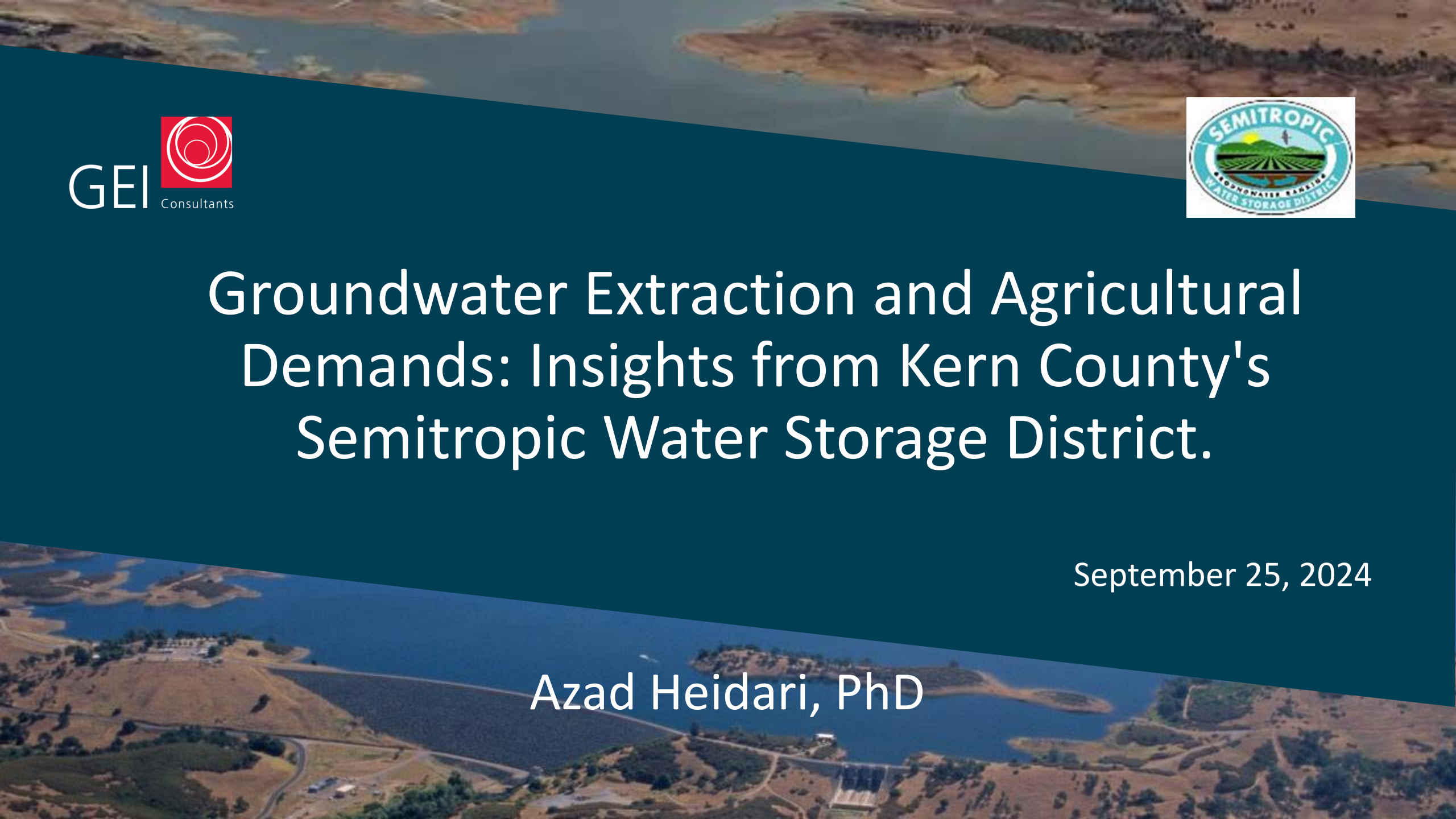


Groundwater Extraction and Agricultural Demands: Insights from Kern County's Semitropic Water Storage District.

September 25, 2024

Azad Heidari, PhD

Agenda

- Goals and Objectives
- Model setup and input data
- Improving input data and model
- Results
- Next steps

Goals and Objectives

Overarching goal

- Analyze the water use and groundwater extraction in Semitropic Water District (SWSD) in Kern County, CA during 1983 to 2022.

Objectives

- Develop reliable hydrologic/rootzone models (IDC).
- Estimate historical agricultural water demand.
- Estimate historical the groundwater extraction/recharge.
- Run future scenarios to assess the impact of land use, water use, and policy change.

Groundwater Extraction Assumption

- The net ground water extraction is defined as the difference between applied water and surface water delivery to the area.

Model Setup and input data

Main Inputs

- **Landuse/ Land Cover**: 1980 to 2010 extracted from C2VSIM
  2010 -2016 District Crop Survey.
  2016-2022 Land IQ & Crop Survey.

- **Climate data**: precipitation, min/max temperature, solar radiation, wind speed, relative humidity, dew point temperature.

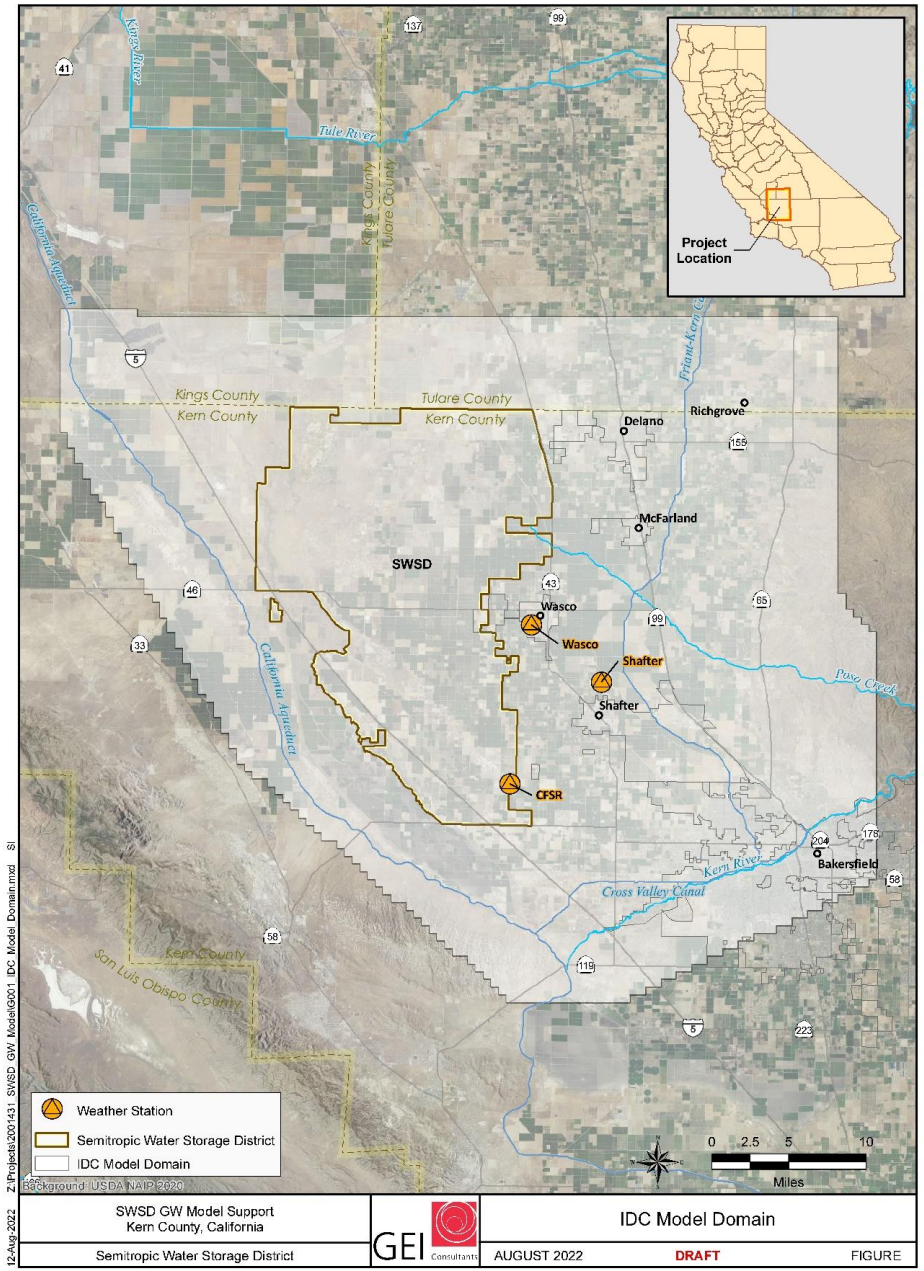
- **Evapotranspiration:** DWR Consumptive Use Program PLUS (CUP+), Remote Sensed ET

- **Soil data:** Wilting point, field capacity, total porosity, pore size distribution index, USDA curve number, saturated hydraulic conductivity → SSURGO database (Processed by DWR tool: Soil Data Builder with GIS).
- **Surface water deliveries:** Initially from C2VSim. Processed District data by Distribution system.

