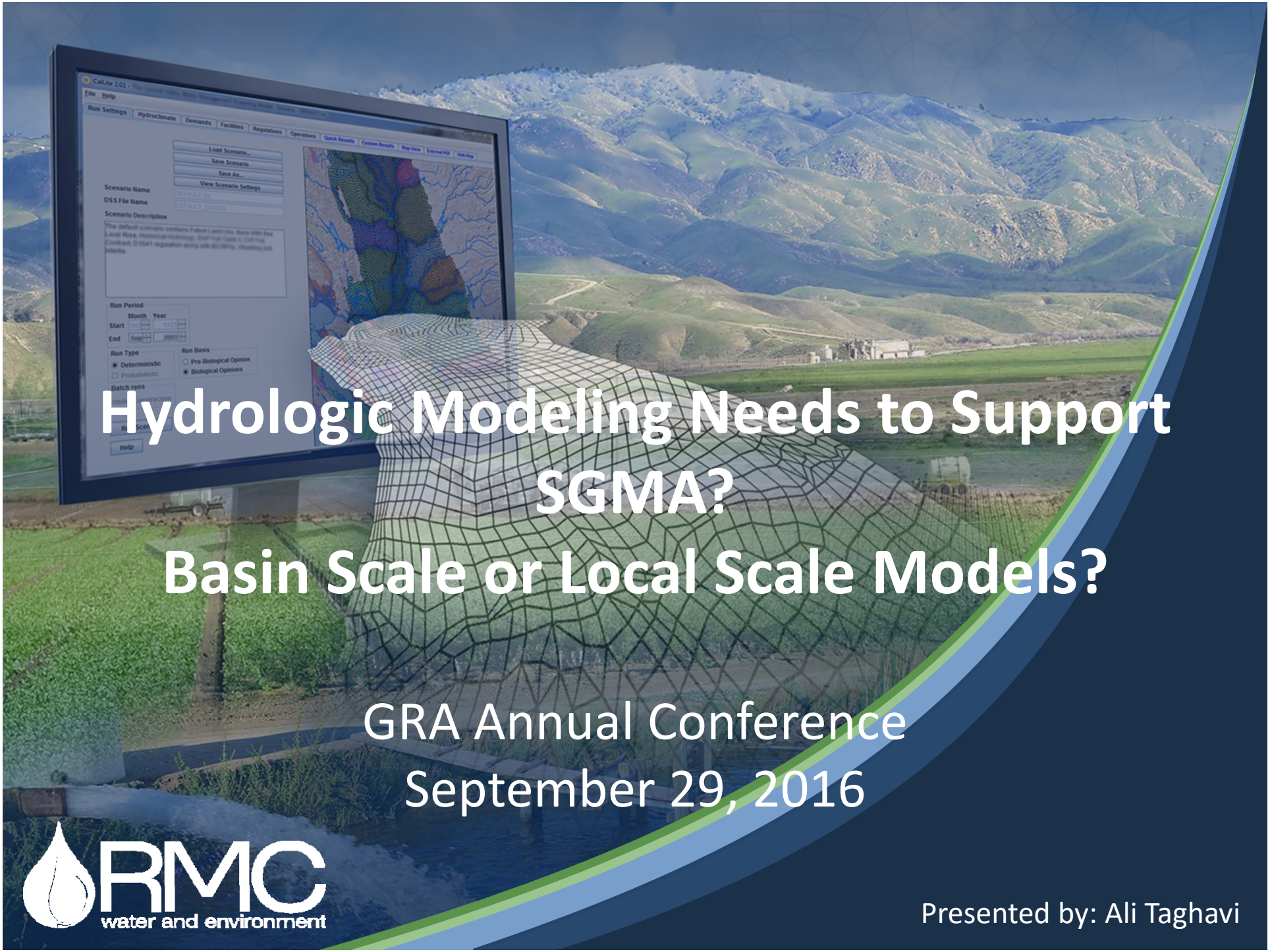


Hydrologic Modeling Needs to Support SGMA?

Basin Scale or Local Scale Models?

GRA Annual Conference

September 29, 2016

RMC water and environment

Presented by: Ali Taghavi

Acknowledgements

- Merced Irrigation District and Merced County, San Joaquin County, DWR, USGS, CWF, TNC
- RMC Modeling Staff:
  - Sara Miller
  - Dominick Amador
  - Craig Altair
  - Mesut Cayar

Key Questions to be Addressed

1. What are different modeling scales and how a local entity can use any one of them for SGMA support
2. Is there a local model needed for evaluation of sustainable GW management?
3. What are the uses of a local model beyond SGMA?
4. What kind of data is needed to develop a local model?

SGMA Identified Undesirable Effects

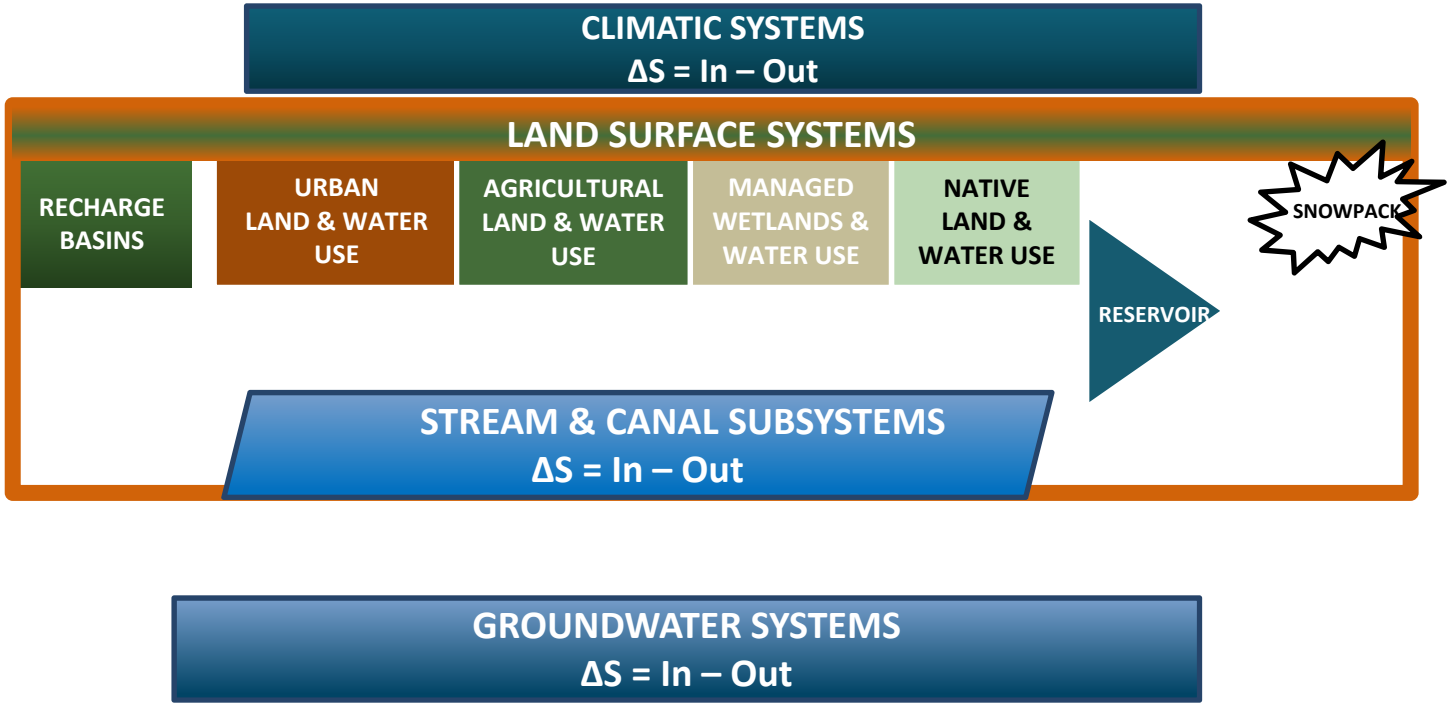
- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality
- Significant and unreasonable land subsidence
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

SGMA, GSP, Modeling

- "Groundwater and surface water models used for a Plan shall meet the following standards:
  1. The model shall include publicly available supporting documentation.
  2. The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data." (Code of Regulations Title 23, Div. 2, Ch. 1.5, Subchapter 2, Art. 3, §352.4 (f))

