DCC operation.

15.4 Future Considerations

The tests that are planned for this year are part of an ongoing process to achieve the best possible flow-salinity model using the least possible computation time.

Acronyms and Abbreviations

ADCP – Acoustic Doppler Current Profiler

ANN – Artificial Neural Network

BRM – Bromate

CALSIM – California Water Resources Simulation Model

CART – CALSIM ANN Refinement Team

CCC PP #1 – Contra Costa Canal Pumping Plant #1

CCWD – Contra Coast Water District

CVP – Central Valley Project

D-1485 – SWRCB Water Rights Decision 1485

D-1641 – SWRCB Water Rights Decision 1641

DAYFLOW – DWR Delta Daily Boundary Flow Model

DCC – Delta Cross Channel

DICU – Delta Island Consumptive Use

DMC – Delta Mendota Canal

DO – Dissolved Oxygen

DOC – Dissolved Organic Carbon

DOI – Delta Outflow Index

DSM1 – Delta Simulation Model 1

DSM2 – Delta Simulation Model 2

DWR – California Department of Water Resources

EC – Electrical Conductivity

E/I – Ratio of Delta Exports to Delta Inflows

ESO – DWR's Environmental Services Office

HYDRO – DSM2 Hydrodynamics Model

IEP – Interagency Ecological Program

IEP-PWT – IEP DSM2 Recalibration Project Work Team

ISI – Integrated Storage Investigation

JP – Jersey Point

MSE – Mean Squared Error

MWQI – DWR's Municipal Water Quality Investigations

NDO – Net Delta Outflow

O&M – DWR's Operation and Maintenance

PTM – Particle Tracking Model

PWT – Project Work Team (see IEP-PWT)

RS – Rock Slough

QUAL – DSM2 Water Quality Model

QWEST – Approximation of Western Flow in Delta

SNNS – Stuttgart Neural Network Simulator

SQL – Structured Query Language

SWP – State Water Project

SWRCB – State Water Resources Control Board

TDS – Total Dissolved Solids

TTHM – Total Trihalomethane

TOC – Total Organic Carbon

USBR – U.S. Bureau of Reclamation

USFWS – U.S. Fish and Wildlife Service

USGS – U.S. Geological Survey

UVA – Ultraviolet Light Absorbance

VISTA – Visualization Tool and Analyzer

WIMS – Water Information Monitoring System

WQMP – Water Quality Management Plan