Location and Climate Data

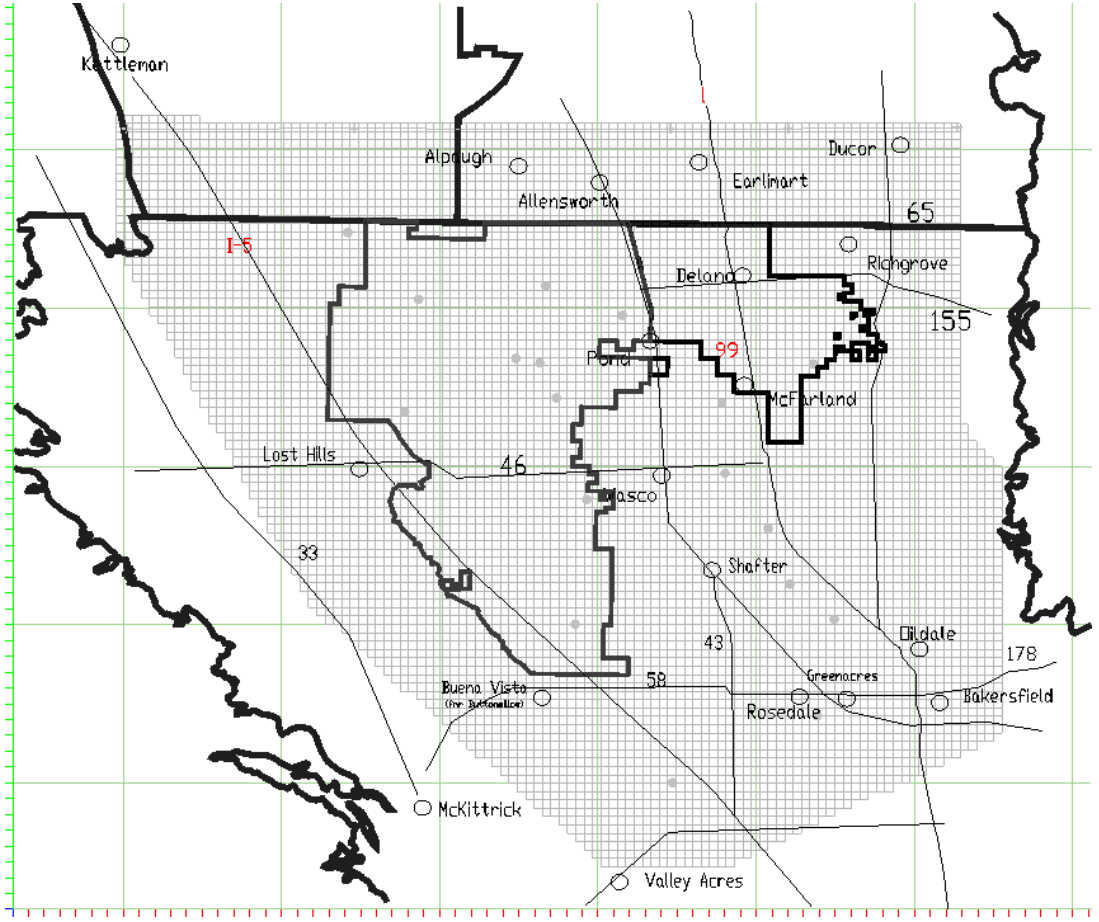
Station	Source	Starting date
Shafter	CIMIS	6/1982
Wasco	NOAA	01/1901
CFSR	CFSR	01/1979

NOAA: National Oceanic and Atmospheric Administration.
CFSR: The National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis.
CIMIS: California Irrigation Management Information System (CIMIS)



Grid Cells

- **GEI ½-mile MODFLOW Grid**
- **Element (Cell) Size:** 0.25 sq. mi. (160 acres)
- **Total Active Area:** 1,780 sq. mi.
- **Active Cells:** 7,191 cells