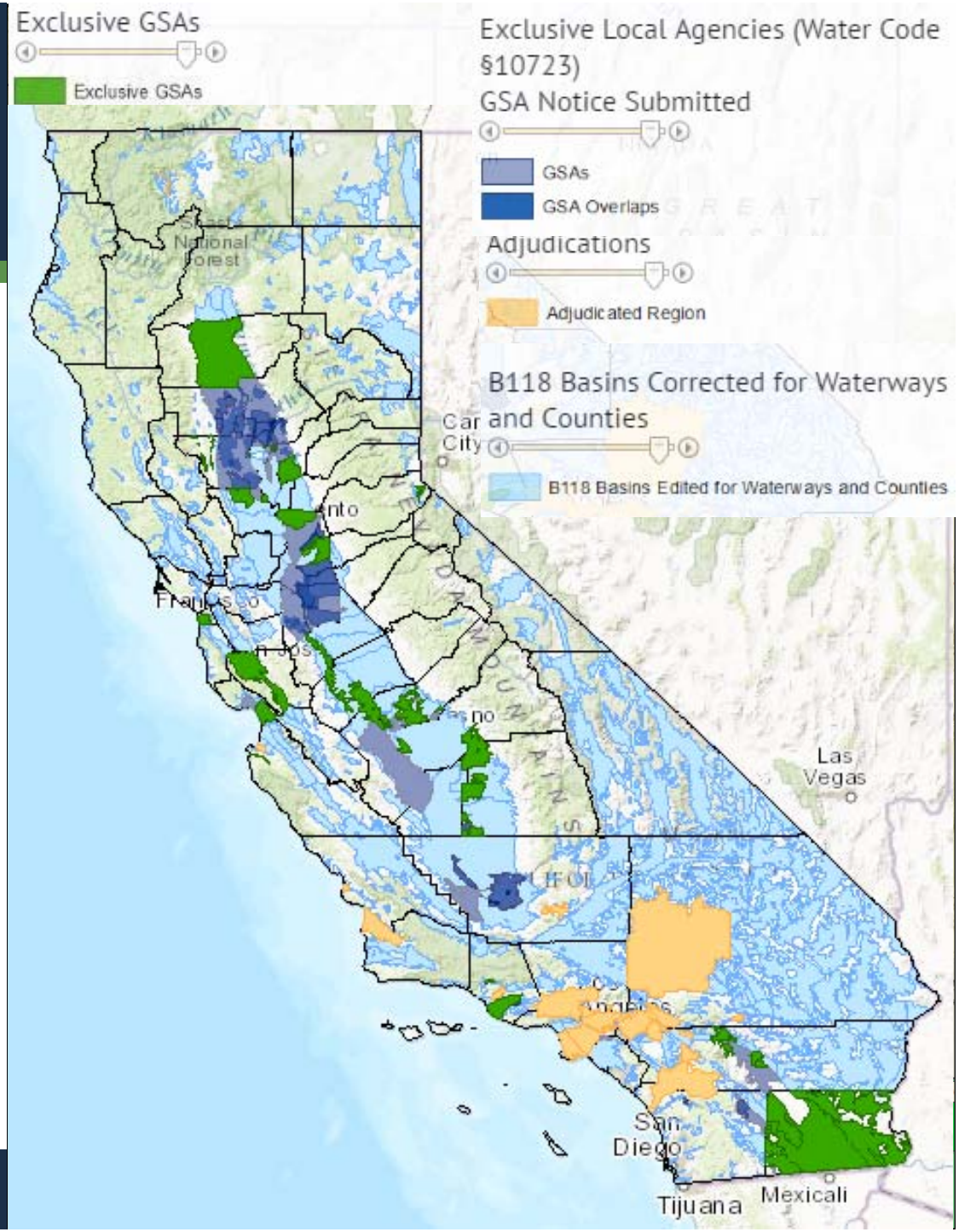
- "… 'Water budget' means an accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored." (Water Code §10721 (x))

SGMA Calls for Comprehensive Water Budget



Modeling Scales

- Counties
- Hydrologic Regions
- Groundwater Basins
- Groundwater Subbasins
- Water and Irrigation Districts
- GSA Map (as of 8/5/2016)



Modeling Scales

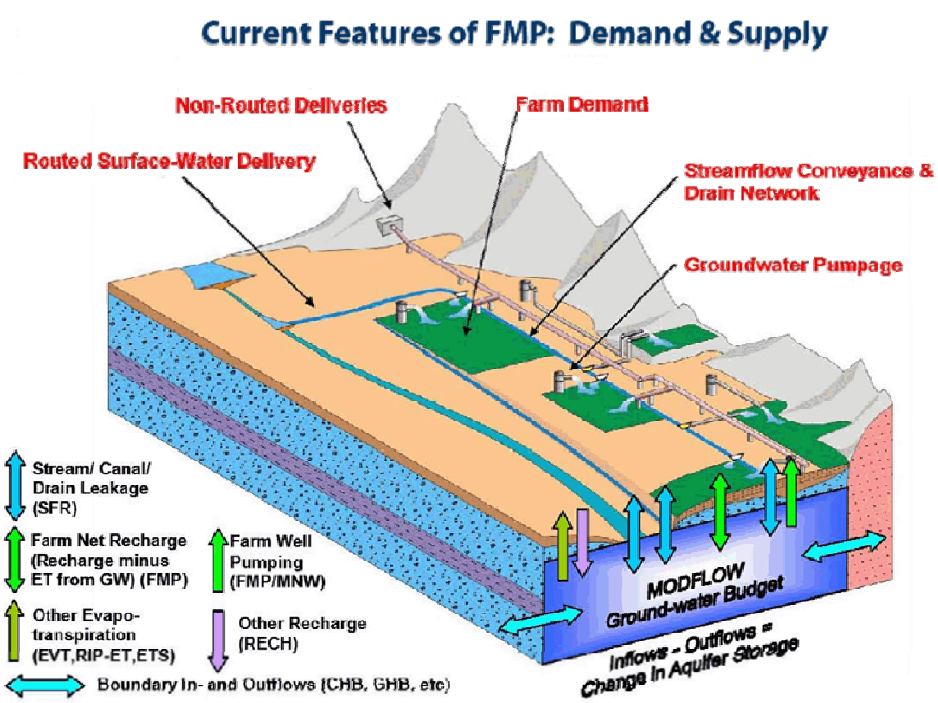
- **Basin:** Representing hydrologic conditions at basin scale
- **Regional:** Representing resolution of data and analysis at regional scale
- **Local:** Representing resolution of data and analysis at local scale

Basin Scale Model

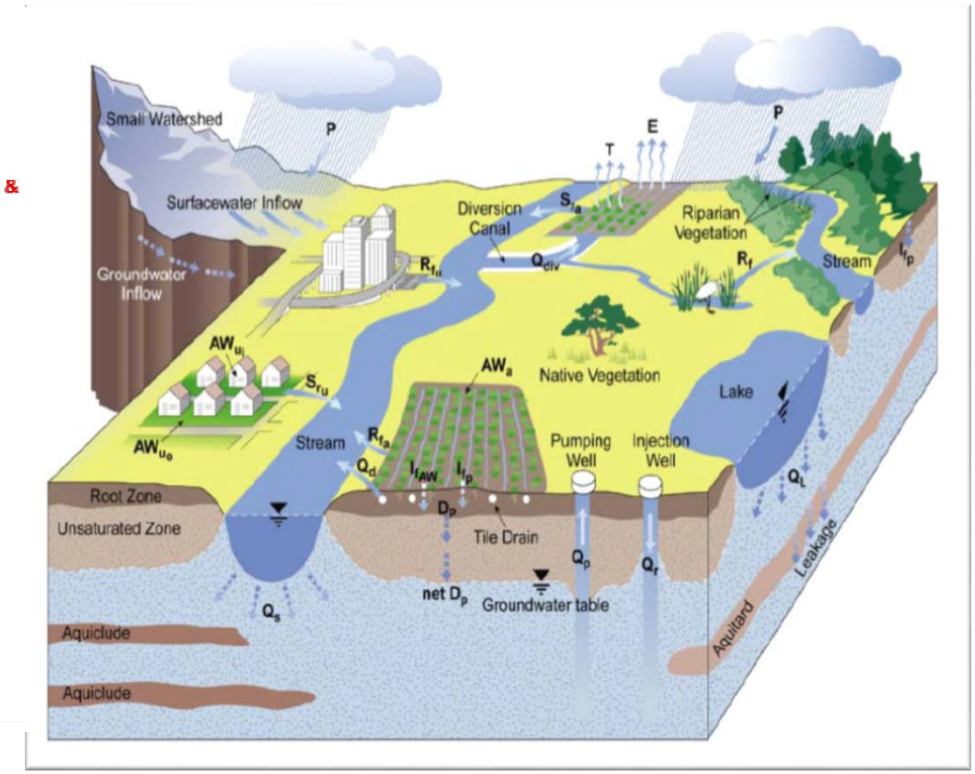
- Scale: Entire groundwater basin
- Spatial scale of typical input data are provided at the Depletion Study Area (DSA)
- Typical grid spacing is several miles
- Temporal scale is typically at annual or monthly level
- Water budgets are presented at the groundwater basin scale
- Sometimes Water Budgets can be presented at the scale of a DSA.
- Example: C2VSim coarse-grid (C2VSim-CG)

