



ONE WATER

MF-OWHM Sessions at 2026 CWEMF Conference

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April 21, 2026

3pm → Happy Hour/Poster Session



Today's 7 Presentations & Speakers

(1) New Conjunctive Water Management (CWM) – *Randy Hanson (One-Water Hydrologic)*

(2) New and upcoming MF-OWHM features – *Dr. Scott Boyce (U.C. Davis)*

(3) Modeling Future Groundwater Depletion to Evaluate Sustainability Goals set by SGMA in the Critically Overdrafted Basins of the Central Valley, California, USA (2020 – 2070) – *Logan C. Platt (UCSD)*

(4) Simulating Future Flow and Salt Transport in the Delta-Mendota Subbasin – *Barbara Dalgish (LSCE)*

(5) Toward Solute Transport modeling framework through an Integrated Hydrogeological Model – *Mohamed Nassar (LSCE)*

(6) Evaluating Seawater Intrusion under Climate Change model updates and uncertainty analysis for Pajaro Valley, California – *Marisa Earl, (INTERA & USGS)*

(7) A River Runs Through It: Subsurface Connectivity and Exchanges Between the Salinas River and Groundwater Subbasins – *Dr. Wesley Henson (EKI & USGS)*



ONE WATER

Conjunctive Water Management for Sustainability of Water Supplies ***(Gestión Conjunta del Agua para la Sostenibilidad)***

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Dr. Richard Evans, Principal Hydrogeologist
Jacobs Engineering, Melbourne, Victoria, Australia

April 21, 2026

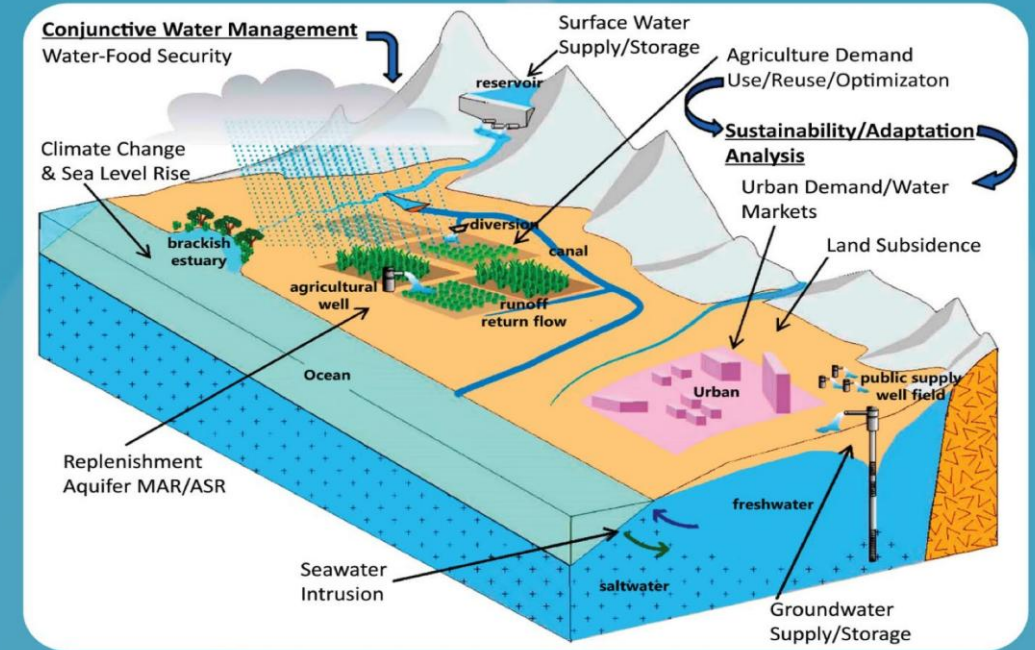


Conjunctive Water Management →

Conjunctive Water Management (CWM):
The integral resource management of consumptive use from all water sources for all uses providing a diverse portfolio that facilitates reliable mechanisms for adaptation, mitigation, replenishment, and sustainability within a supply-and-demand framework for human and environmental needs and is connected to other potential drivers of supply and demand including land use, population, industry, climate, and transboundary governance.

John Cherry's Groundwater Project

<https://gw-project.org/books/conjunctive-water-management/>
(Evans & Hanson, 2025)



Conjunctive Water Management

Richard S. Evans and Randall T. Hanson



Aligning Management/Governance Framework with Climate Cycles & Growth

1) Annual-Interannual:

Operations: Urban, Industry, & Agricultural Supply & Climate Variability

2) Internannual-Decadal:

Operations/Development/Governance & Climate Variability/Change

3) Multi-Decadal:

Build infrastructure for Development/Replenishment & Climate Variability/Change

4) Multi-Century:

Sustainability, Mitigation, & Adaptation

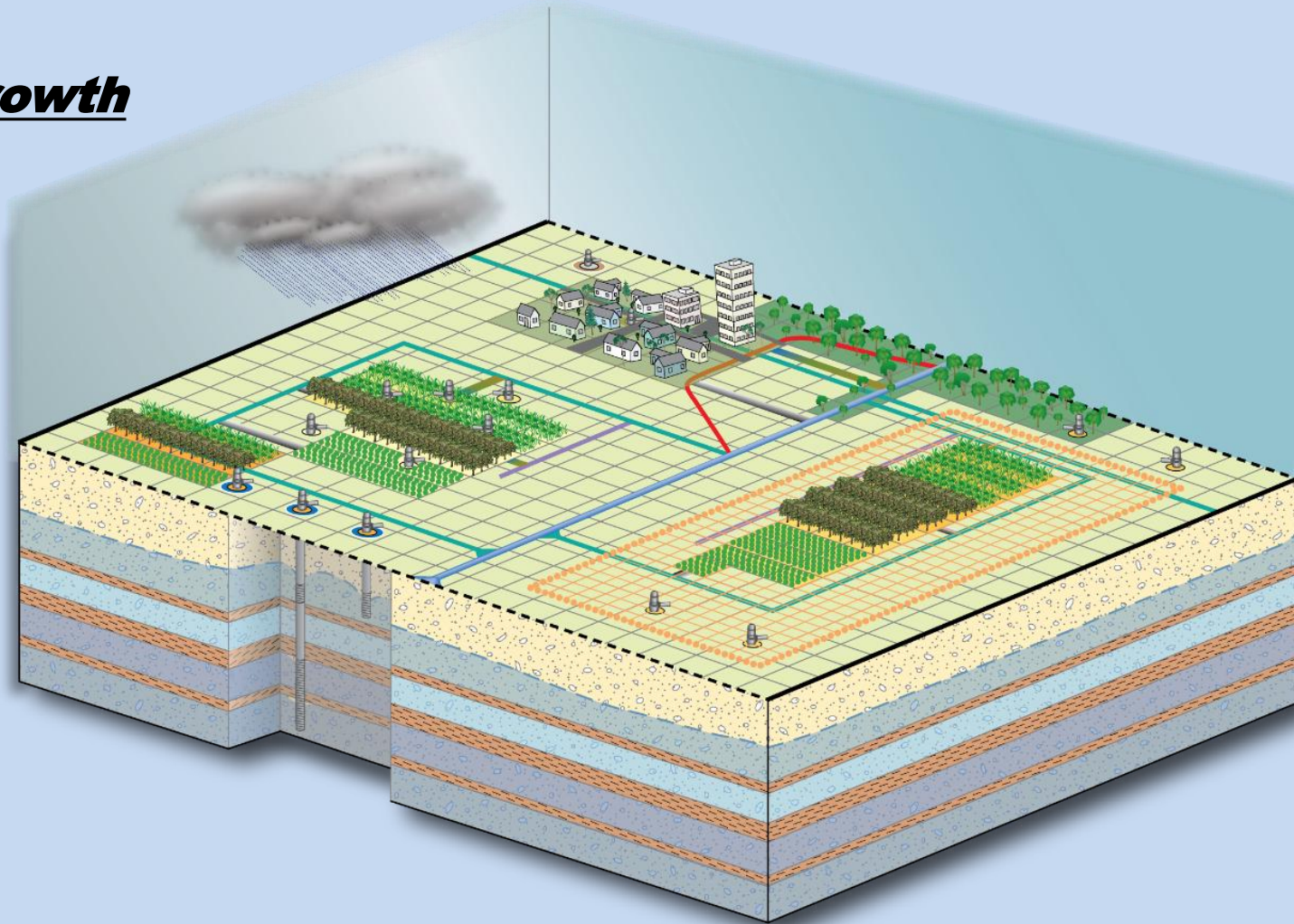
Supply Drivers: Direct Use, Reuse, Imports, Climate, MAR, FloodMAR, & DeSal

Demand Drivers: Population Growth, Land & Industry Development, Climate Variability/Change & Exports

Conjunctive Use:

Combined use of precipitation, surface water, recycled, imported, saline waters, and groundwater to optimize the use and quality of all water resources throughout the watershed and connected aquifer systems for human and environmental uses that promote sustainability. (Evans and Hanson, 2025)

One-Water Conjunctive-Use Modeling: All The Water → All The Time → Everywhere



SMART VALLEYS → SCADA + Self-Updating IHM Models

Smart Farms, Houses, & Factories



Smart Agriculture, Cities, Industry, & Reservoirs



(Land/Satellite/Drone Data Systems) ← **Smart Watersheds** ← **Smart Valleys**



Data Network Example: Distrito De Riego Del Rio Yaqui, Sonora, Mexico → 530 Pozos, 2 Presas, Suelo, Climatico, y mas!!



← Mexico's Wheat Basket



Climate/Boundary
Conditions

Water
Infrastructure/
Governance

Land Use and
Plant Water
Demands

One-Water Model
Self-Updating
Inputs/Observations

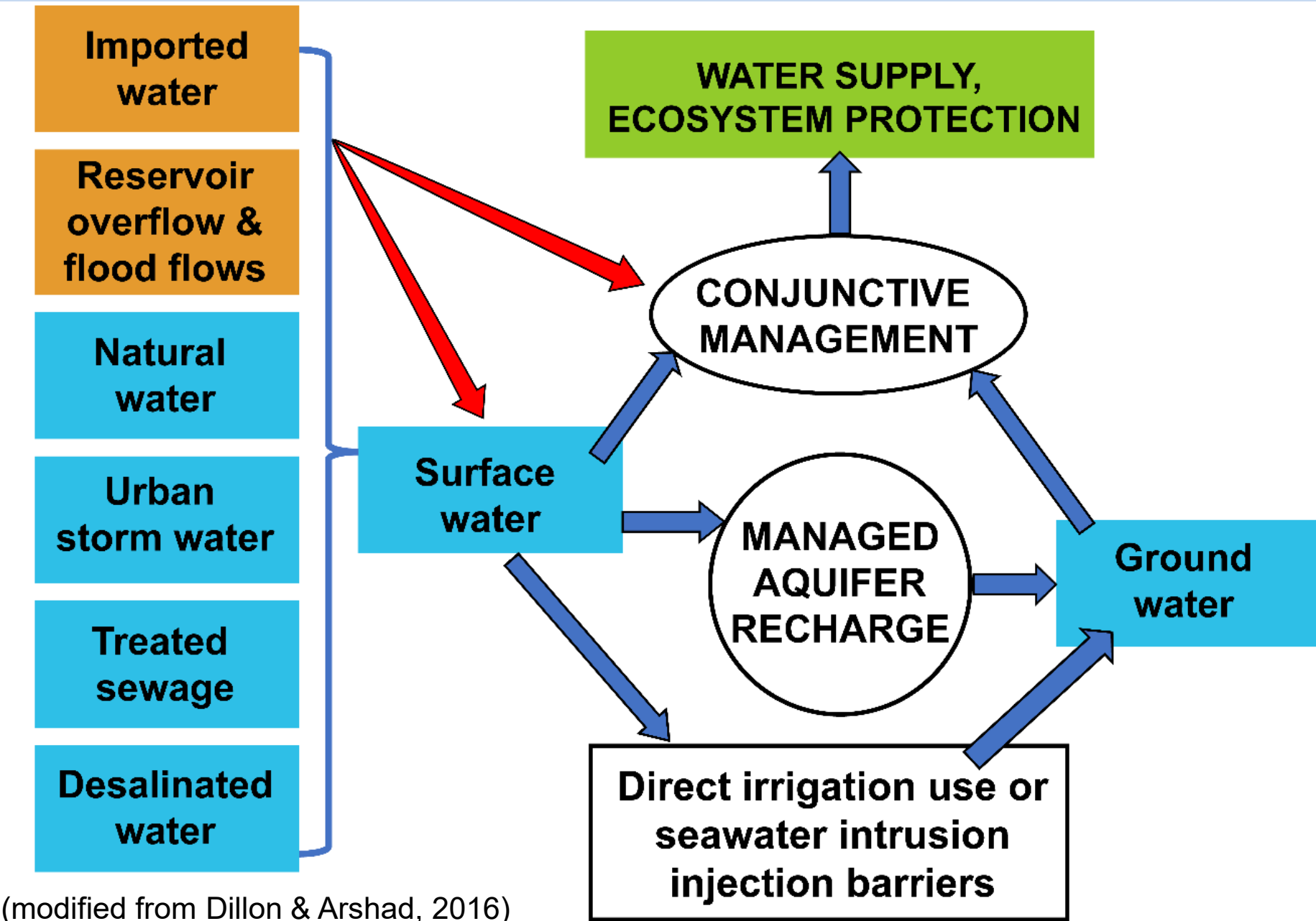
Managed Aquifer Recharge (MAR), ASR, & FloodMAR