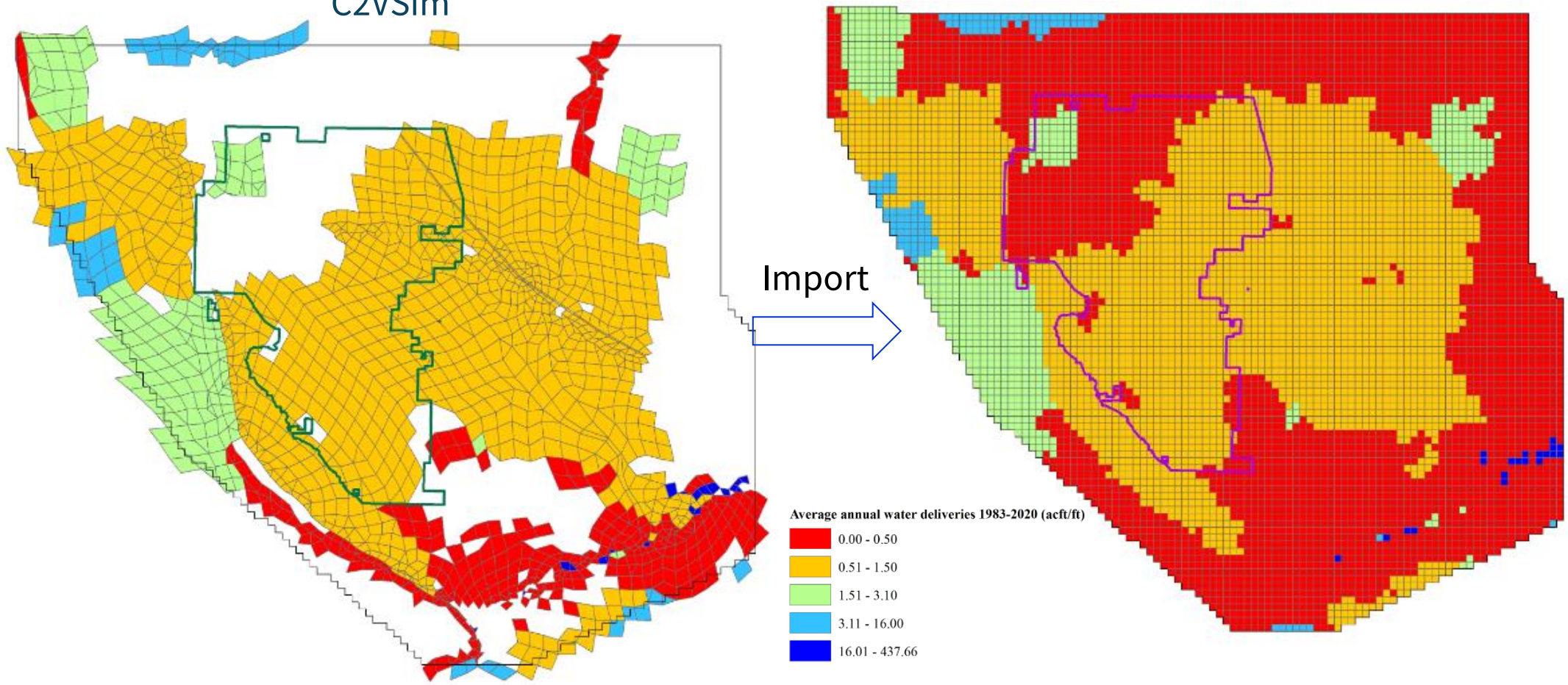


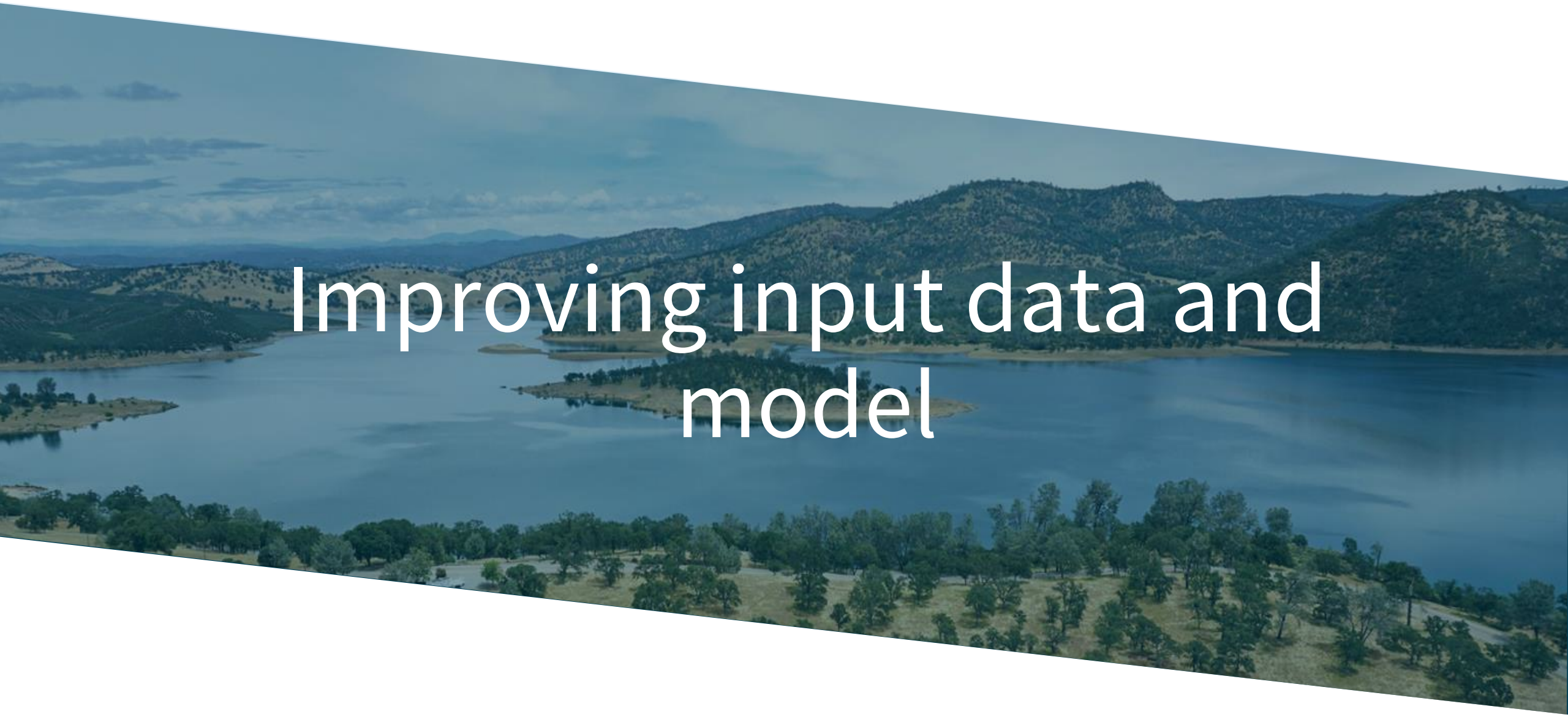
Historic Water Deliveries (average annual 1983-2020).

C2VSim

IDC

Import

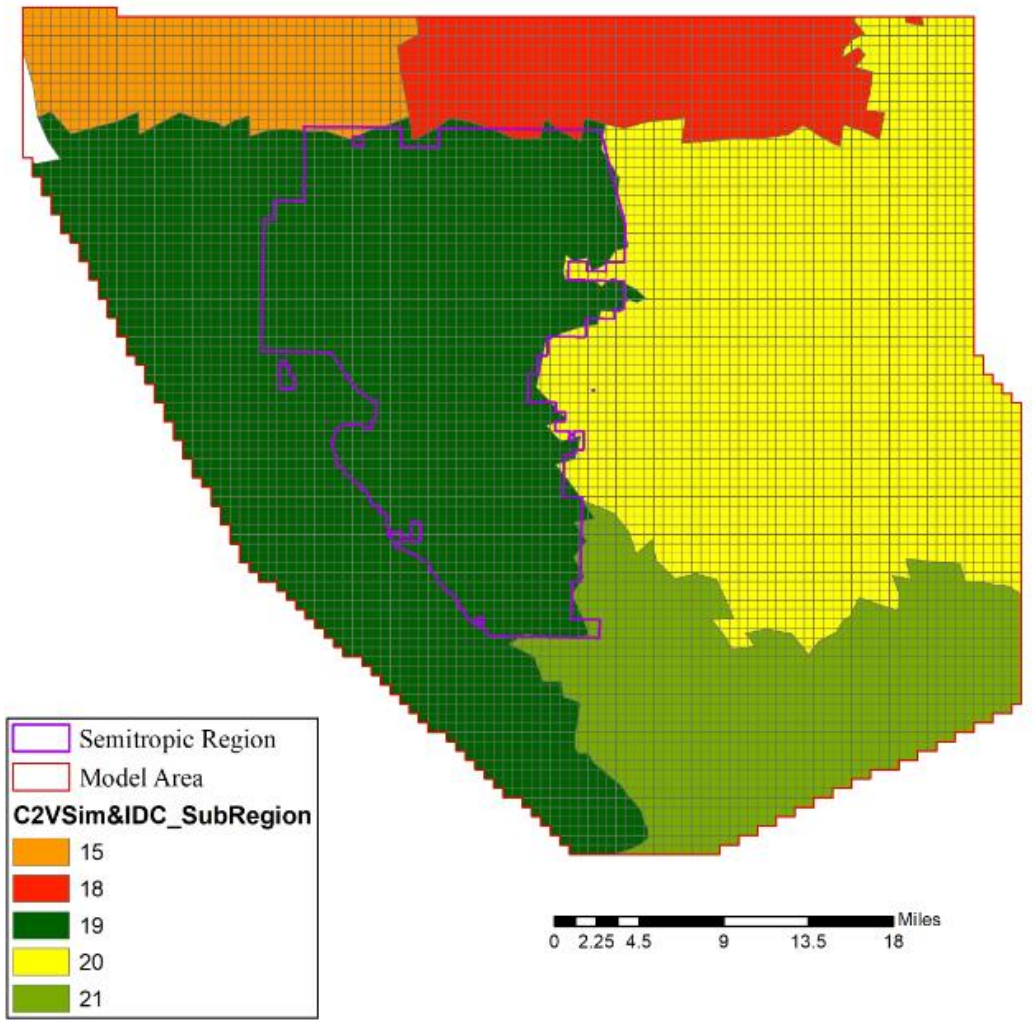




Improving input data and model

Calibration & Improvements

- **Extracted from modified C2VSim:**
  - ✓ Irrigation months (specific for crop and region)
  - ✓ Soil moisture content for triggering irrigation (0.35 to 0.7 of available water content)
  - ✓ Population and water use per capita
- **Consulting with model developers at DWR**
  - ✓ Soil hydraulic conductivity
- **Measured Climate and ET data**
  - ✓ Beginning in 2017, Semitropic began an extensive climate data collection effort within their service area, which included the installation and operation of several climate stations.
- **Refined Surface Water Distribution Network**

