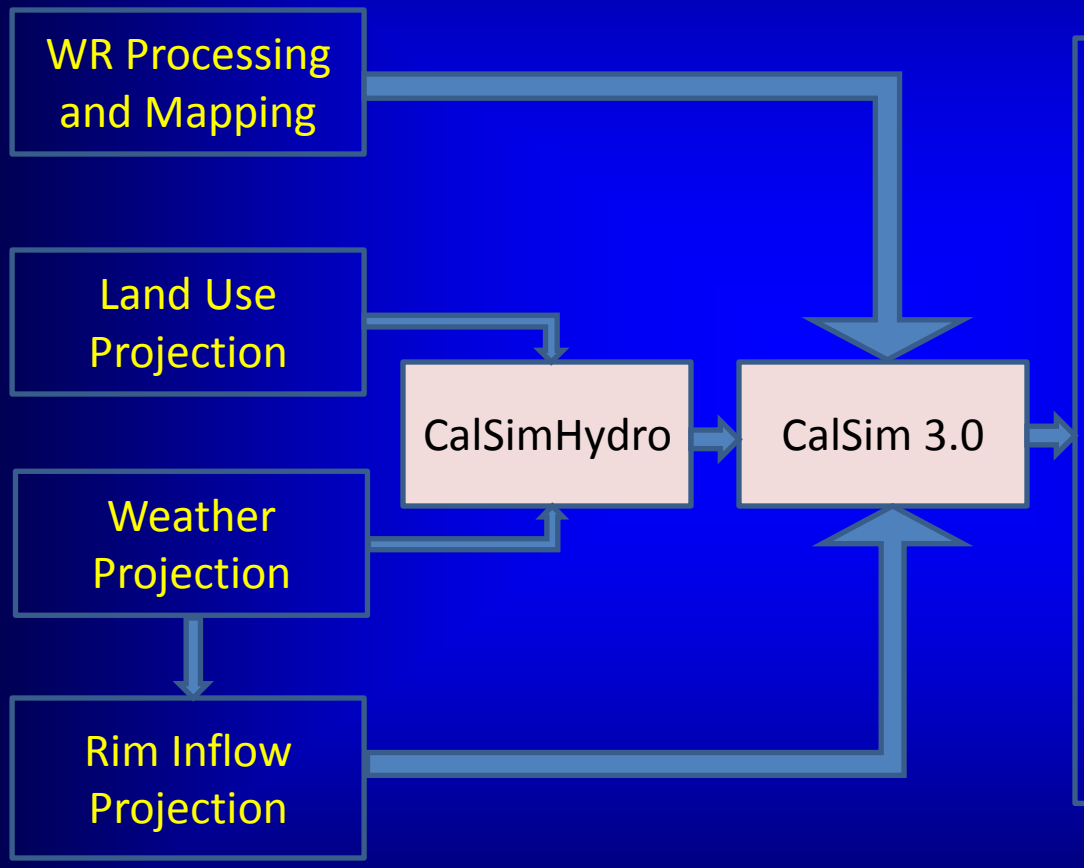
A CalSim Model for Water Rights Diversion in Sacramento Valley (CalSimWR)

Presenter: Z.Q. Richard Chen
Collaborators: Liheng Zhong and Hongbing Yin
Bay-Delta Office
CA Department of Water Resources