Role of MAR in CWM.

Amount of recharge economically or technically achievable is generally less than the annual groundwater deficit. A combination of demand management & recharge enhancement is essential to restore a groundwater system to equilibrium (Dillon et al., 2009)

Most effective mechanism is direct use of these captured, recycled, or imported waters with the additional benefits:

- Multi-aquifer wells add groundwater recharge to deeper aquifers
- Reduced power consumption.



(modified from Dillon & Arshad, 2016)

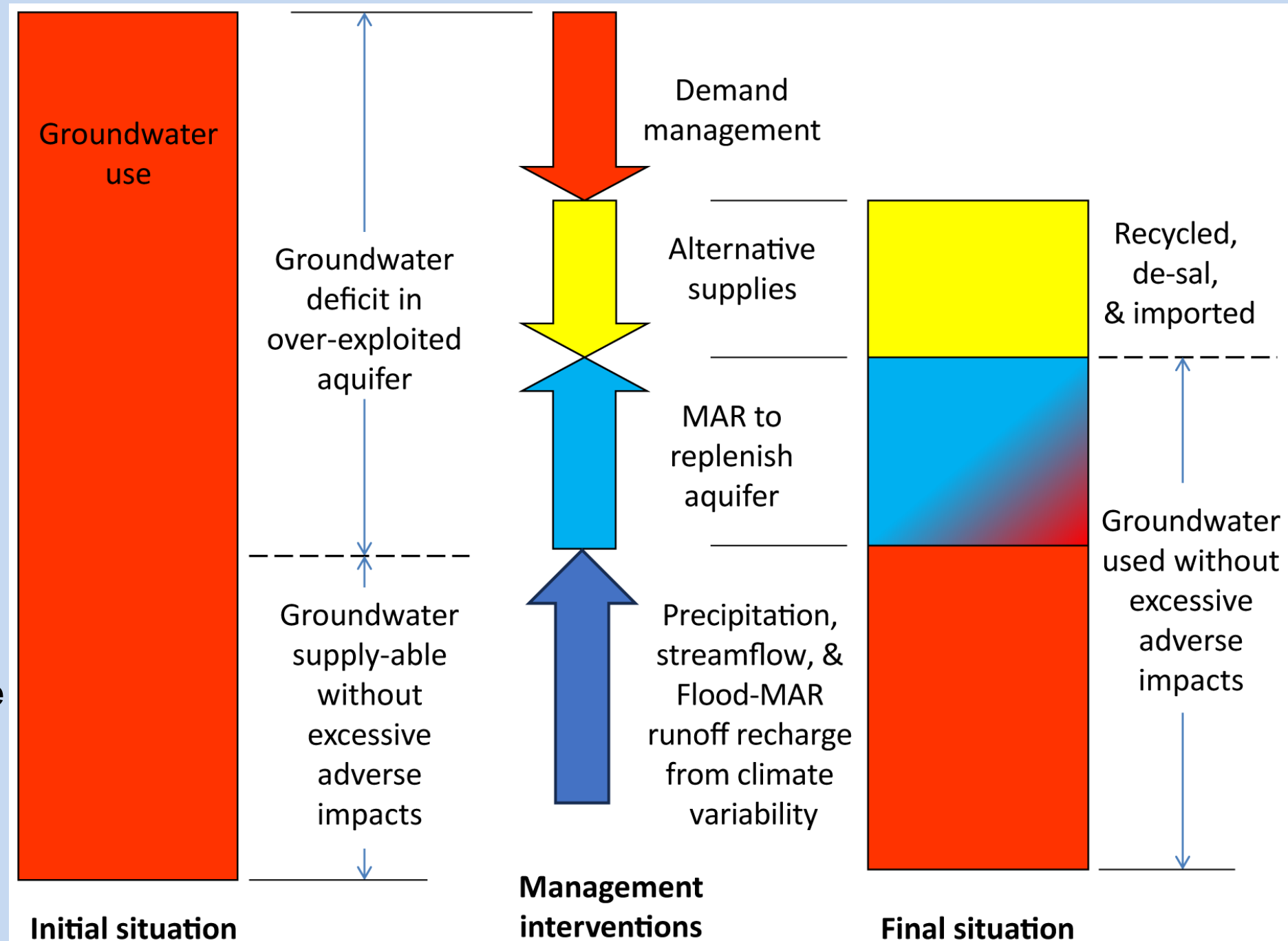
CWM Sustainability Framework & Goals

Bring aquifer back to dynamic nonequilibrium with reduced changes:

- (1) Reduce extraction (Demand Management),**
- (2) Add supply sources,**
- (3) Both!!**

Using groundwater replenishment, or alternative supplies (Conjunctive Use)

Reduce Demand - land use or other demand drivers
(modified from Dillon et al., 2012)