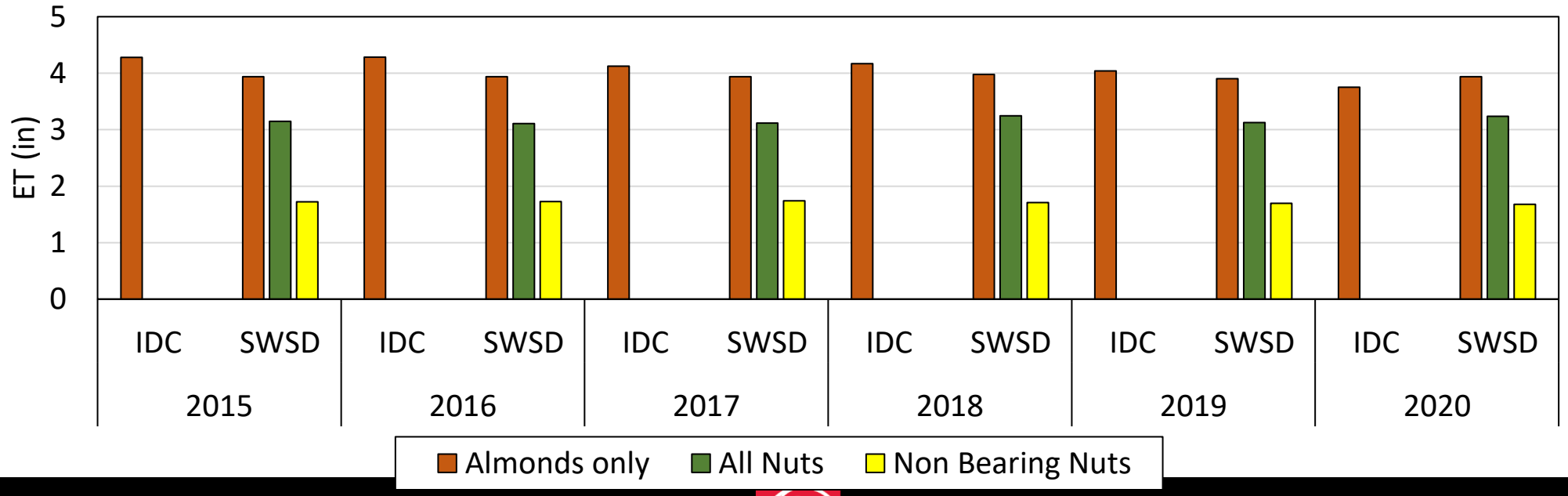


Improving ET calculations

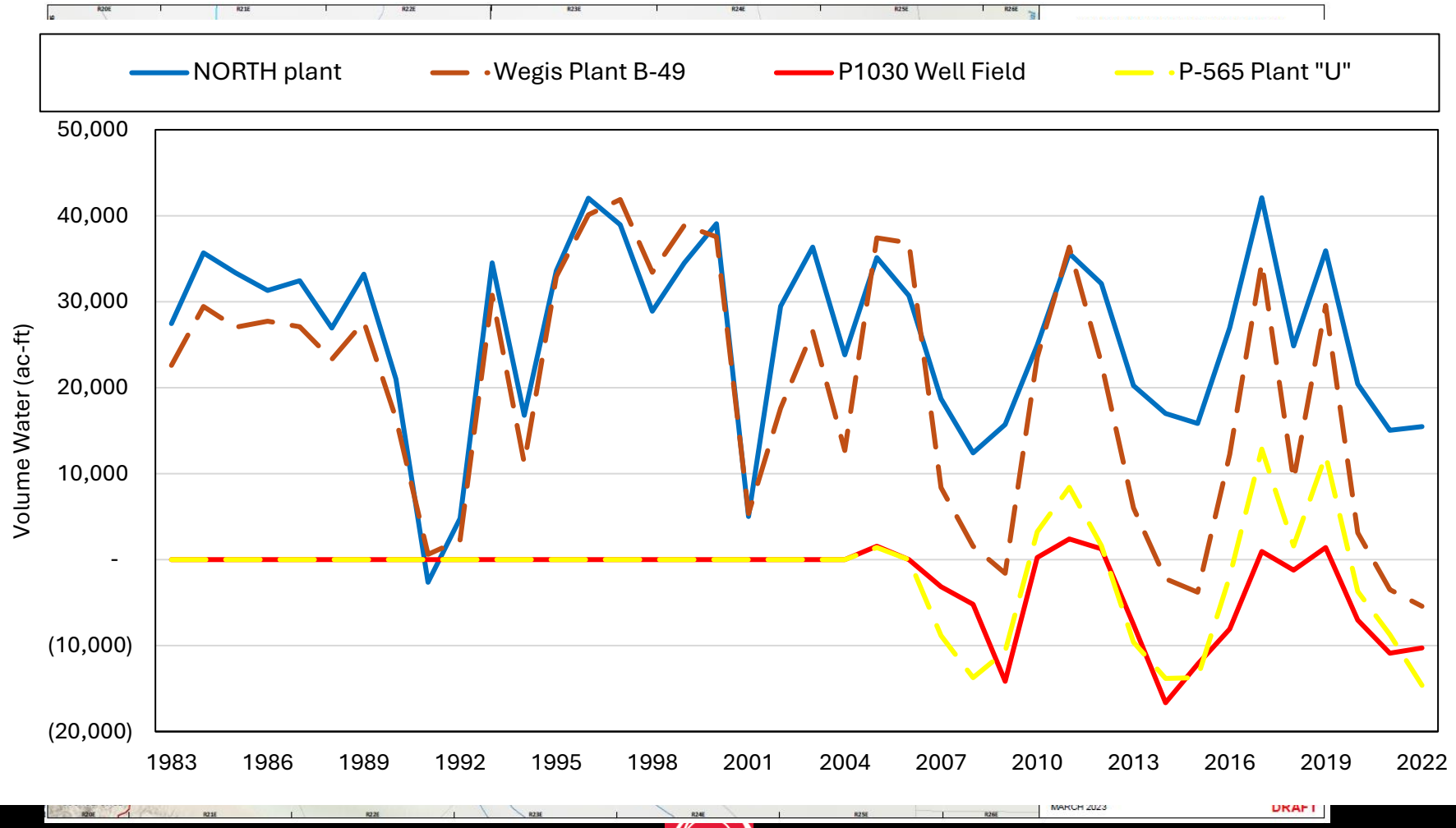
- Recognizing the substantial land area and significant differences in ET rates, we have divided the "Nut trees" group into four distinct categories.
- New categories:

A. Almonds (bearing), B. Almonds (non-bearing)

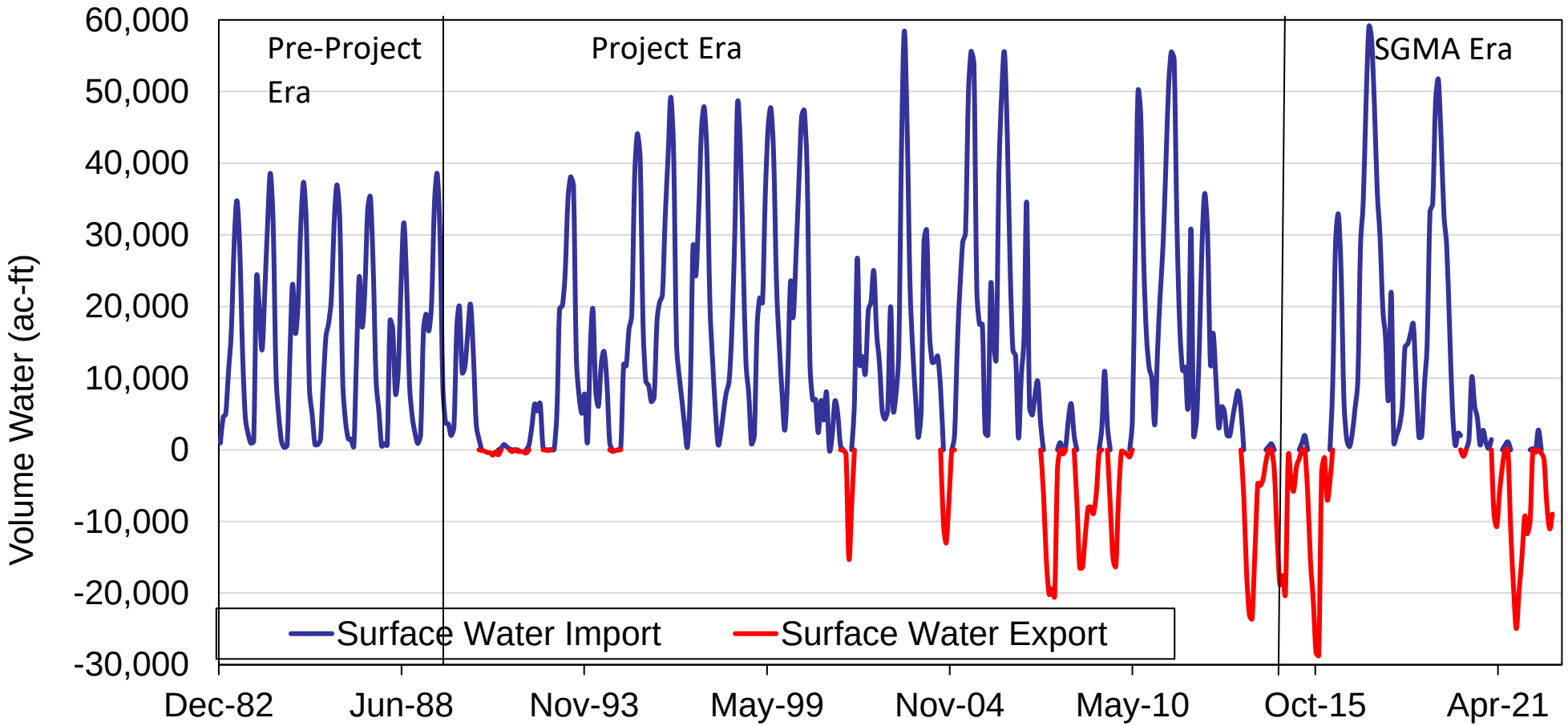
C. Pistachios (bearing), D. Pistachios (non-bearing)



