An Overview of Managed Aquifer Recharge in California

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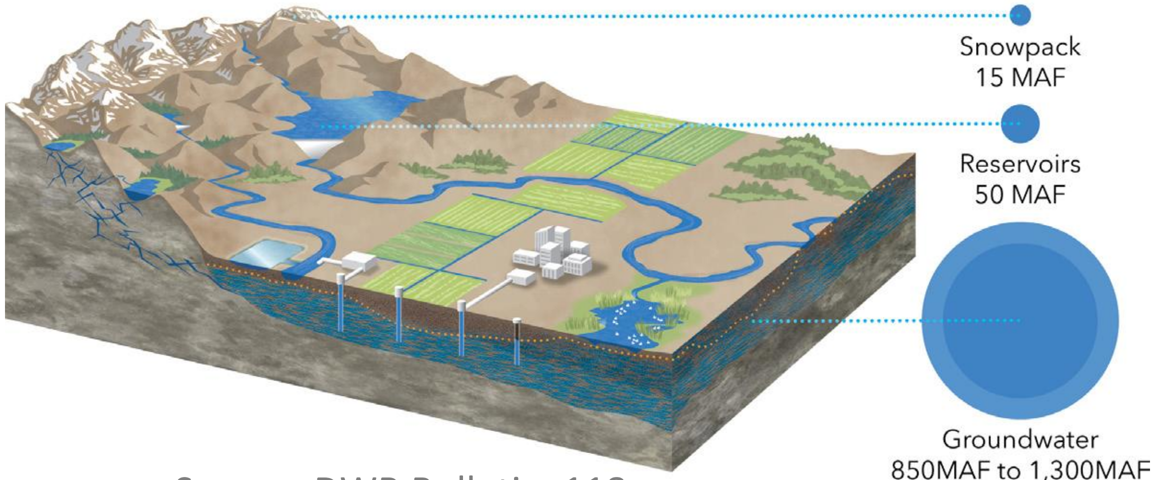
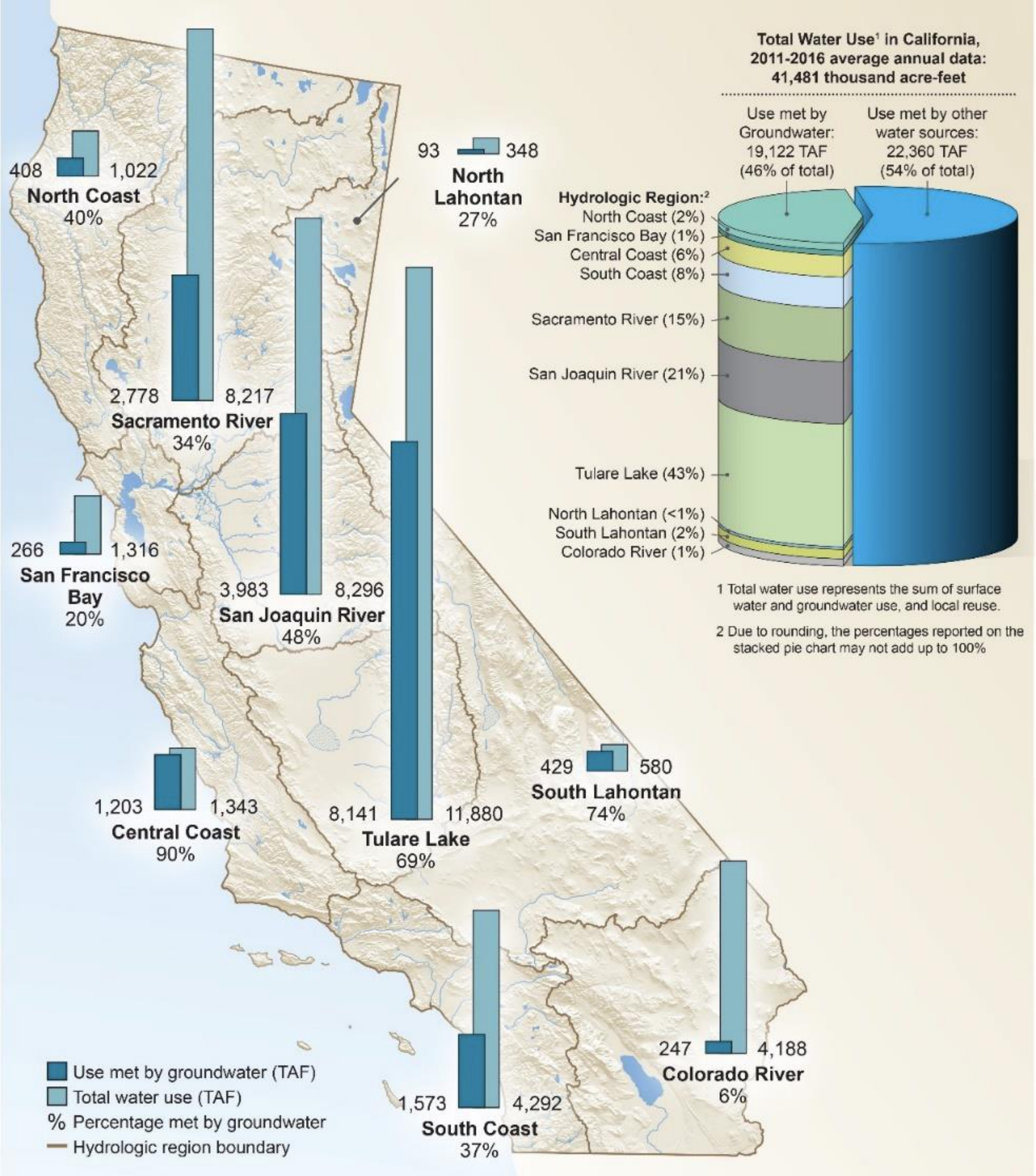
Groundwater and California