Common Modeling Platforms for SGMA

Modflow-OHM



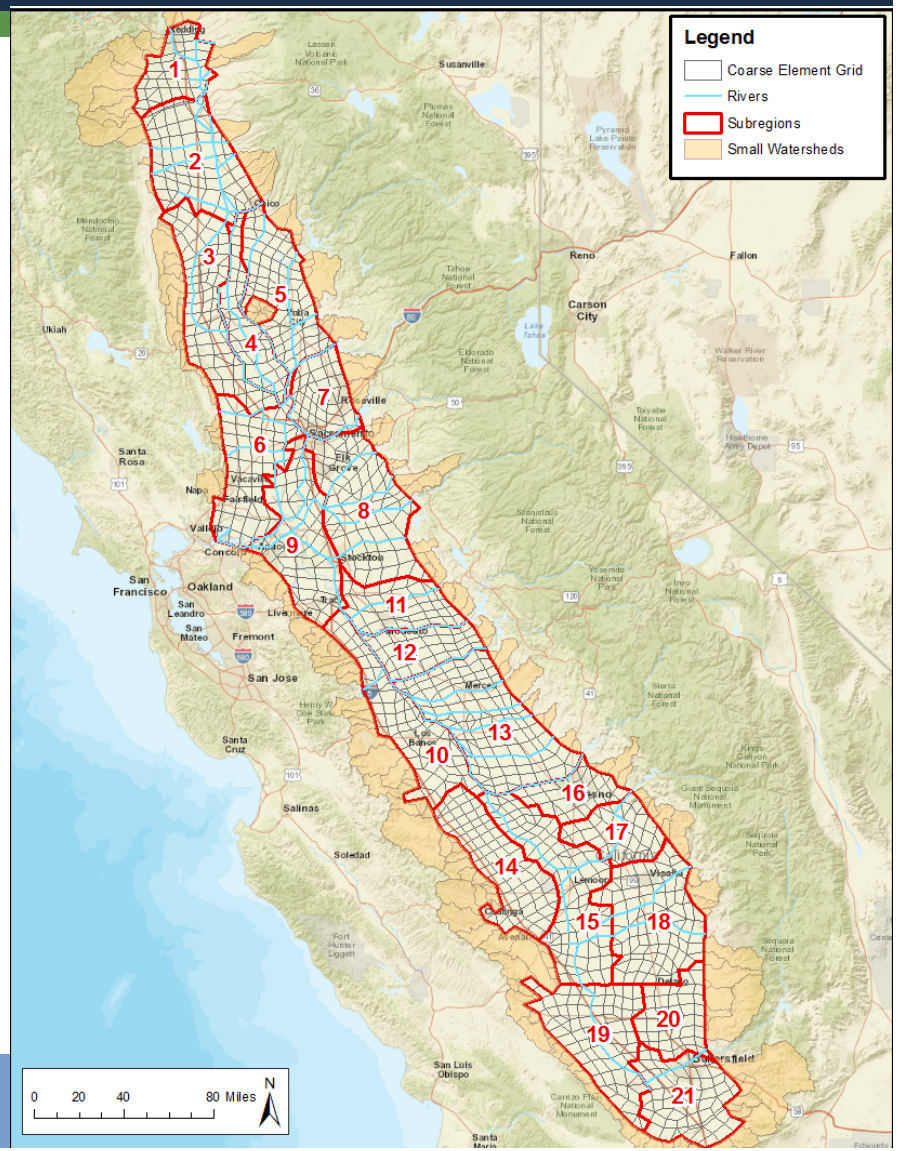
IWFM



Basin Scale
C2VSim Model Features

- 3 Layer Aquifer (+3 Aquitard Systems)
- 1,393 GW Nodes
- 1,392 Elements
- Avg. Elem Area = 14.4 Mi^2
- Simulation 1922-2009
- Monthly Time Step
- 21 Subregions

- DWR maintains this model for statewide applications supporting the Bay-Delta Office, CalSim 3 Integration, CWP support, hydrology development



Regional Scale Model

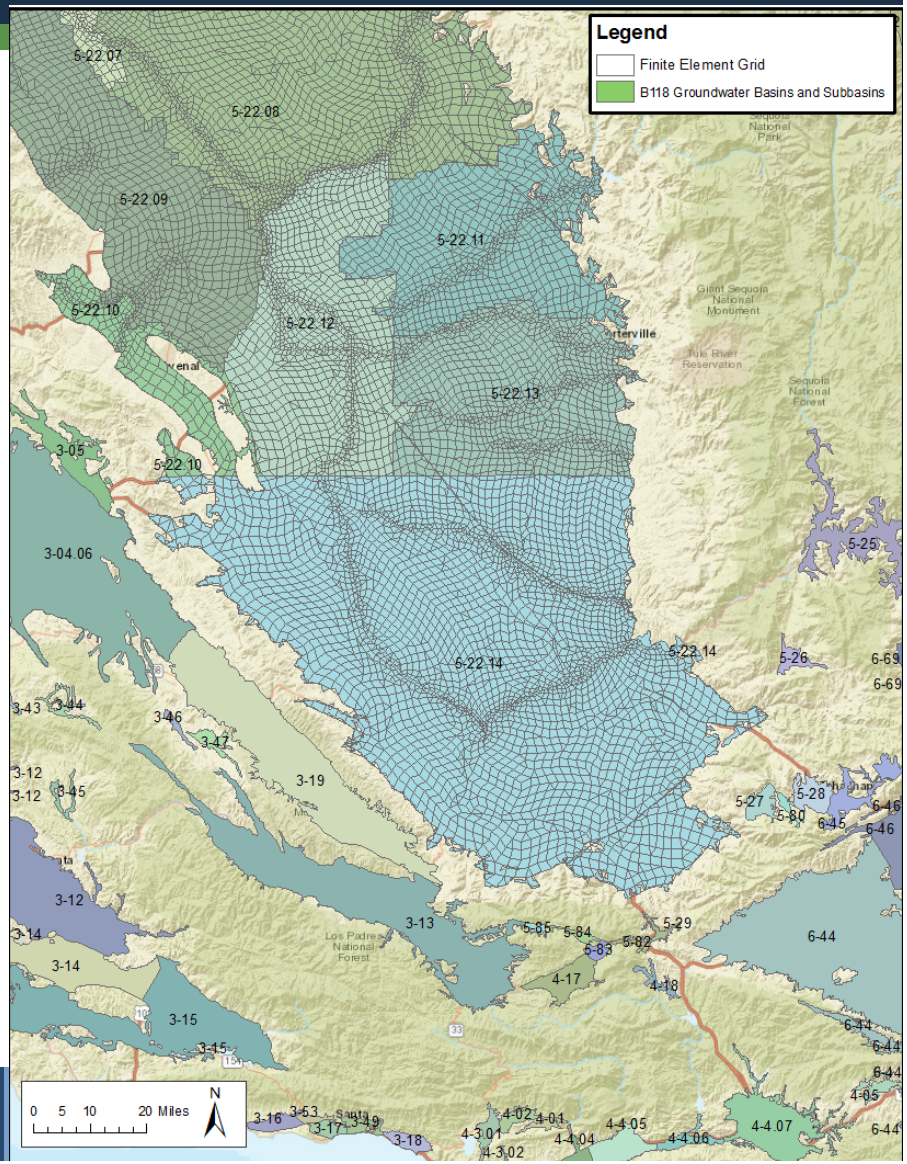
- Spatial extent ~ Basin-scale model
- More refined spatial and temporal resolution (~1-2 miles)
- Temporal scale ~ quarterly or monthly scale
- Examples:
  - DWR's C2VSim fine-grid (C2VSim-FG),
  - United States Geological Survey's Central Valley Hydrologic Model (CVHM)

Regional Scale
CVHM Features

- 43,218 Finite Difference Elements
- Grid Area = 1 Mi^2
- Simulation 1961-2015
- Monthly Time Step
- 10 Layer Model
- 21 Subregiona
- ModFlow_OHM PlatformIntegrated Water Flow Model (IWFM) Platform

Regional Scale
C2VSim-FG Model Features

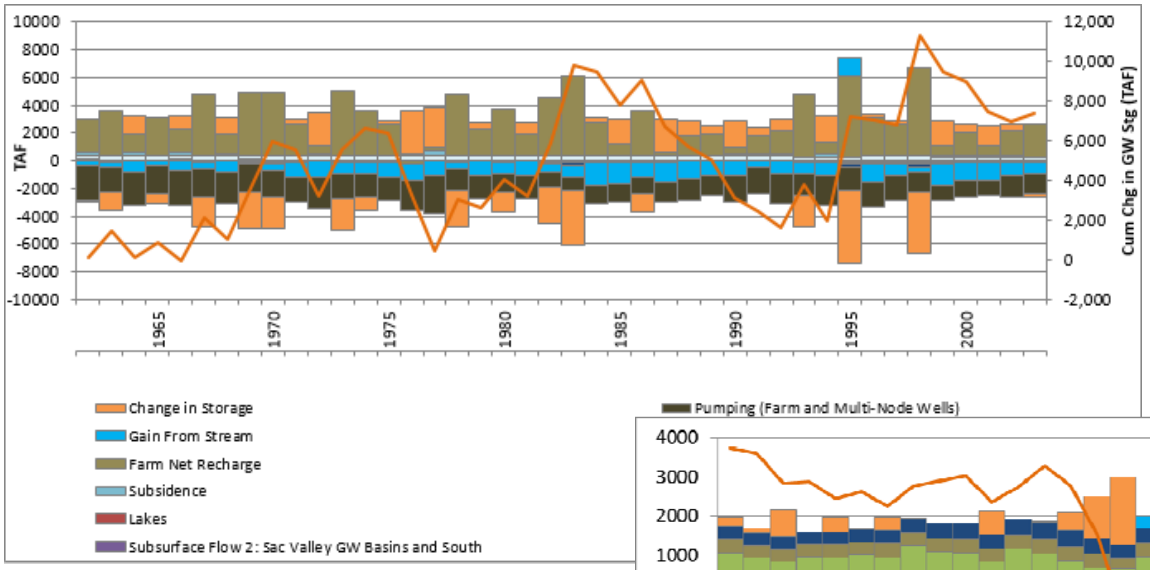
- 32,537 Finite Elements
- Avg. Elem Area = 0.64 Mi^2
- Simulation 1922-2015
- Monthly Time Step
- 4 Layer Aquifer (+3 Aquitard Systems)
- 21 Subregions
- Integrated Water Flow Model (IWFM) Platform



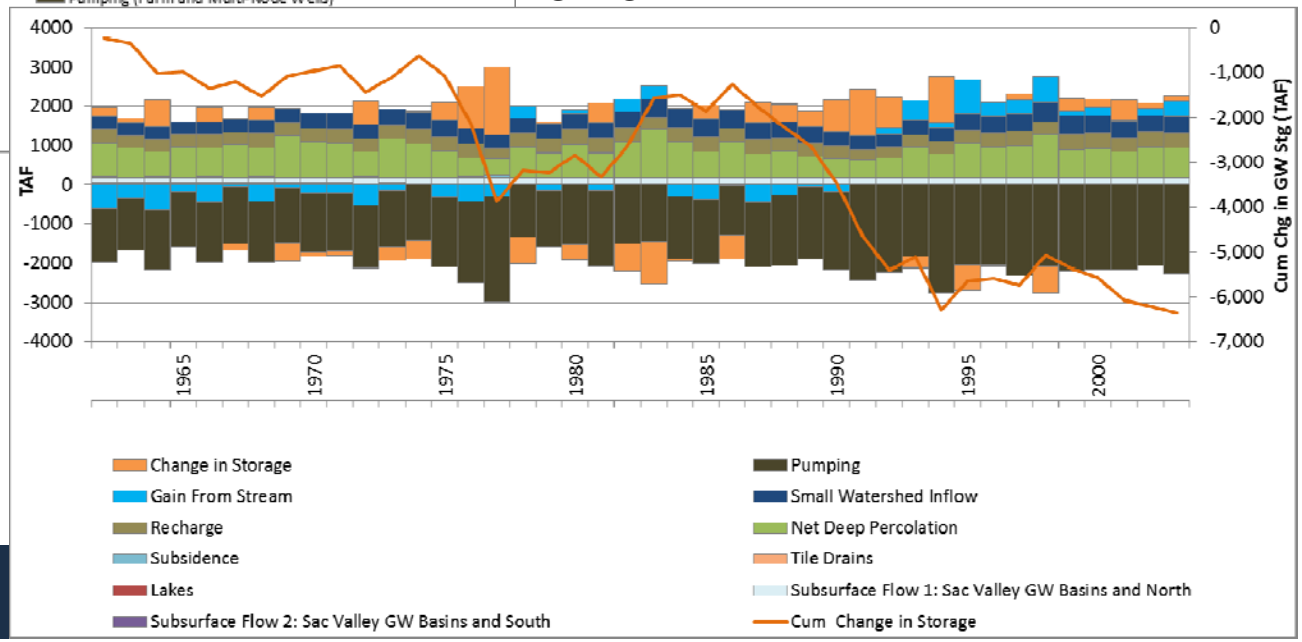
Both Models Provide Basin-scale and Regional-Scale GW Budget