Improving Surface Delivery Data

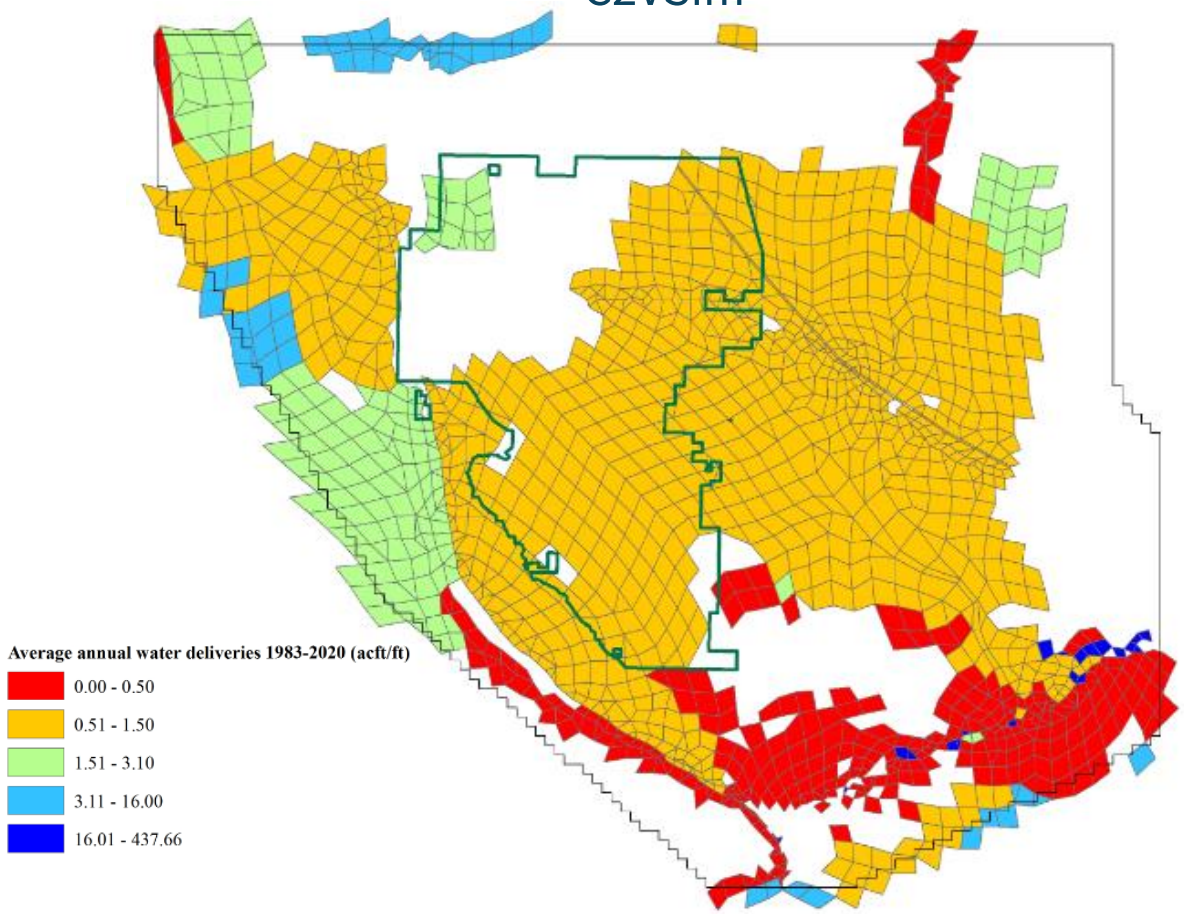


Refined Surface Water Distribution Network

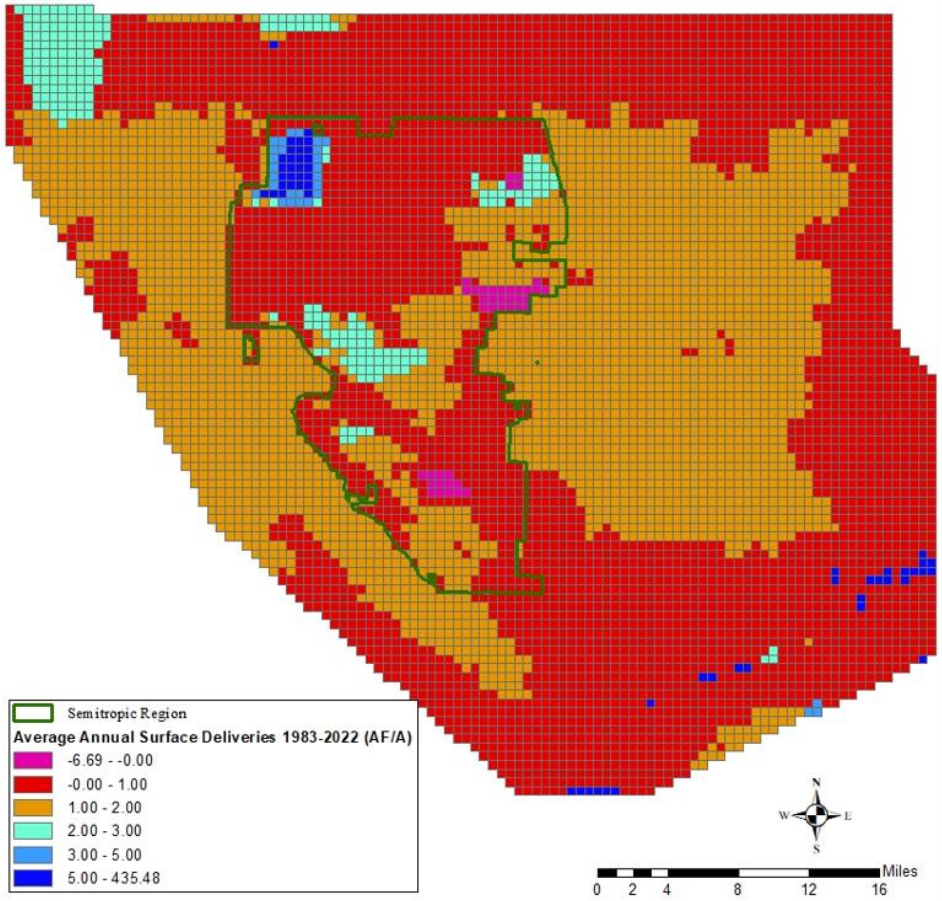


Improved Water Deliveries

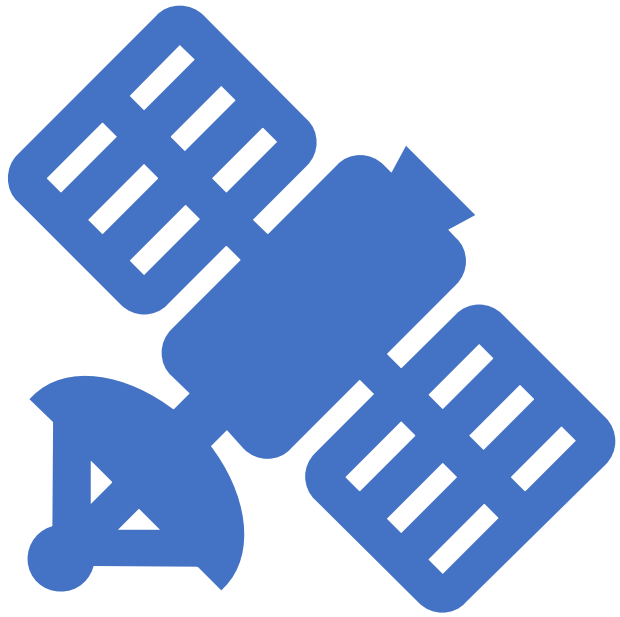
C2VSim



IDC



Using Remote Sensed ET



Challenges with Remote Sensed ET:

- Remote sensed ET has two limitations:
  - It includes all ET, including precipitation and open water evaporation.
  - It does not account for losses such as deep percolation.

Resolution:

- Remote sensed ET could be utilized as an input to IDC, enabling IDC to factor in losses and calculate effective precipitation.

Enhancing Accuracy:

- This integration empowers IDC to deliver more precise calculations.

Update Irrigation Timing in IDC:

- The irrigation months will be updated according to the remote sensed ET.

Results

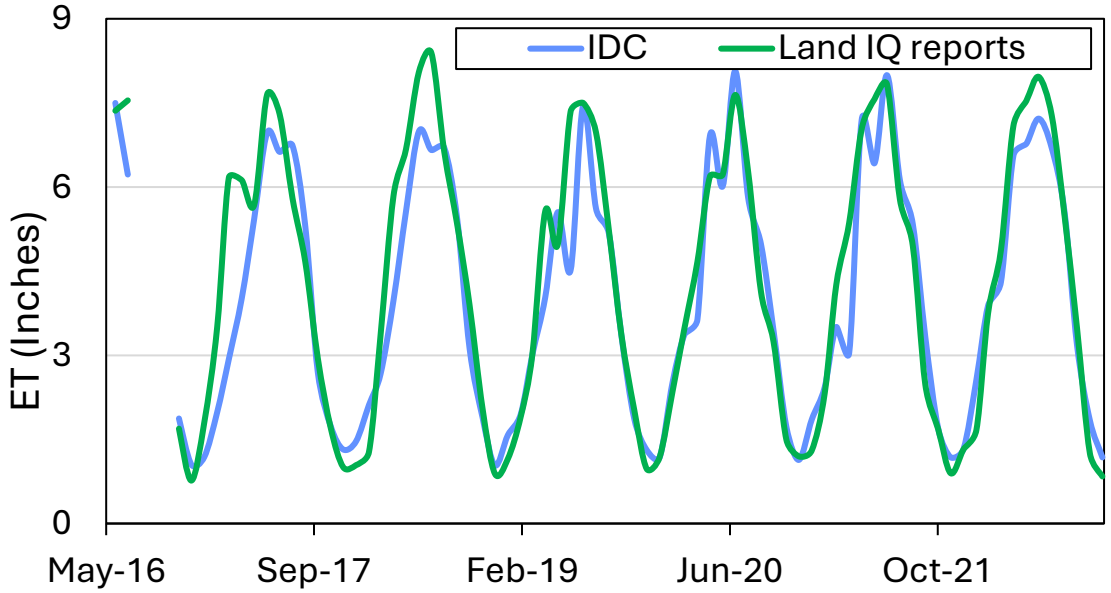
Announcement

- **Draft Results:** The data presented here is still in draft form.
- **Under Review:** Data is currently being reviewed for accuracy and completeness.
- **Subject to Change:** Final results may differ based on ongoing evaluations.