- It is older surface water filling the pores and fractures of underground materials
- Supplies 30% to 60% of beneficial use (12- 23 MAF/yr)
- State's largest storage volume
- Common property resource



Source: DWR Bulletin 118



Source: DWR Bulletin 118

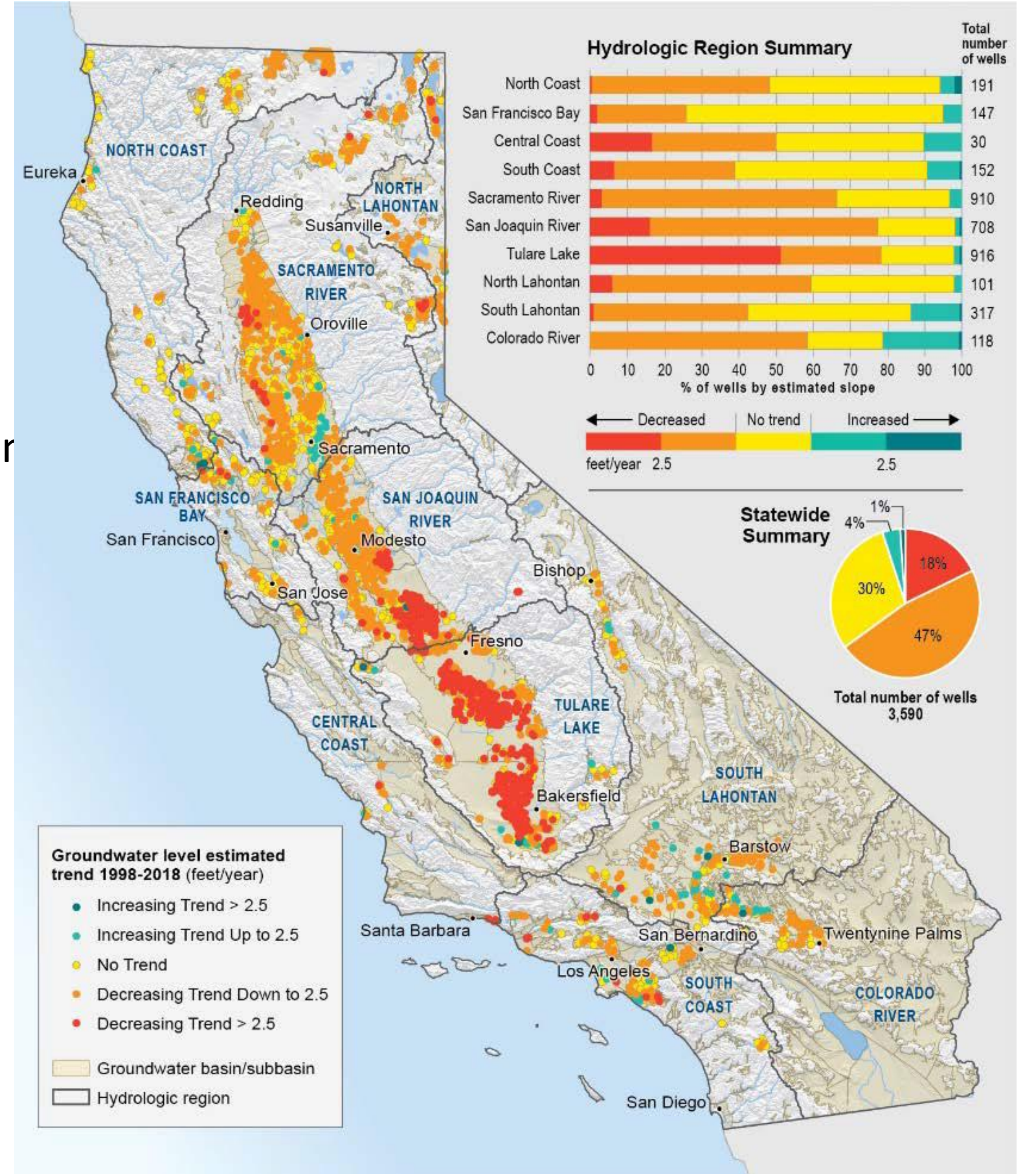
Major Current and Future Challenges for Groundwater