Sacramento Valley Groundwater Basin Budget

CVHM



C2VSim



Local Scale Model

- Generally higher spatial resolution than a regional model (~Less than a mile)
- Temporal scale at monthly or daily level
- Local surface water courses, creeks, sloughs, and canals
- Examples of local models are the Sacramento County Integrated Water Resources Model (SacIWRM) and Merced Water Resources Model (MercedWRM).

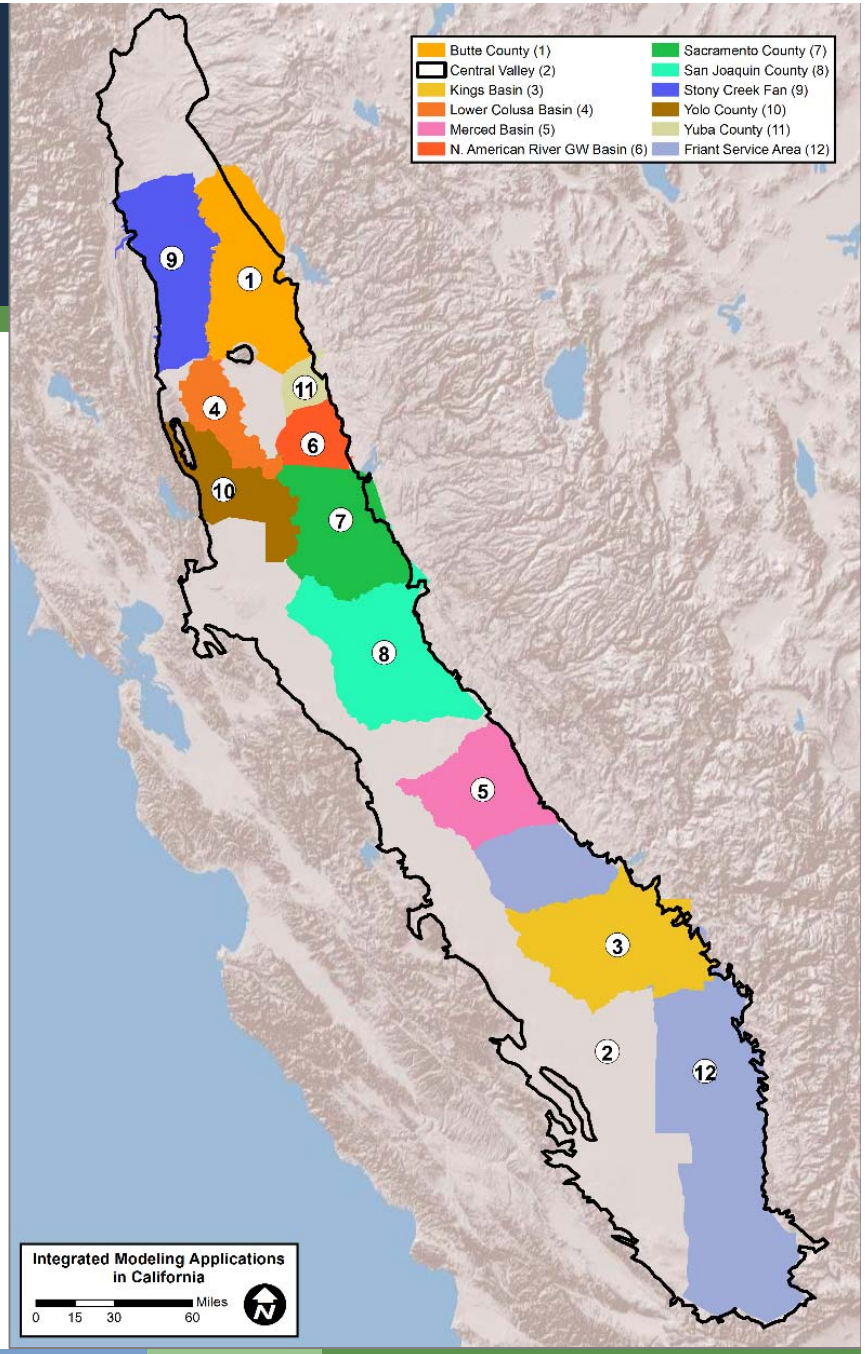
Modeling Scales Applications

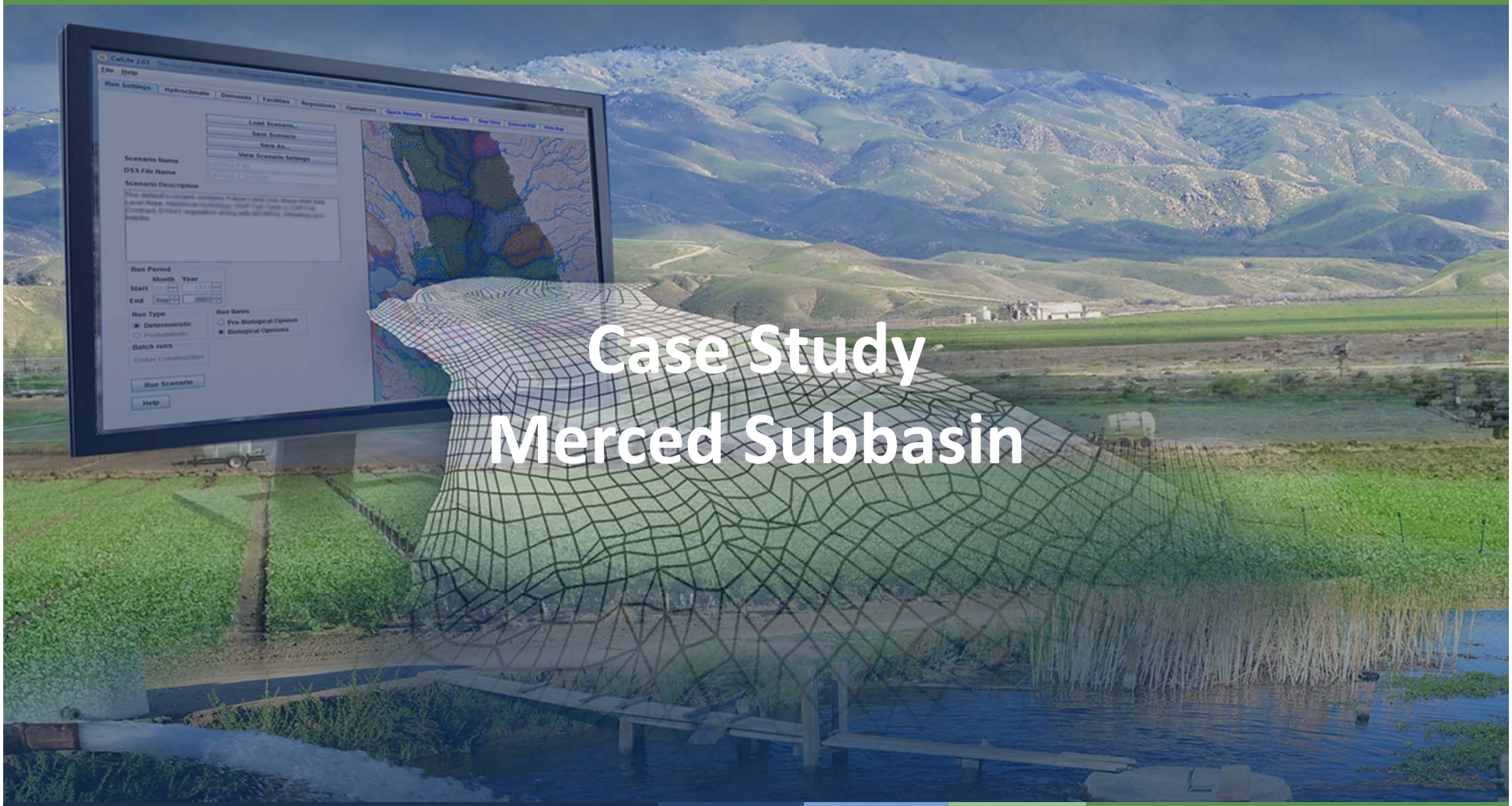
Modeling Scale	Planning	Operations	SGMA
Basin	High	Low	Low
Regional	High	Medium	Medium
Local	High	High	High

High
Medium
Low

Examples of Local Models

- Butte Basin Groundwater Model (BBGM-IWFM)
- Kings Integrated Water Flow Model (Kings-IWFM)
- Merced Water Resources Model (MercedWRM)
- Sacramento Area Integrated Water Resources Model (SacIWRM)