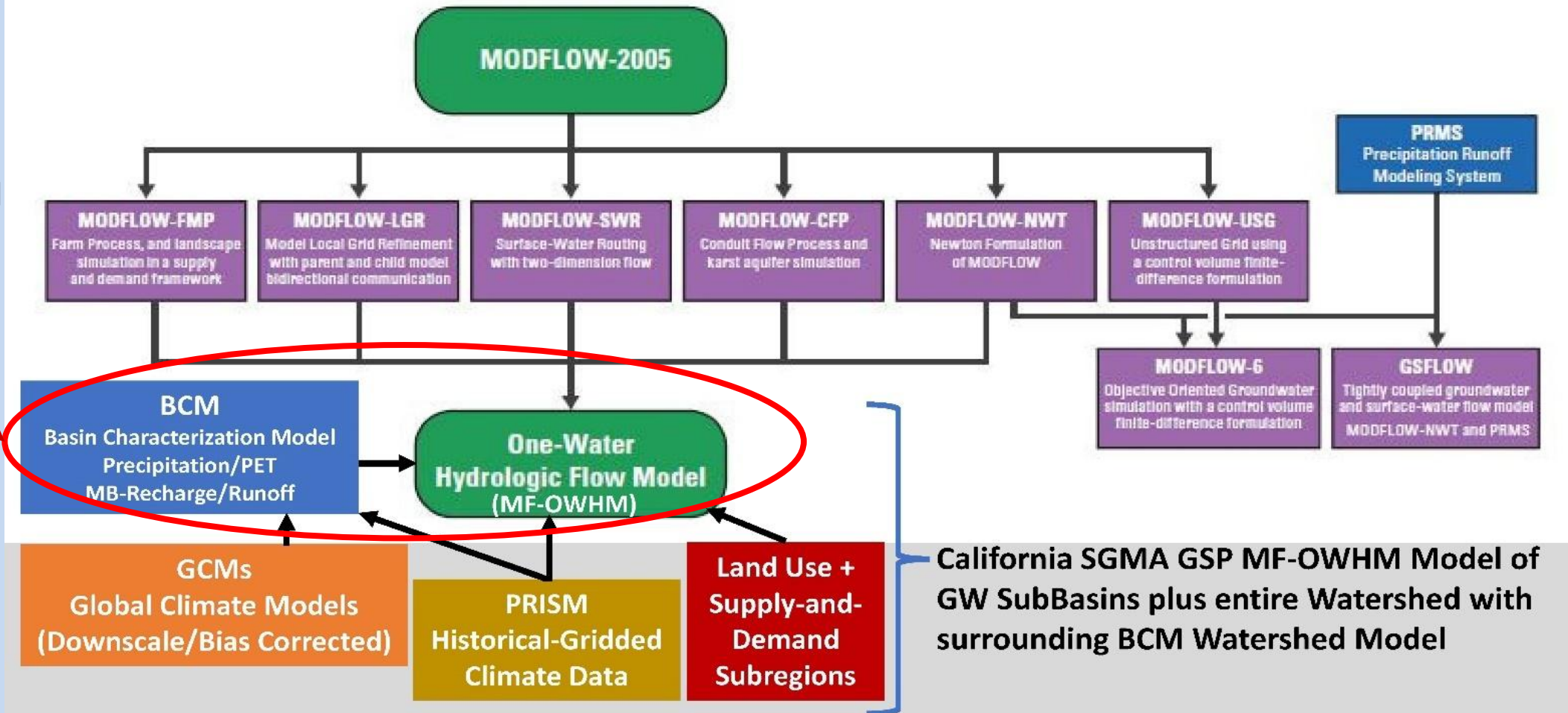




Integrated Monitoring/Modeling for CWM & Sustainability

MF-OWHM2 Conjunctive-Use Modeling Framework is Fusion/Update/Upgrades of MF-2005 Code Family

Passively
Coupled
Watershed
Rainfall -
Runoff model
(BCM) +
IHM model
(MF-OWHM)



USGS Download site One-Water (Modflow-OWHM2 ver 2.3.0): <https://code.usgs.gov/modflow/mf-owhm>

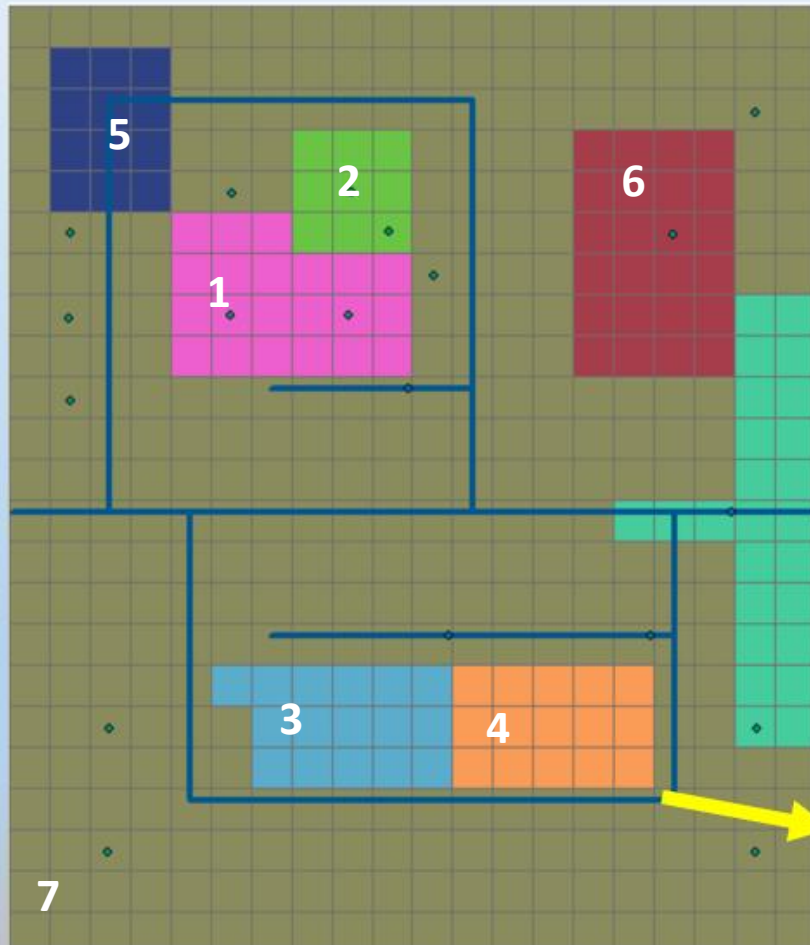
Conjunctive-use modelling framework → Combines land use, supply-and-demand subregions, and global climate model (GCM) data into a two-model linked framework: Watershed (BCM) & Basin (IHM) models (modified from Boyce et al., 2020).