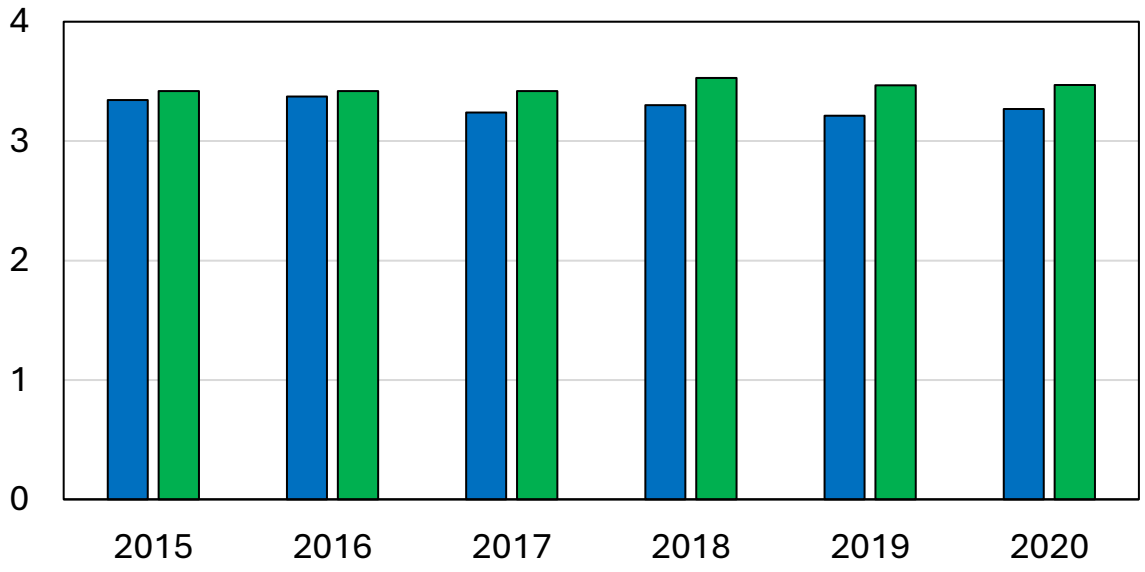
Semitropic Region – ET (alfalfa)

- The results from IDC match the measured values reasonably well. It captures the trends thoroughly with the highest ET values occurring during the months of June, July and August (7.2 inches average) and the lowest moths of Nov, Dec, Jan and Feb.

Monthly ET values for Alfalfa



Annual ET values for Grapes

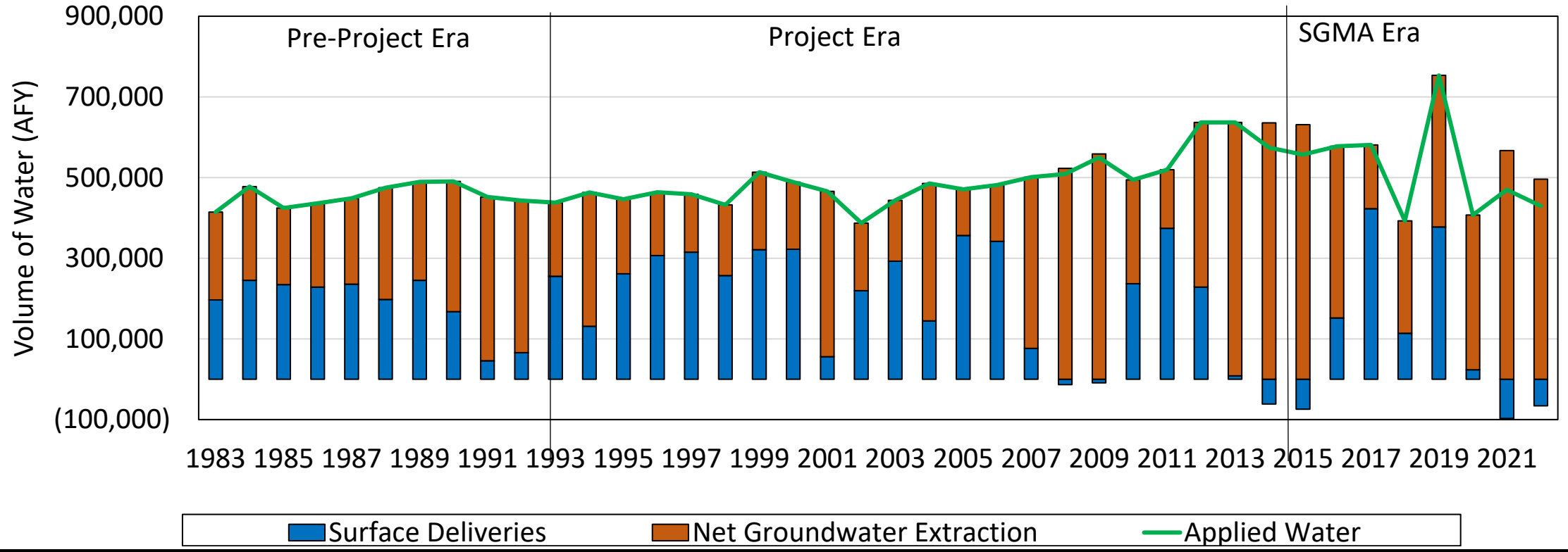


Water Balance – Semitropic

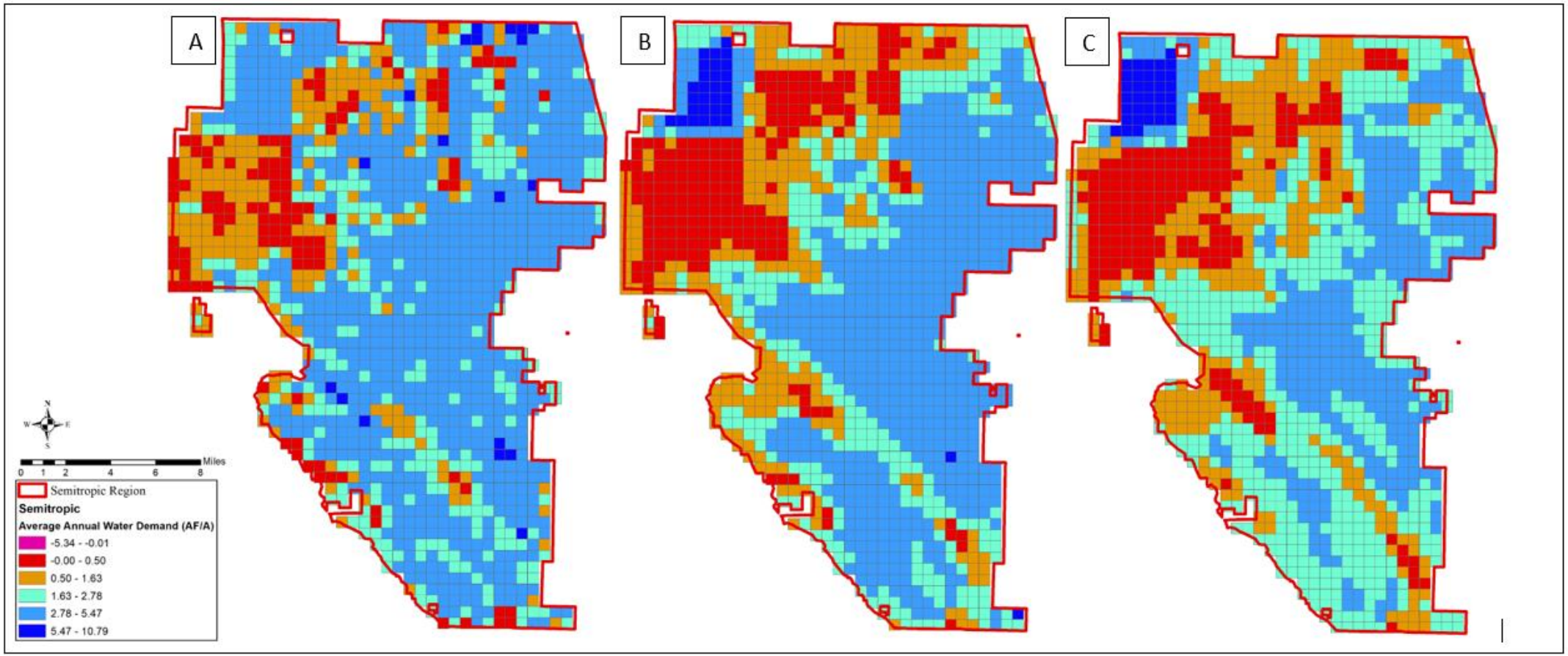
- The groundwater extraction (water demand in excess of the surface water delivered) is 311,000 AFY on average.