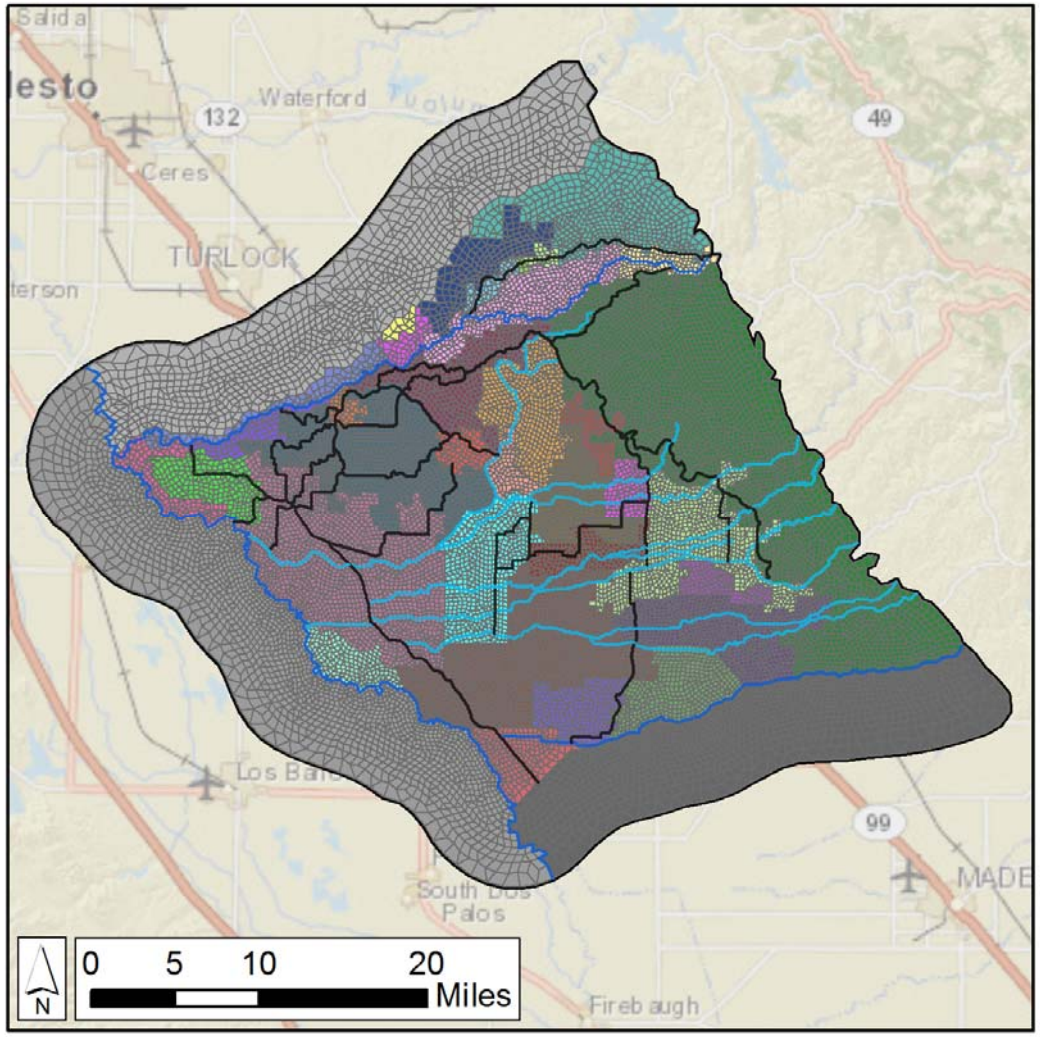
Case Study
Merced Subbasin

Merced WR Model Subregions in C2VSim

- Hydrologic Region: San Joaquin River
- Merced Subbasin is mainly within the larger C2VSim Subregion 13

Merced WR Model
Model Grid

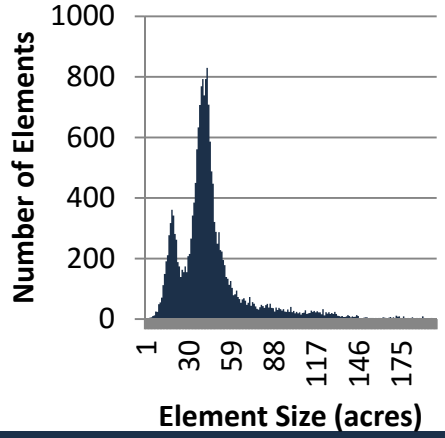
- Bulletin 118 Groundwater Basin Boundaries
- 37 Subregions
- Canal/Stream Locations
- Topography/Drainage
- Water Quality Modeling
- Boundary Buffer
- Optimize Triangular and Quadrilateral Elements