Water Use/Movement - Coupled to Land Use in Supply-and-Demand Framework

Farm Process establishes a supply and demand framework for a specified land use



A water demand is calculated for each Land Use



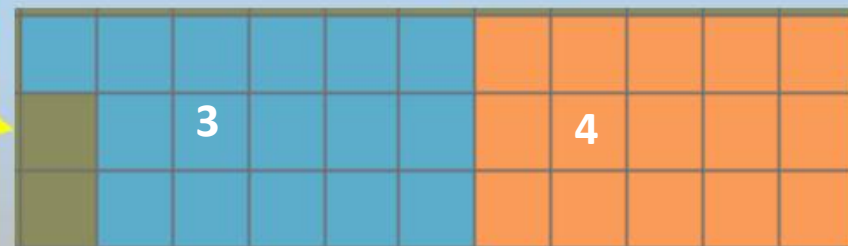
The use and movement of water is subdivided into Water Balance Subregions (WBS)

A WBS defines a group of land uses with common water supply

Precipitation, Wells, stream diversions, reservoir releases, non routed deliveries (pipelines, reuse) and groundwater are potential sources to meet demands

Supply and demand is accounted for on each WBS

WBS (Farm)



Fractional Land Use
(Multiple crops/Land Use per cell)

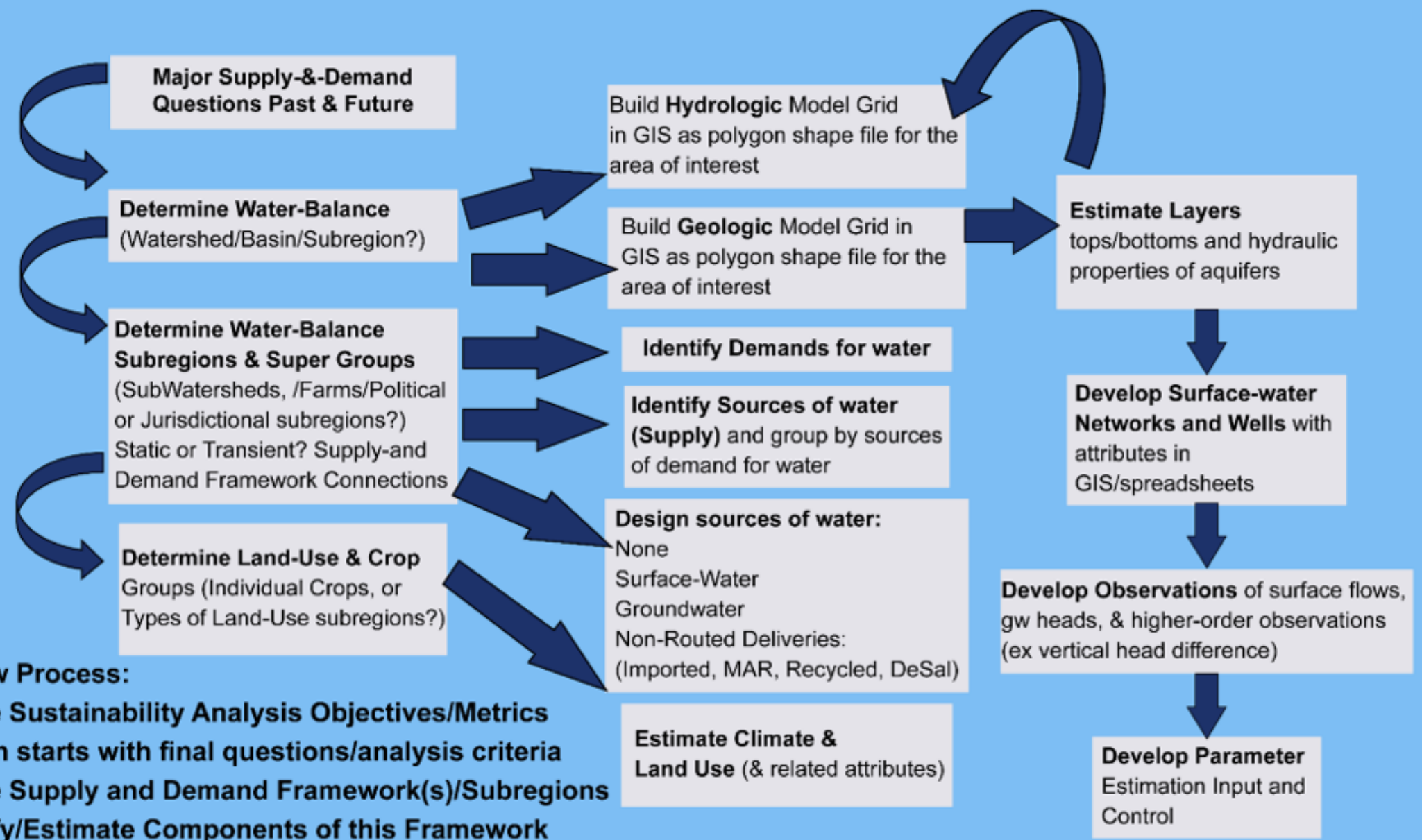


■ VRC ■ Vineyard ■ Native



One Water

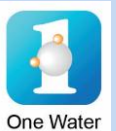
Workflow for IHM development with MF-OWHM for CWM sustainability analysis



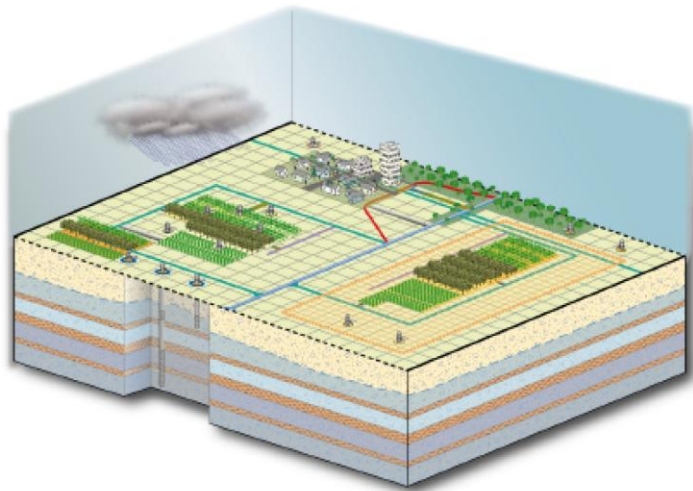
Workflow Process:

- 1) Define Sustainability Analysis Objectives/Metrics
- 2) Design starts with final questions/analysis criteria
- 3) Define Supply and Demand Framework(s)/Subregions
- 4) Identify/Estimate Components of this Framework
- 5) Build Model Components and integrate into MF-OWHM

(Evans & Hanson, 2025)



CWM Example-Model Scenario Exercises with MF-OWHM



One-Water Conjunctive-Use Modeling:

All The Water → All The Time → Everywhere

Randall T. Hanson

CWM Analysis with an Integrated Hydrologic Model (IHM)

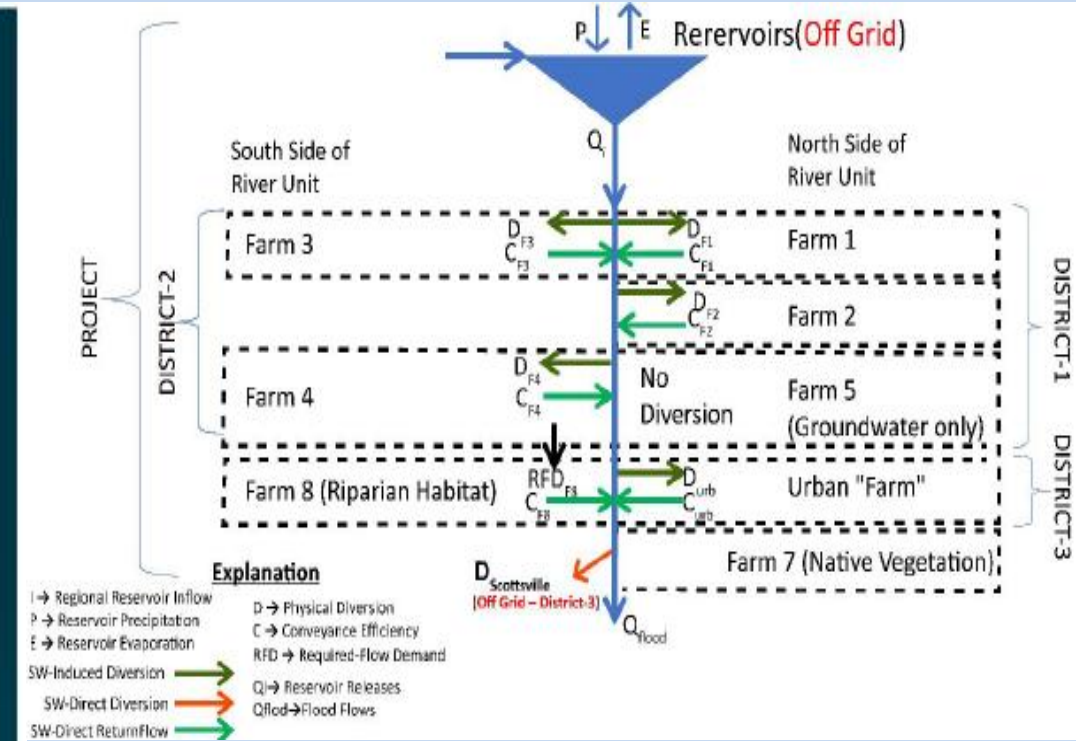
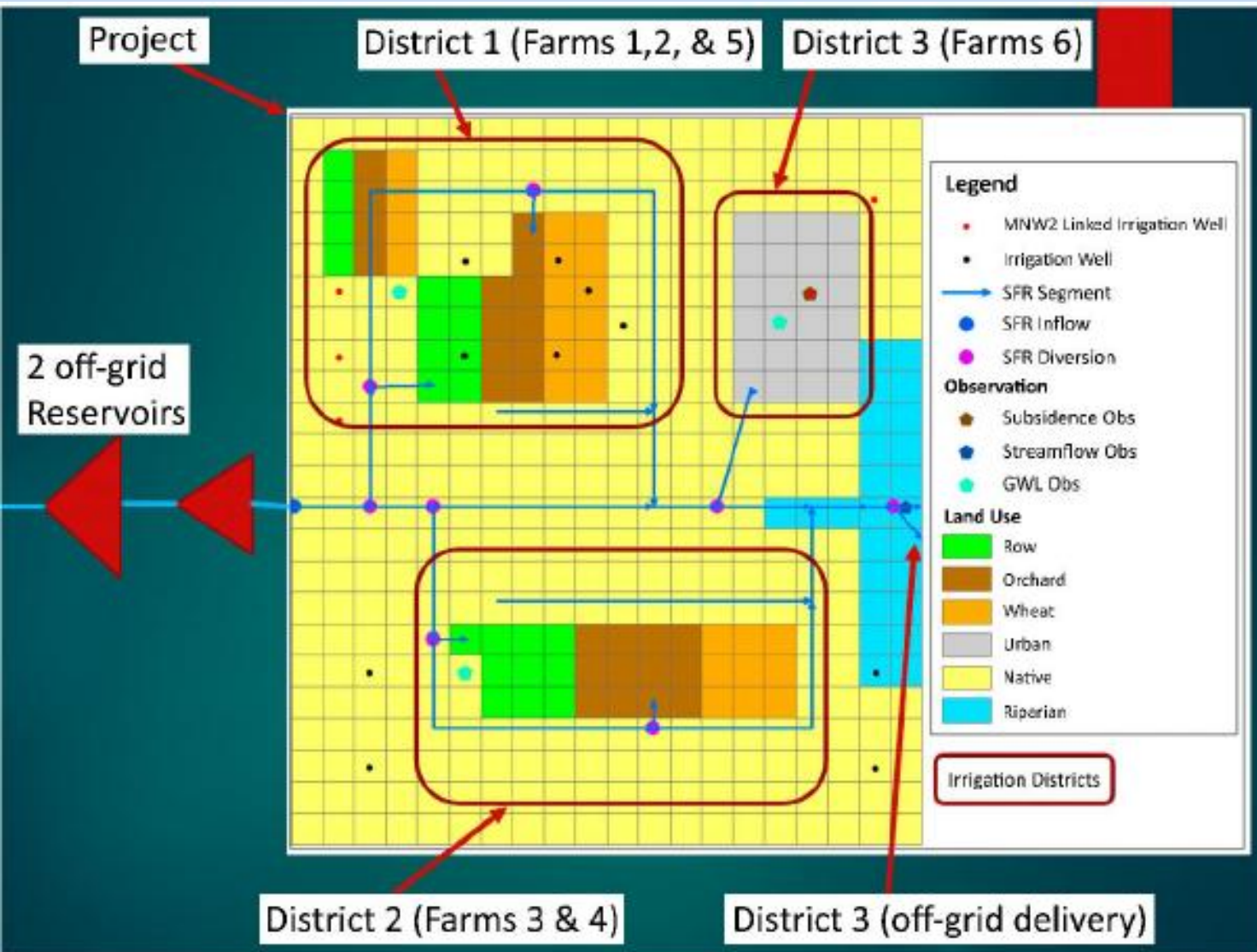
Six scenarios address the following variations from a base case.