Average annual water demand is estimated to be 489,000 AFY

Average annual surface water delivery is estimated to be 178,000 AFY

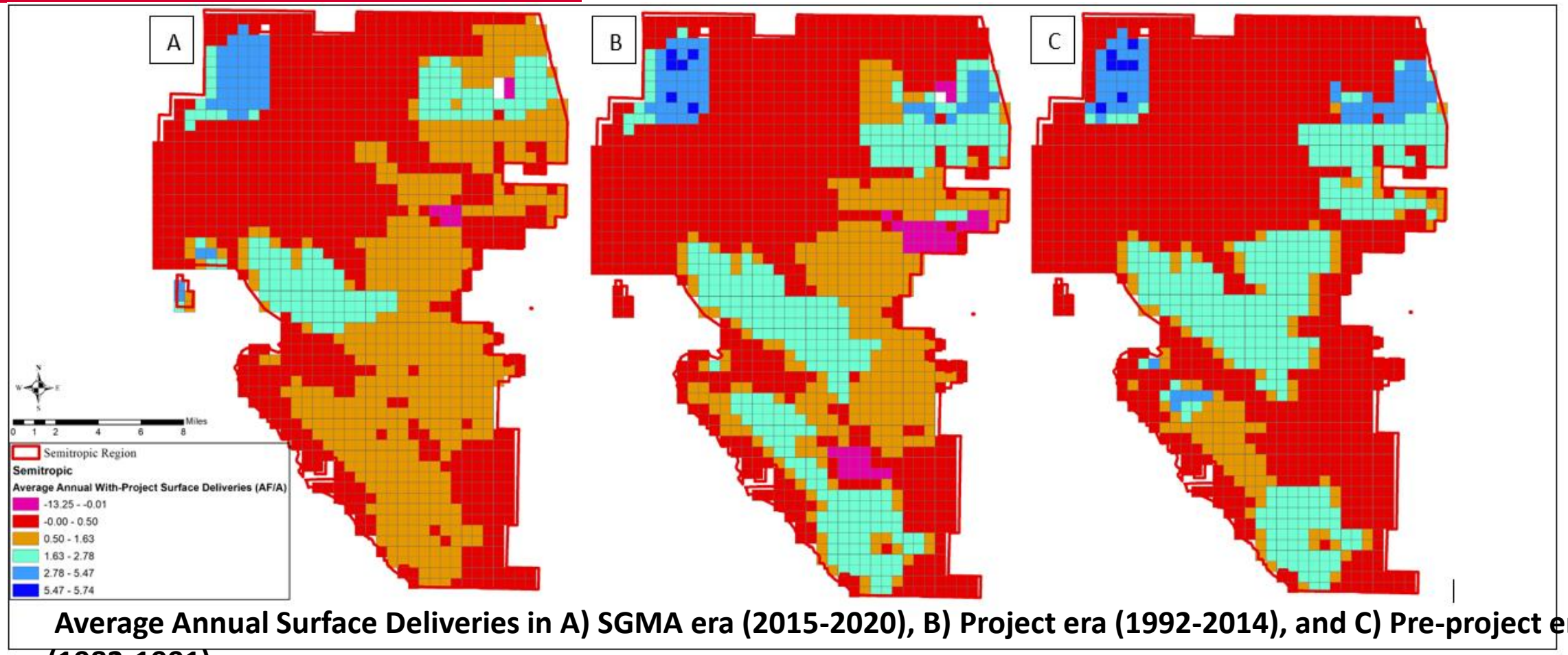


Water Demand – Semitropic



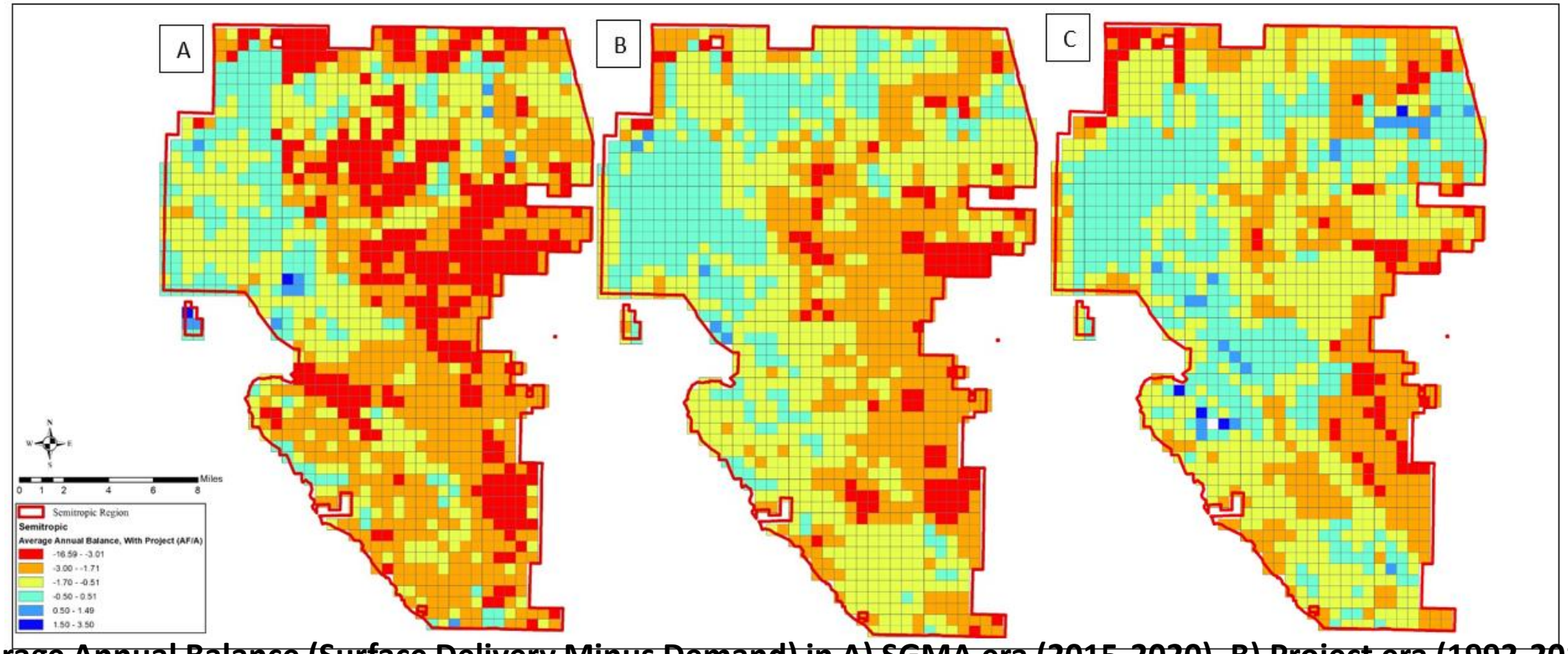
. Average Annual Water Demand in A) SGMA era (2015-2020), B) Project era (1992-2014), and C) Pre-project era (1983-1991).

Water Deliveries – Semitropic



Average Annual Surface Deliveries in A) SGMA era (2015-2020), B) Project era (1992-2014), and C) Pre-project era (1983-1991).

Water Balance – Semitropic

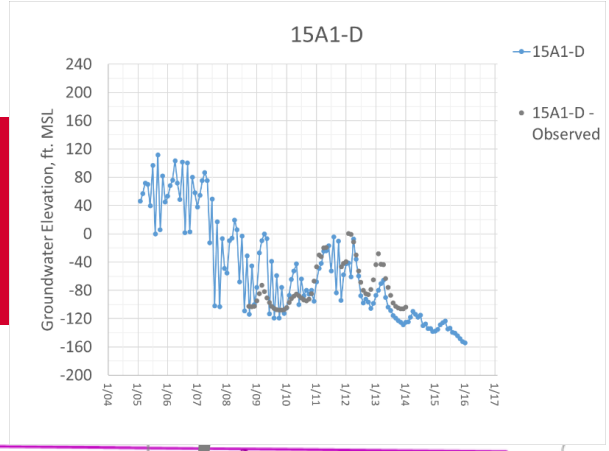


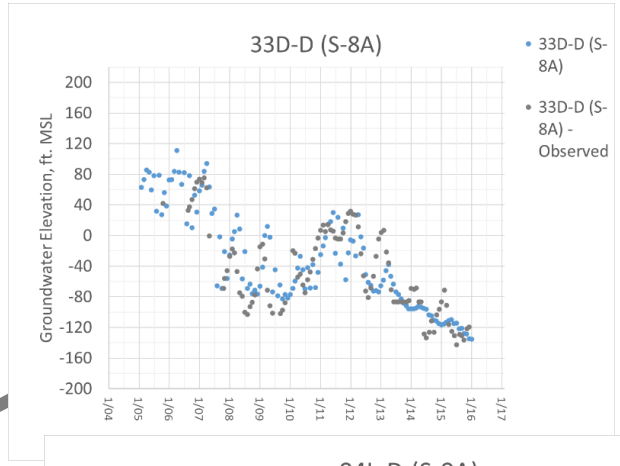
Average Annual Balance (Surface Delivery Minus Demand) in A) SGMA era (2015-2020), B) Project era (1992-2014), and C) Pre-project era (1983-1991).