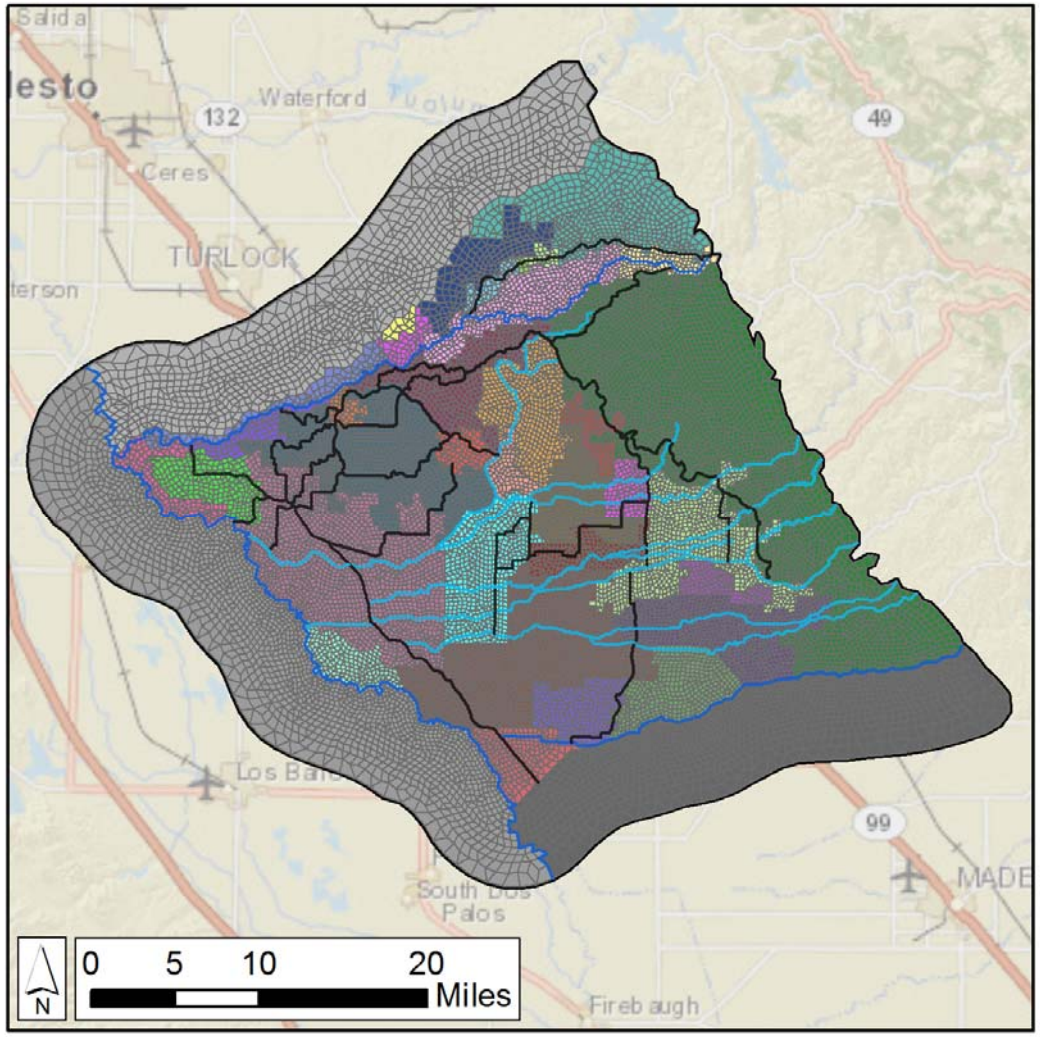


Merced WR Model
Model Grid

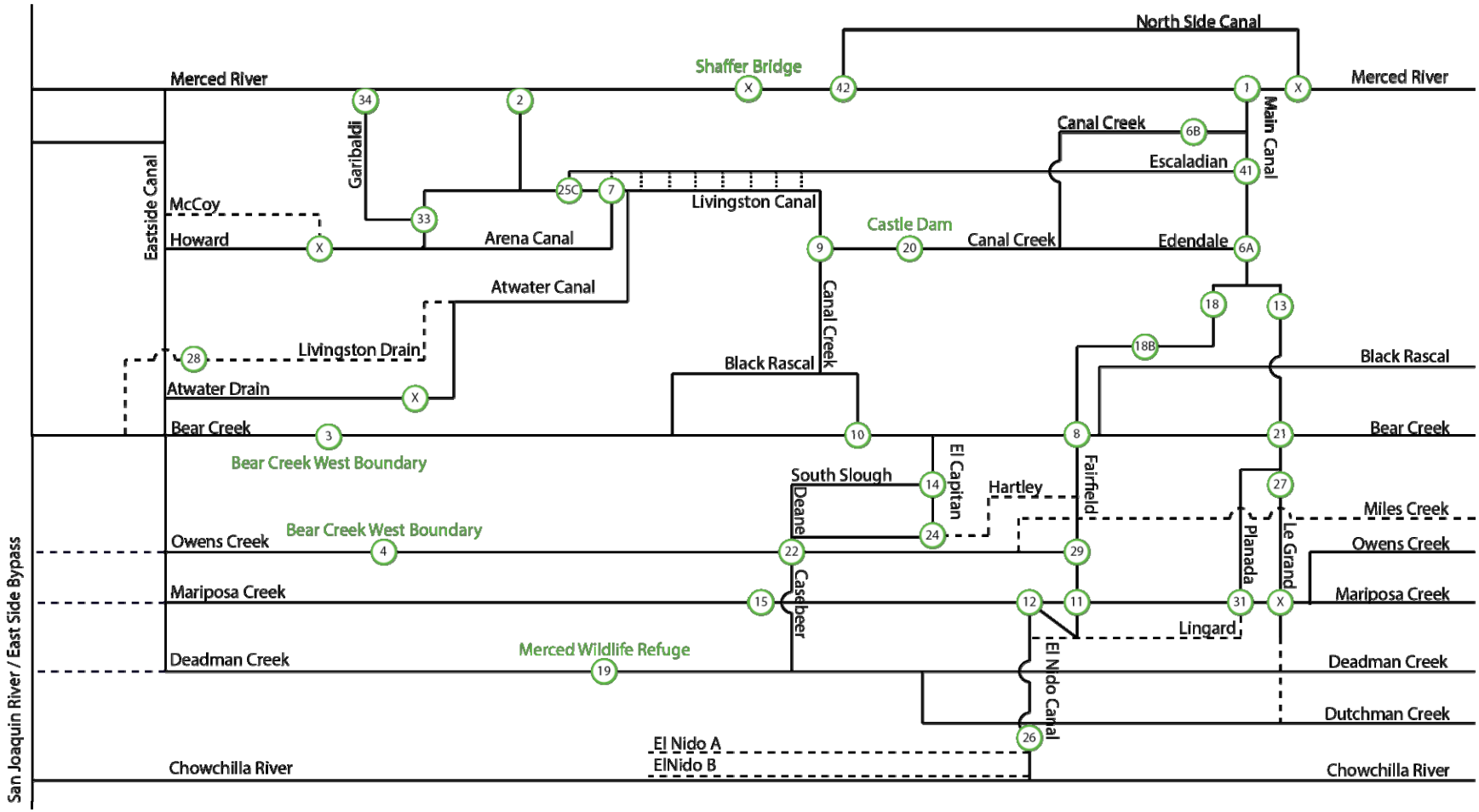
Grid Statistics

- 17,696 Nodes
- 19,563 Elements
  - ¼ mile discretization
  - MAGPI Size = 24 Acres
  - Buffer Size = 60 Acres
- 37 Subregions





Merced WR Model
Surface Water Network



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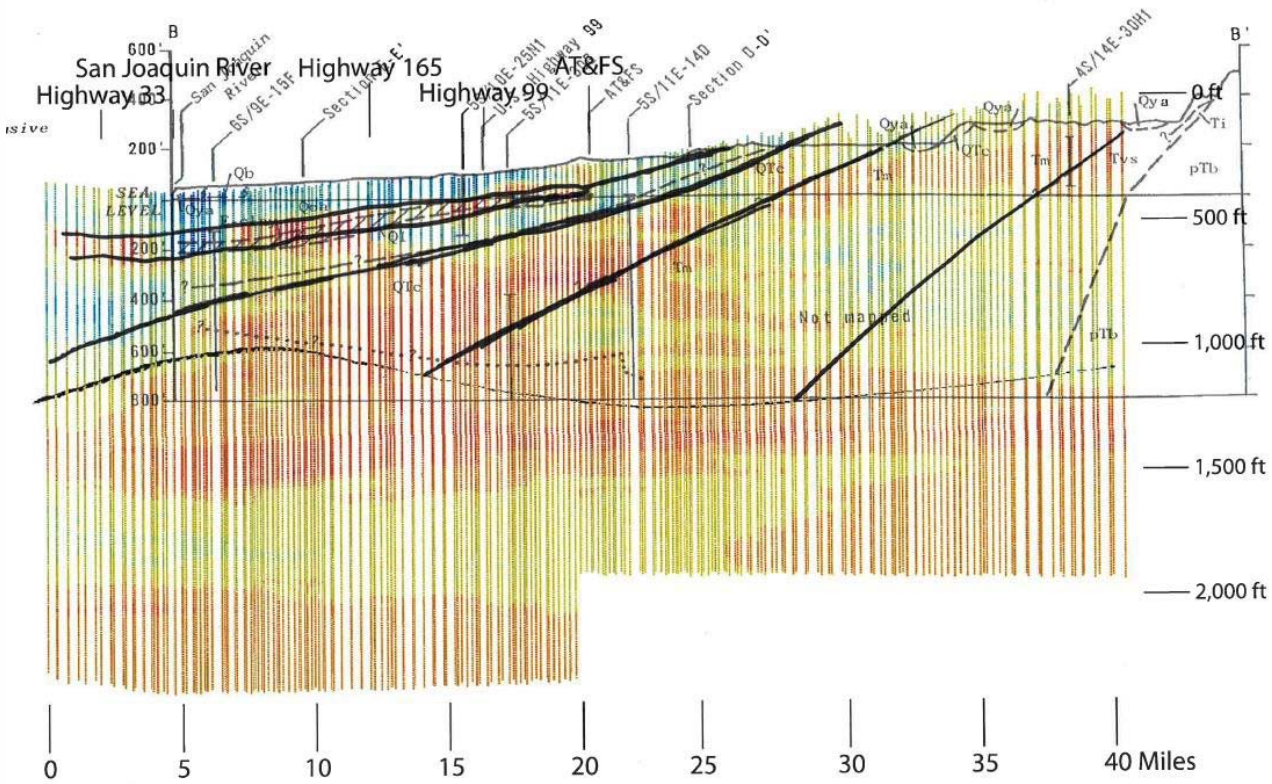
Merced WR Model Used USGS Texture Analysis for Model Layering



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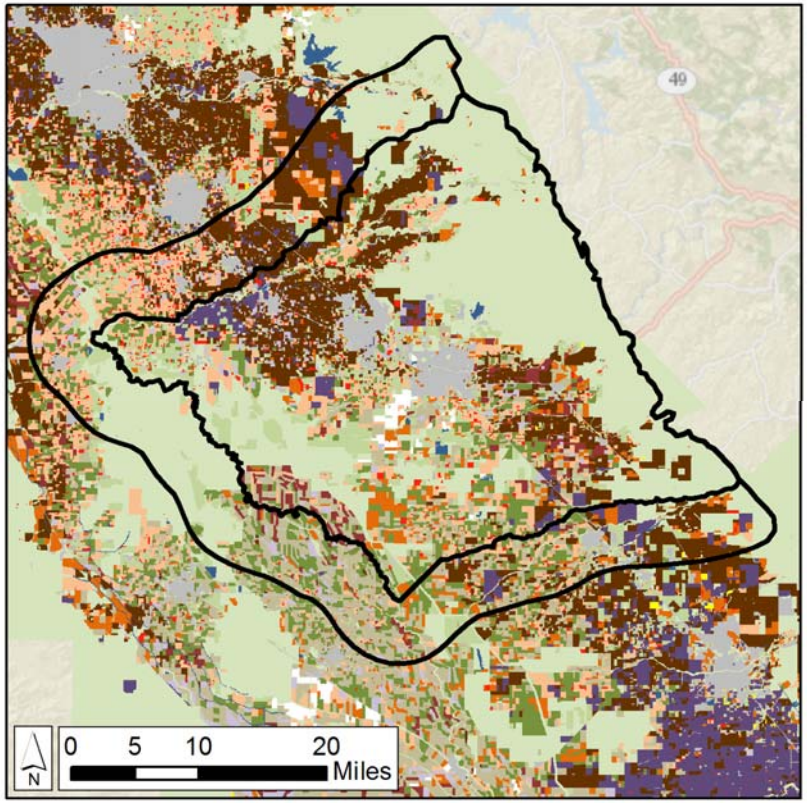
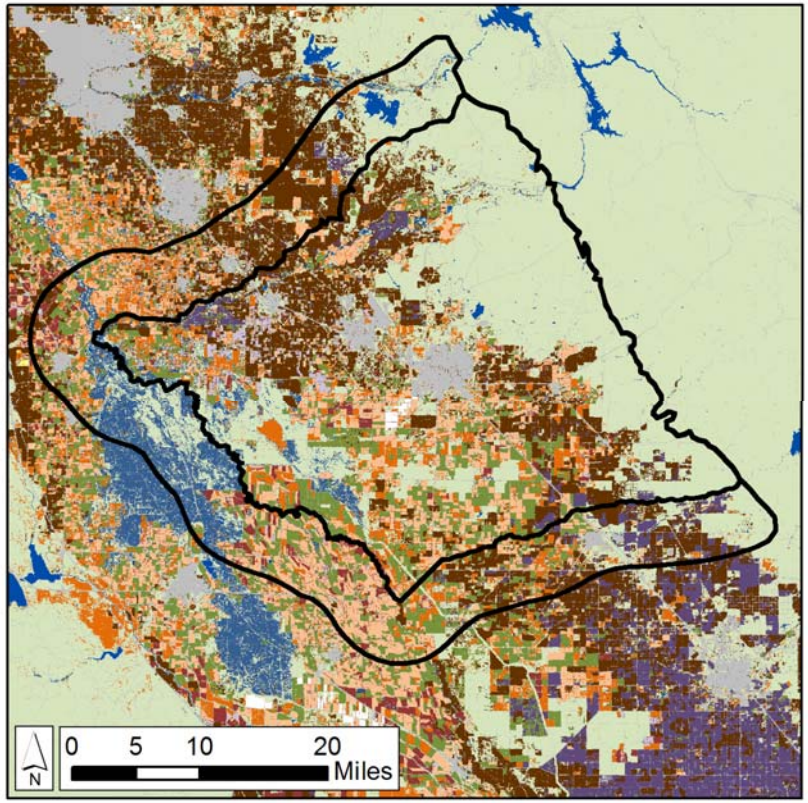
Merced WR Model Relied on Detail Land Use Data