- (1) Addition of an Urban Well → Effects on Streamflow and Subsidence**
- (2) Change Crop Type → Change Winter Wheat to Vegetable Row Crops and to Orchards Effects on Water Demand**
- (3) Addition of Salinity Flushing → Effects on Water Demand & Water Sources**
- (4) Adjustment of Water Demand to Equal Supply for Sustainability → Effects on Reduction of Demand to Equal Supply**
- (5) Changed Water Supply and Demand due to Climate Change → Effects of Warm/Dry and Cool/Wet on Water Demands**
- (6) Adjustment of Surface-Water Operations (SWO) → Effects of Reservoir Operations & Operating framework to enhance Surface-Water Deliveries**

Using the USGS IHM:
Modflow-One-Water Hydrologic Model (MF-OWHM)



Reservoir Operations (SWO) only with USGS MF-OWHM



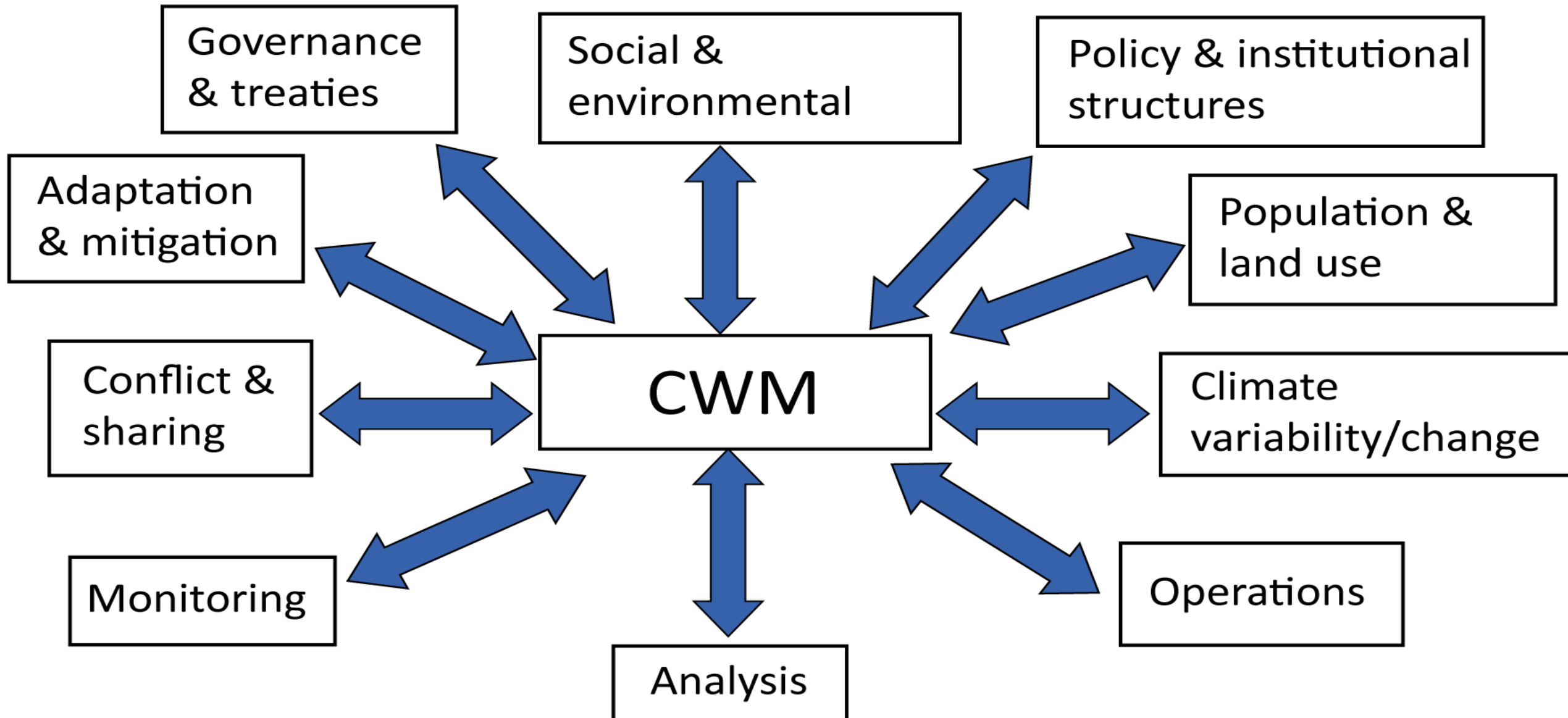
Simulation of Reservoir Operations Includes:

- (1) Reservoir Storage & Releases → FMP/SFR
- (2) Effects on Surface-Water and Groundwater Deliveries
- (3) Allocations, Carry Over, Allotments, Deliveries, District Charges & Credits

3 CWM-SWO Scenarios:

- (1) Base Case with SWO,
- (2) SWO + Surface-Water Allotments (Constraints),
- (3) SWO + Salinity Flushing