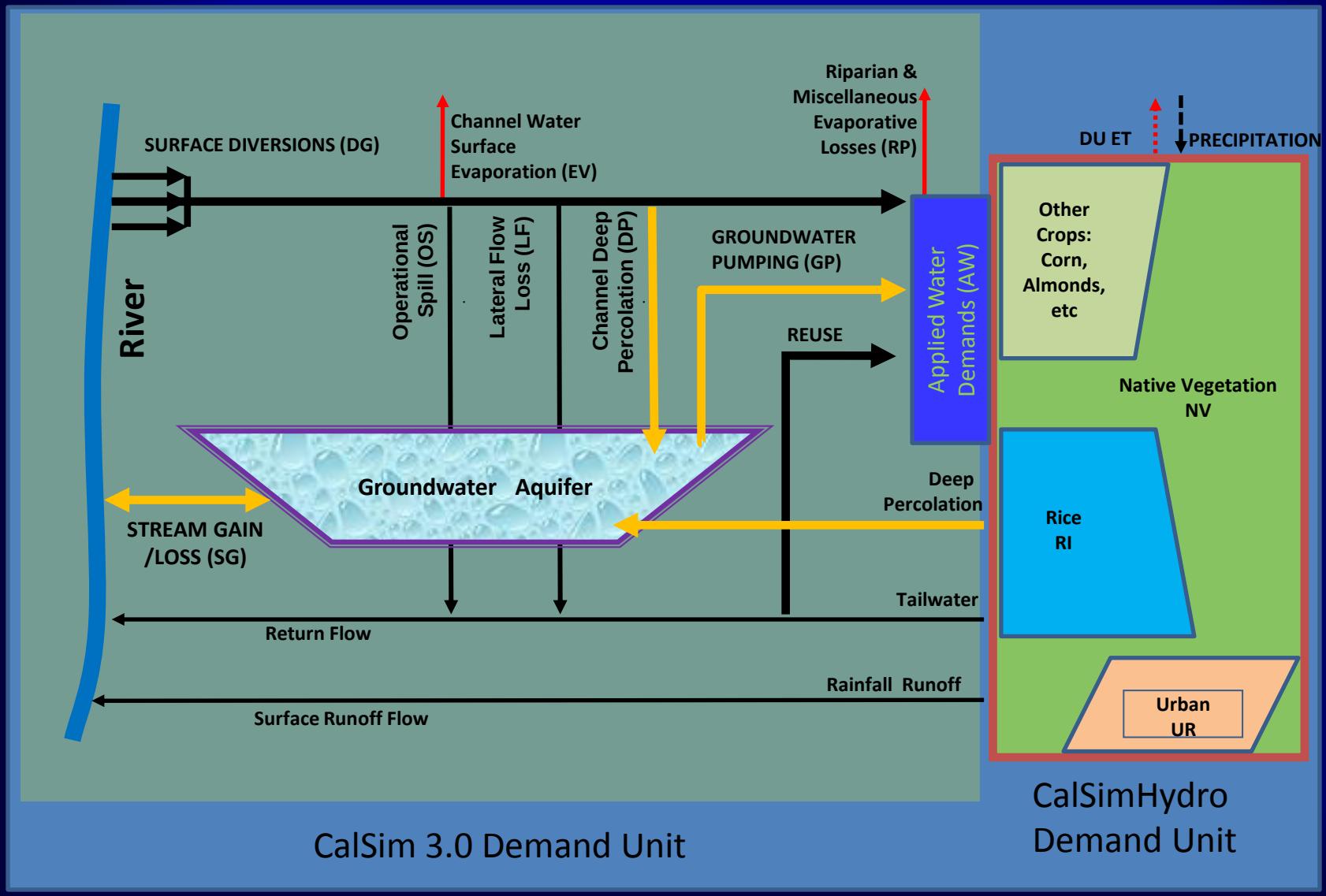
CWEMF Annual Meeting
April 11, 2016

Incorporating Water Rights Based Diversions Into CalSim 3.0



1. **Hydrologic analysis without system regulations and reservoirs**
2. Hydrologic analysis with added system regulations and reservoirs
3. Update projection and analysis at anytime as new info becomes available

How to model reasonable and beneficial use of water



Implementation of Water Rights

Use Additional Cycles

1) Cycle1 to determine unimpaired flows in the Sacramento Valley Streams,

2) Cycle2 to determine riparian water rights diversions,

3) Cycle3 to determine other pre-project water rights diversions, and

4) Cycle4 to determine project water rights diversions to storage

Implementation of Water Rights

Partition inflows to project reservoirs by the first 3 cycles

1) Flow for riparian water rights

2) Flow for other pre-project water rights

3) Flow into project storage as project water

Implementation of Water Rights

Partition flows in main stems of Sacramento River by CalSimWR

1) Flows for riparian water rights holders

2) Flows for pre-project water rights holders

3) Flows that originate from CVP and SWP project storages

4) Other flows

Implementation of Water Rights

A CalSim Model with Water Rights Diversion (CalSimWR)

CalSimWR =
CYCLE1 + CYCLE2 + CYCLE3 + CYCLE4 + CalSim 3.0

Two modes of CalSimWR applications

1) one in a long-term planning context, and

2) the other in a real-time context.