1995 DWR Land Use



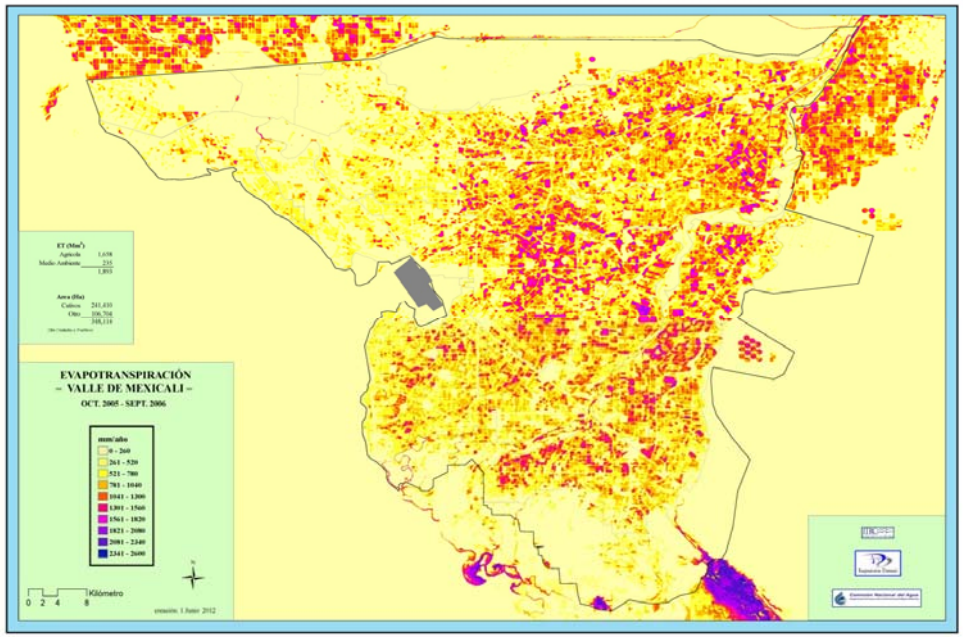
2013 Cropscape Land Use



Merced WR Model
Agricultural Water Demand Estimates using METRIC Methodology

LandSAT Image

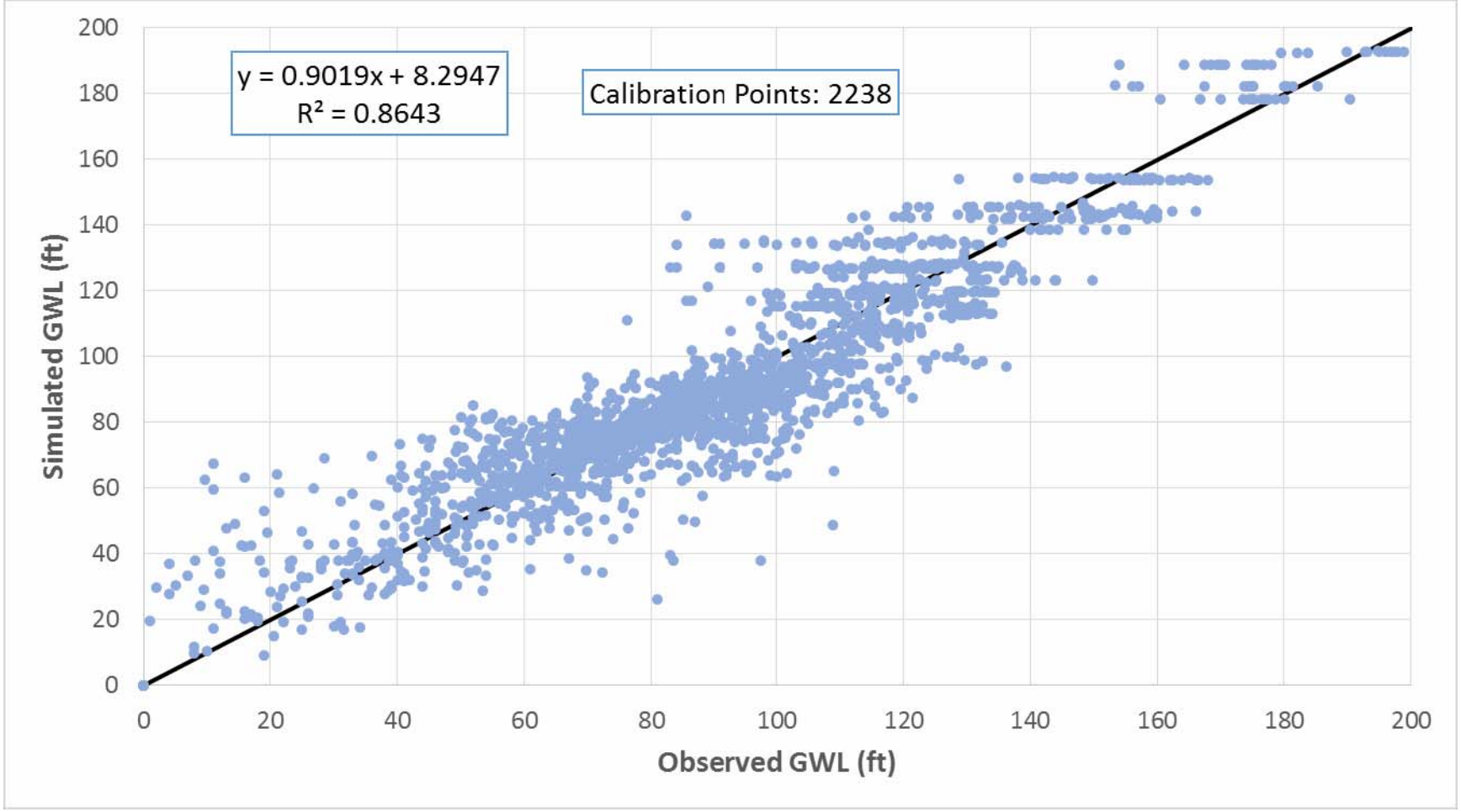
ITRC-METRIC Model Computations



Result = ET

30m x 30 m pixels

Merced WR Model
Calibration Statistics Summary



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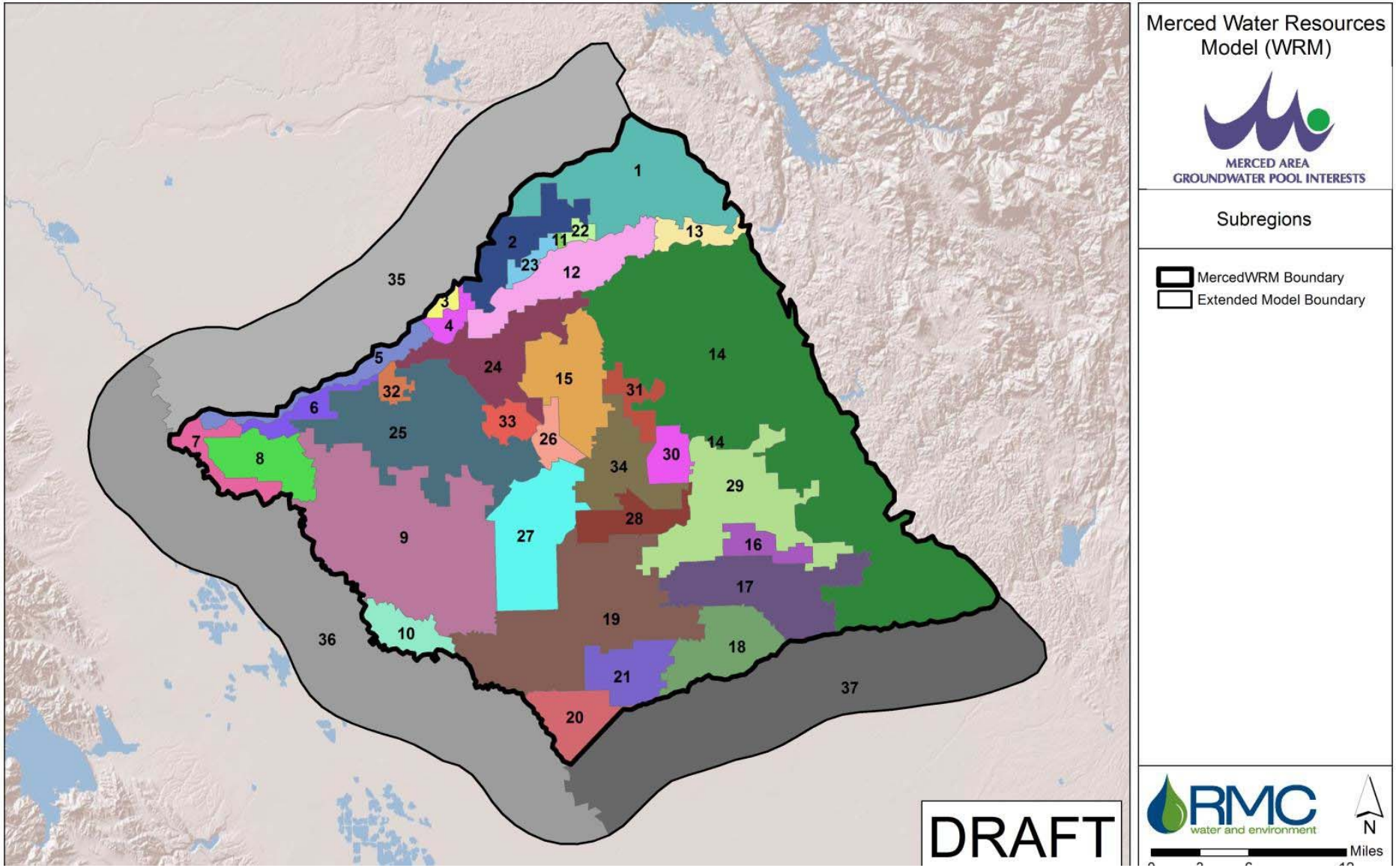
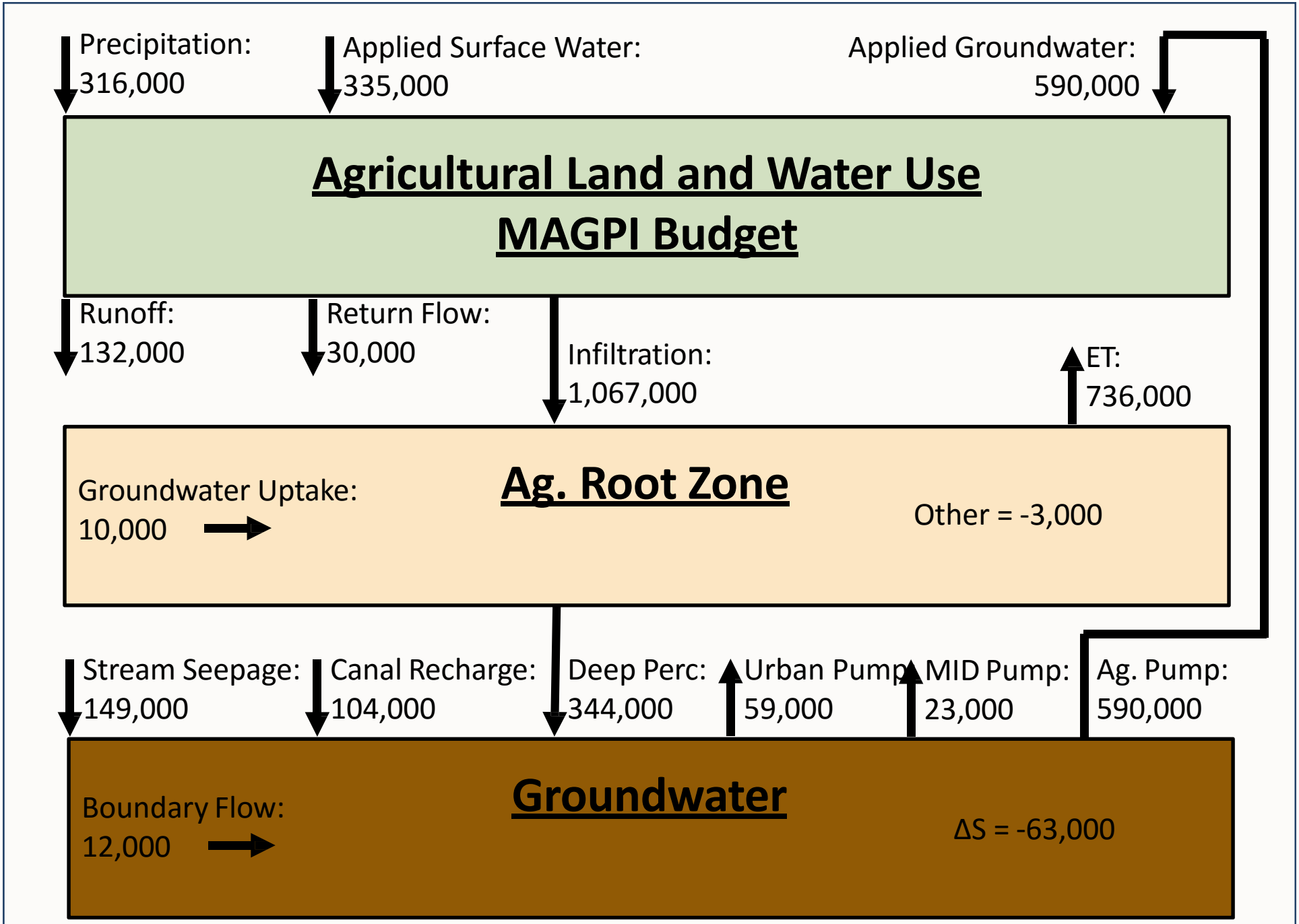
Merced WR Model Subregions





**Average annual for 1995-2013 in AF/year

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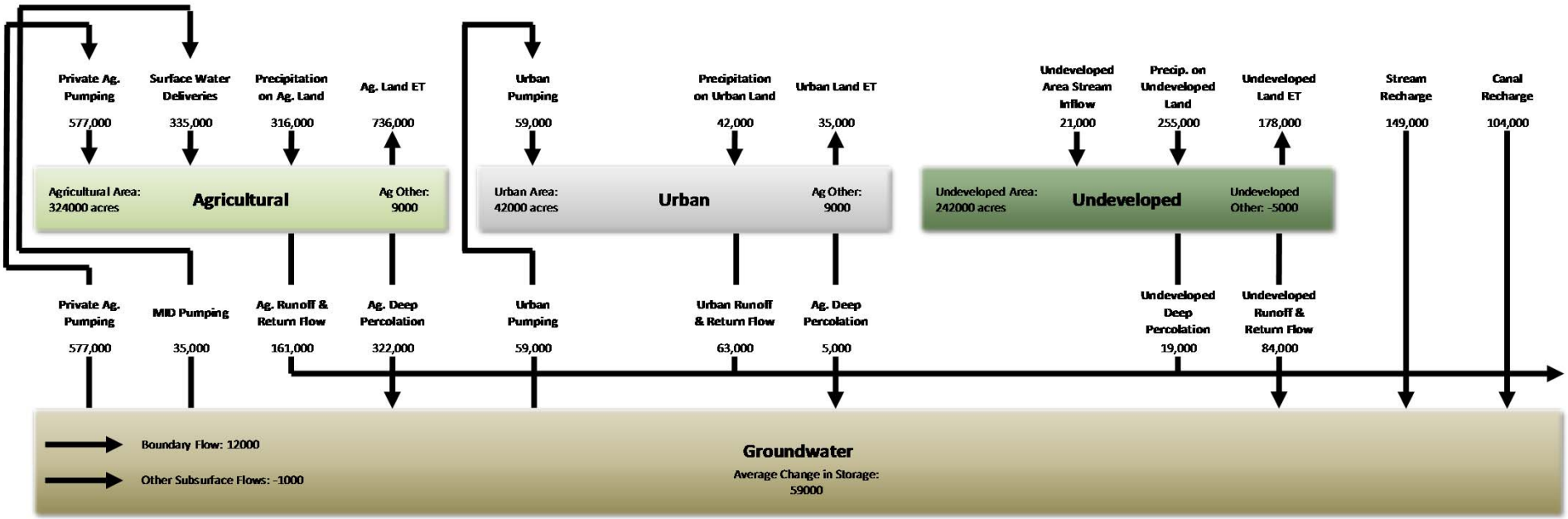
Comprehensive Water Budget
MAGPI Area



A Local Model ….

- Provides significant detail to support SGMA projects as well as local operations
- Requires significantly more data and information
- Costs more, but provides flexibility and control in development, maintenance, ownership of data and results, and use and application

Some final thoughts ….

- If you have a model or are in the process of building one, make sure it is up to date and ready for SGMA
- If you don’t have a model, evaluate the feasibility of developing one that meets SGMA requirements; Work with neighboring GSAs in your Subbasin; build synergy in moving down the SGMA path
- If there is a regional model that covers your area (e.g., C2VSim or CVHM), work with the responsible entity to ensure your area is properly represented
- If there is no model to be had, rely on other analytics to develop your water budget

Data from Existing Models

Major Data Items/Types	C2VSim-FG	CVHM	Other Sources
Topography	From C2VSim coarse grid	Using DEM	DEM
Geology	3 layers	10 layers	USGS texture model, drillers logs
Aquifer Parameters	Horizontal and vertical hydraulic conductivities, specific storage, specific yield	Hydraulic conductivities correlated to fraction of coarse-grained sediment, specific yield and specific storage	USGS report