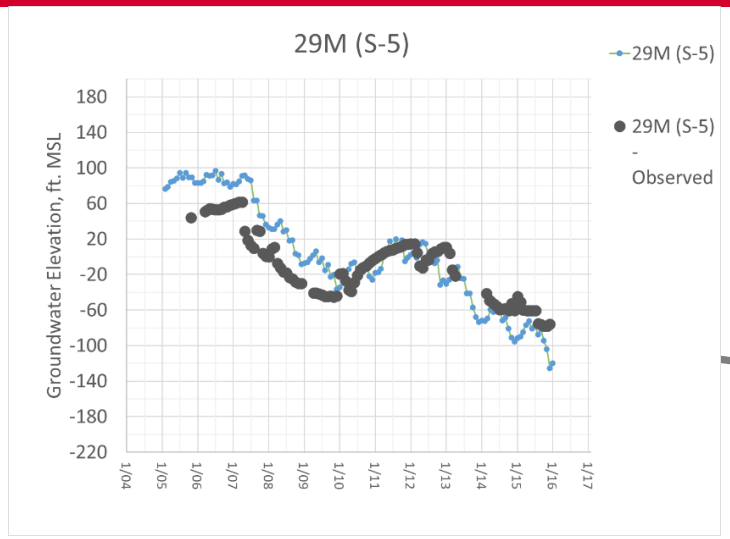
Final Products of the IDC for MODFLOW

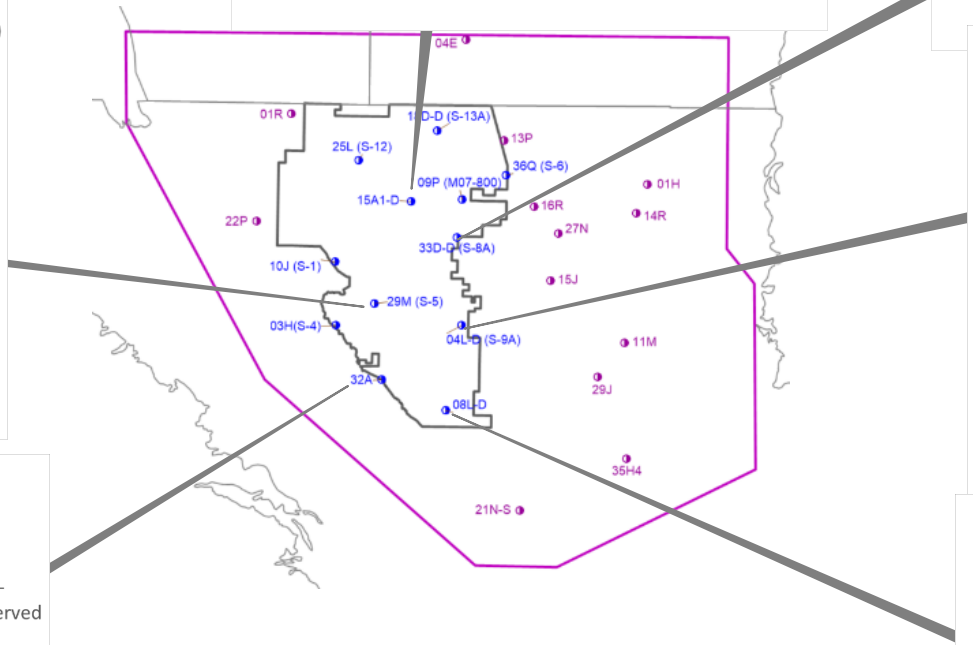
- ✓Groundwater Extraction/Recharge
- ✓Deep Percolation
- ✓Surface Water Deliveries
- ✓Water Demand

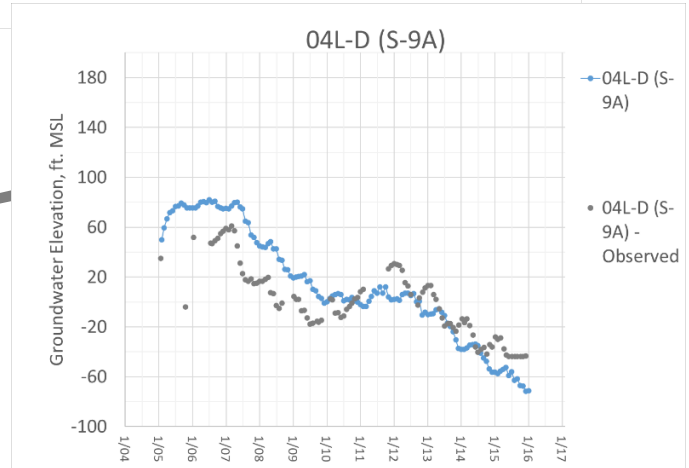
Sample MODFLOW plots

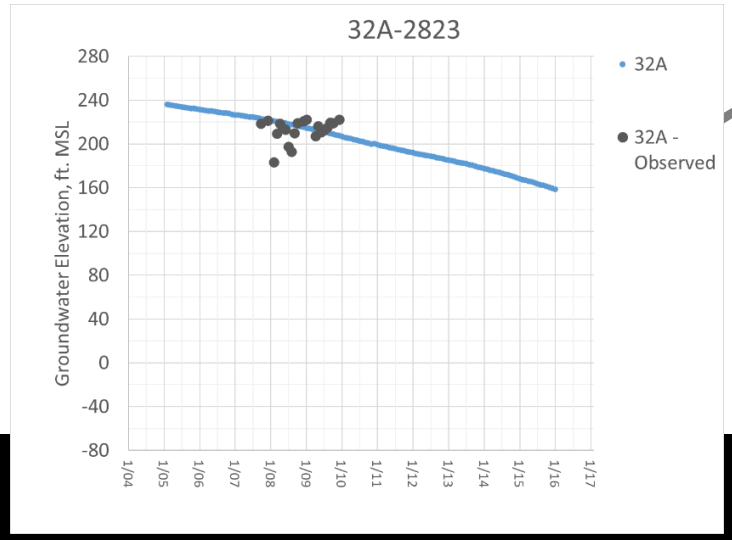


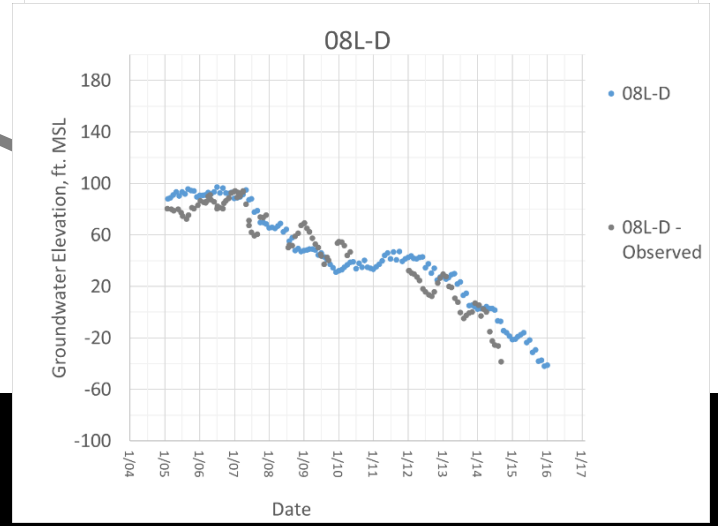












Typical Calibration Plots, 2005-2010

Next Steps

Next Steps

- ✓Finalize and Incorporate Remote Sensed ET Data.
- ✓ Update and Improve Surface Deliveries Data.
- ✓ Enhance IDC Run: Use the latest version and apply recommendations from IDC developers.
- ✓ Review and Quality Check: Prepare data for the final model run.
- ✓ Re-Calibrate and Validate Results.
- ✓ Run MODFLOW Using Improved Data.
- ✓ Execute Future Scenarios.

Questions and Answers

GEI Consultants

Thank you

We look forward to taking your questions