Social and Physical interfaces within CWM supply-and-demand framework

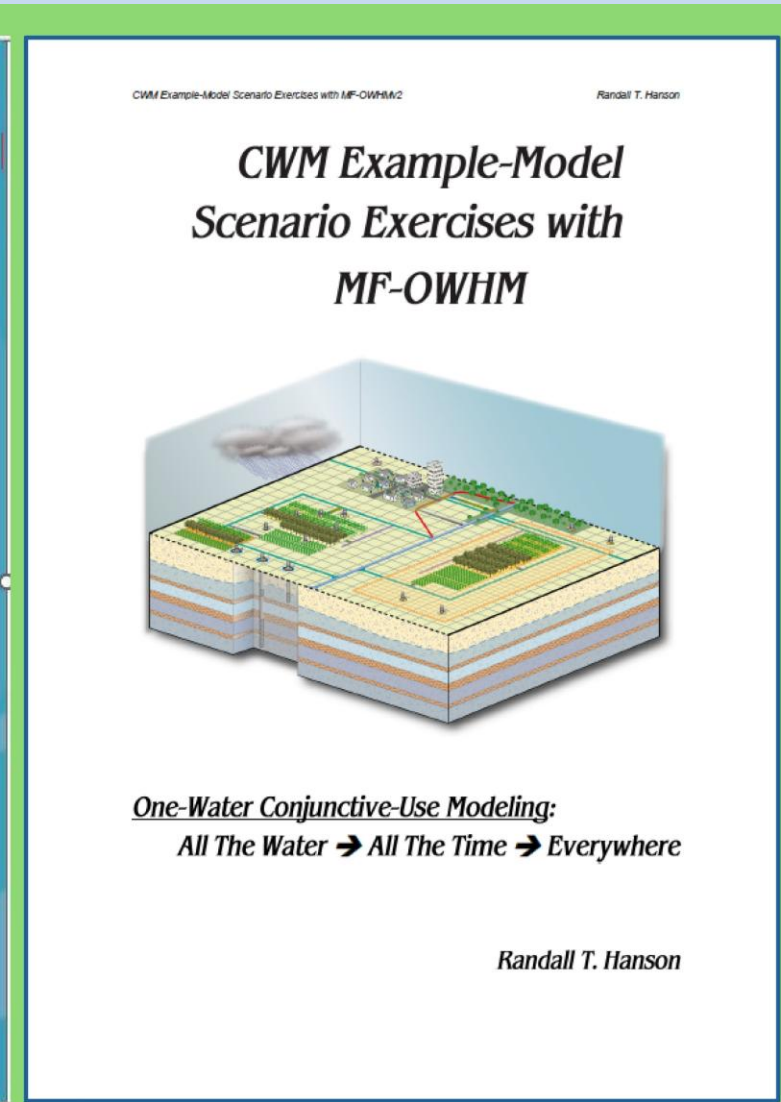
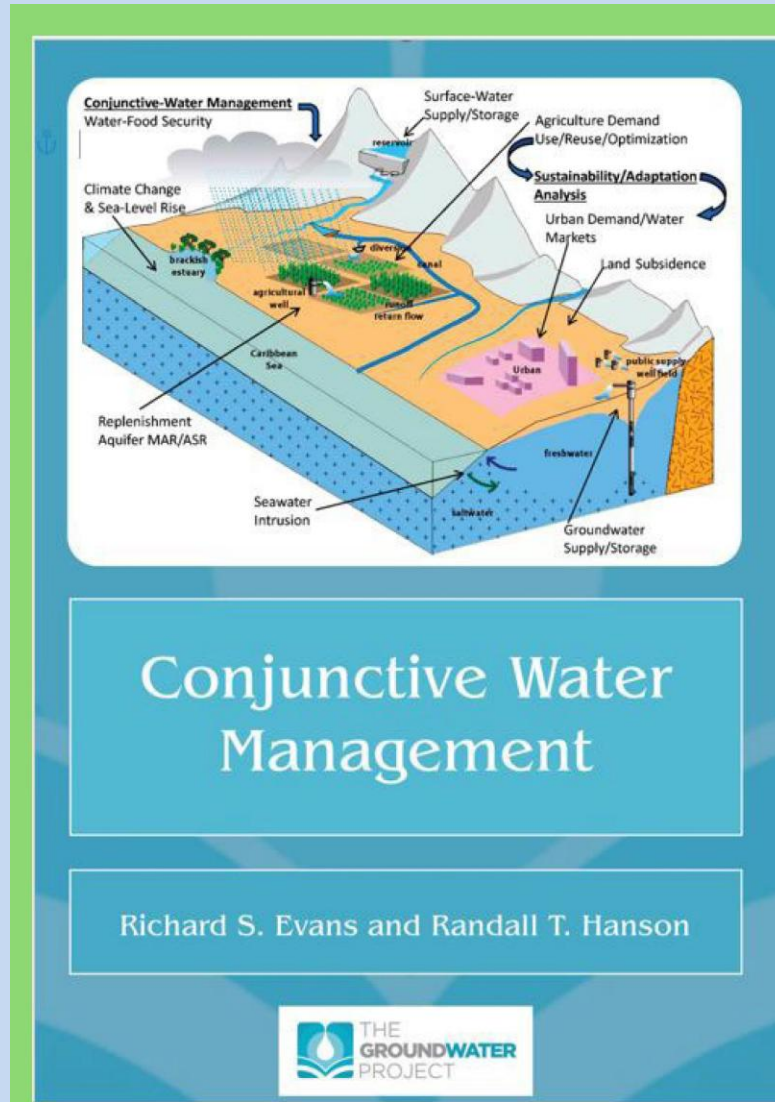


Conjunctive Water Management

Over 3,279 downloads from John Cherry's Groundwater Project of our two Conjunctive Water Management books since September, 2025 release from 139 countries with top 10:

1. USA
2. Brazil
3. China
4. Australia
5. Canada
6. Ethiopia
7. India
8. Peru
9. Italy
10. Mexico

Spanish version coming soon too!!



CWM books also recognized by AGU Hydrology Chapter:

(https://drive.google.com/file/d/1AFyvWzUB0KSBtBRpqddmmzh_RS6nfFqE/view?usp=drive_link).

John Cherry's Groundwater Project: <https://gw-project.org/books/conjunctive-water-management/>
(Evans & Hanson, 2025)



More MF-OWHM To Come!!

GROUND-WATER SUSTAINABILITY = STRAWBERRY FIELDS FOREVER ?

Pajaro Valley, Monterey Bay, California, USA (Hanson et al., 2014)