Stream Geometry	Bottom elevation, rating table, stream bed hydraulic conductivity, stream bed thickness, and wetted perimeter		DWR floodplain program
Stream Flows	Inflows	Inflows	USGS stream gages
Soil Parameters	Saturated hydraulic conductivity, porosity, field capacity, wilting point, and PSDI for each element	Saturated hydraulic conductivity, porosity, field capacity, wilting point, and PSDI for each element Capilary fringe thickness	SSURGO, STATSGO2

Data from Existing Models (Cont'd)

Major Data Items/Types	C2VSim-FG	CVHM	Other Sources
Rainfall	From PRISM	By cell from PRISM	PRSM, weather stations
Evapotranspiration	By crop type (13 types) and subregion, one time step	Estimate monthly for each cell using minimum and maximum temperatures and extraterrestrial solar radiation	CIMIS, SSID /OID METRIC, ITRC (DWR) 2011/2014 ET Maps
Surface Water Diversion	Diversions to demand units	Diversions	Water providers, SWRCB
Groundwater Pumping	Groundwater pumping represented by subregion, distributed to elements by land use	Simulated agricultural and urban pumping by cell (based on land use)	GW Pumping by Water Purveyors
Groundwater Levels	Production and calibration wells	Production and calibration wells	Local knowledge, well permits, AWMPs, GWMPs
Land Use	Urban, Agricultural, Native, and Riparian- by C2VSim coarse grid elements (from DWR land use surveys)- and crop acreage- by subregion (from DWR land use surveys and Ag Commisioner Reports)	Majority land use specified by cell and includes urban, agricultural (12 categories based on DWR class-1), water bodies, and natural vegetation. Land use estimated across time using various sources	DWR LU surveys and LandIQ surveys, USDA CropScape, AWMPs, Co. Ag Commissioner Reports, Local Agencies

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Save As...
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DSS File Name
Scenario Description
Run Period
Month Year
Start
End
Run Type
Deterministic
Probabilistic
Run Basin
Pre-Biological Opinion
Biological Opinions
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