Testing Models

A standalone model for testing CYCLE1

Sac Valley Unimpaired Flows

A standalone model for testing CYCLE2 and CYCLE3

Riparian Rights Diversion

Pre-project Appropriative Rights Diversion

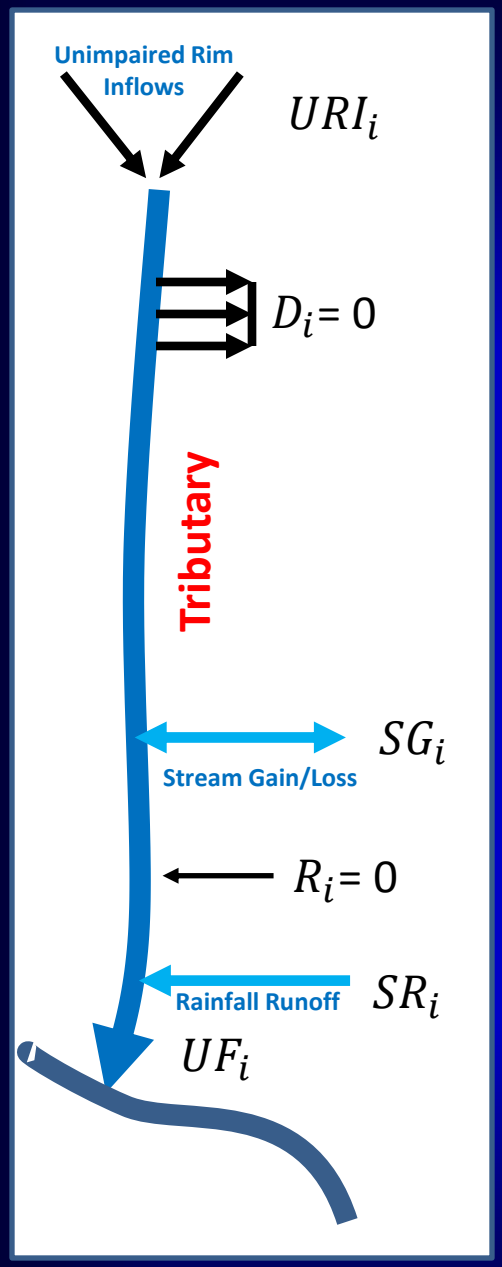
A real-time simulation mode CalSim 3.0

Forecasting at a selected month for the remainder of the water year

A standalone model for testing CYCLE1

Sacramento Valley Unimpaired Flows Model (SVUFM)

- CalSim 3.0 channel network connectivity with
  - all reservoirs and Trinity river removed,
  - all diversions and return flows removed,
  - small tributaries upstream of Feather, Yuba, Bear, and American rivers
  - weirs unchanged
- Unimpaired rim inflows
  - Historical stream gage observation
  - Regression for missing-data period using the period in which gage observations were available.
  - Regression using near by historical stream gage observation
- Valley floor surface rainfall runoff at current land use conditions
  - Fixed land use conditions at 2010 level
  - CalSimHydro simulation results
- Stream gain from groundwater aquifer or stream loss to groundwater aquifer
  - pre-determined by running an Existing Condition C2VSIM model



Valley Floor Unimpaired Flows

$$UF_i = URI_i + SR_i + SG_i$$

1) UF_i – Unimpaired flow at the i-th tributary outlet. No negative flow is allowed in any stream reach in the tributary
2) URI_i – Unimpaired Rim Inflow at the upstream of the i-th tributary.
3) SR_i – Surface Rainfall Runoff along the i-th tributary,
4) SG_i – Stream Gain SG along the i-th tributary

A standalone model for testing Cycle2, and Cycle3

1. Modification to CalSim 3.0 Stream Network
   - add water rights storages
     - American River, Yuba River, Cache Creek (Yolo Bypass)
2. Water supply
   - Add tailwater and wastewater return flow for Cycle 3
3. Water rights diversion
   - SWRCB water right application records, irrigated acreage and location
   - Demand Unit Diversions (CalSimHydro)
4. Riparian and Appropriative Water rights diversion priorities
   - Split water rights diversions (coloring for priority)
   - Split diversion in a demand unit based on water right applications
   - Combination of split diversions
   - Varying weights of a diversion based on seniority of a water rights application

Diversion Priority and Weights

Riparian Rights Base Weight = $W_{riparian}$

Weight for D_{R1} = $W_{riparian}$

Weight for D_{R2} = $W_{riparian}$

Weight for D_{R3} = $W_{riparian}$

Appropriative Rights:

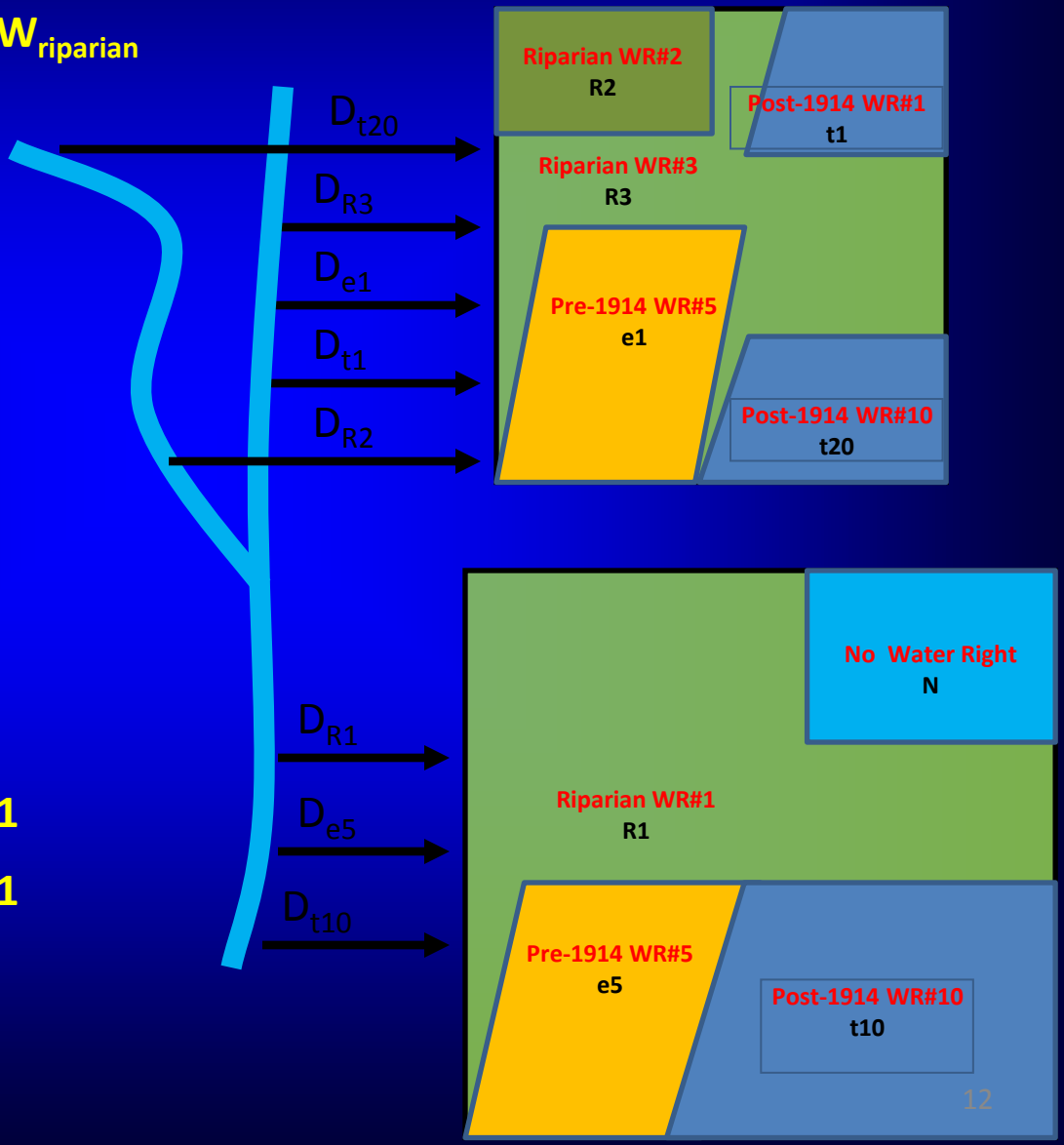
Weight for D_{e1} = $W_{riparian}$ -1

Weight for D_{e5} = $W_{riparian}$ -1

Weight for D_{t1} = $W_{riparian}$ -2

Weight for D_{t10} = $W_{riparian}$ -11

Weight for D_{t20} = $W_{riparian}$ -21



A real-time simulation mode CalSim 3.0

1) Up-to-date reservoir storages (CDEC)
2) Up-to-date groundwater conditions (C2VSIM)
3) Projection of land use condition change
4) Rim/local inflow forecast (SWAT)
5) Projection of water demands and valley floor surface runoff (CalSimHydro)

Summary

- A prove of concept CalSim water rights diversion model
  - CalSim 3.0 schematic,
  - Riparian water rights,
  - Appropriative water rights diversion priorities based on seniority,
  - Using CalSimHydro to compute diversions for beneficial uses,
  - Long term simulation and real-time simulation.

Summary

- **Ongoing and Future Works**
  - Link all water rights to crop acreages in demand units
  - Integrate tested cycles to CalSim 3.0 operations
  - Dynamically interact with groundwater aquifer for real time run mode

Modeling Water Rights Diversion

- Riparian Water Rights
  - Property/parcel adjacent to a stream
  - No explicit limit, but:
    - Water used must be from “natural flow”
    - Water cannot be stored
    - Water used must be for reasonable beneficiary use.
- Pre-1914 Appropriative Water Rights
  - Initiated before Dec 19, 1914
  - Limited to quantity of water use by 1914, or planned to be used
- Post-1914 Appropriative Water Rights
  - Requires a permit or license
  - Explicit limits on water used or water stored