Current

- Chronic groundwater overdraft (~ 2 MAF/yr)
- Subsidence affecting infrastructure and flood managemer
- Dry domestic wells during droughts
- Saline intrusion and other water quality issues
- Increase in hardened water demand

Future

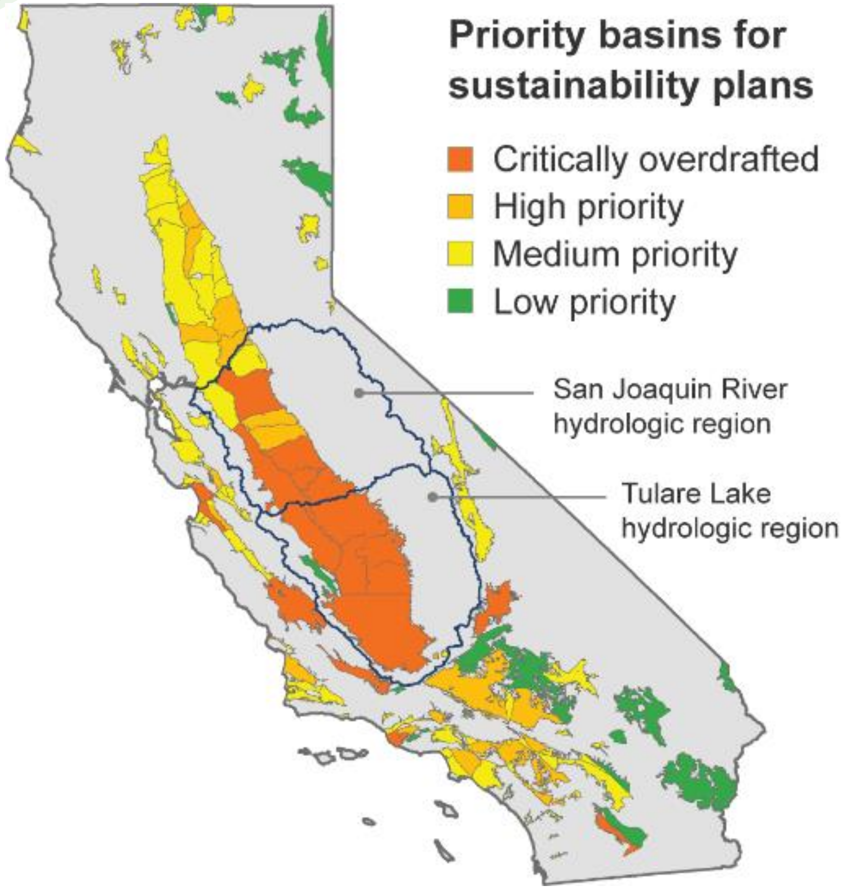
- Warmer temperatures, higher evapotranspiration
- Precipitation volatility
- Limited pumping: SGMA
- Sea level rise

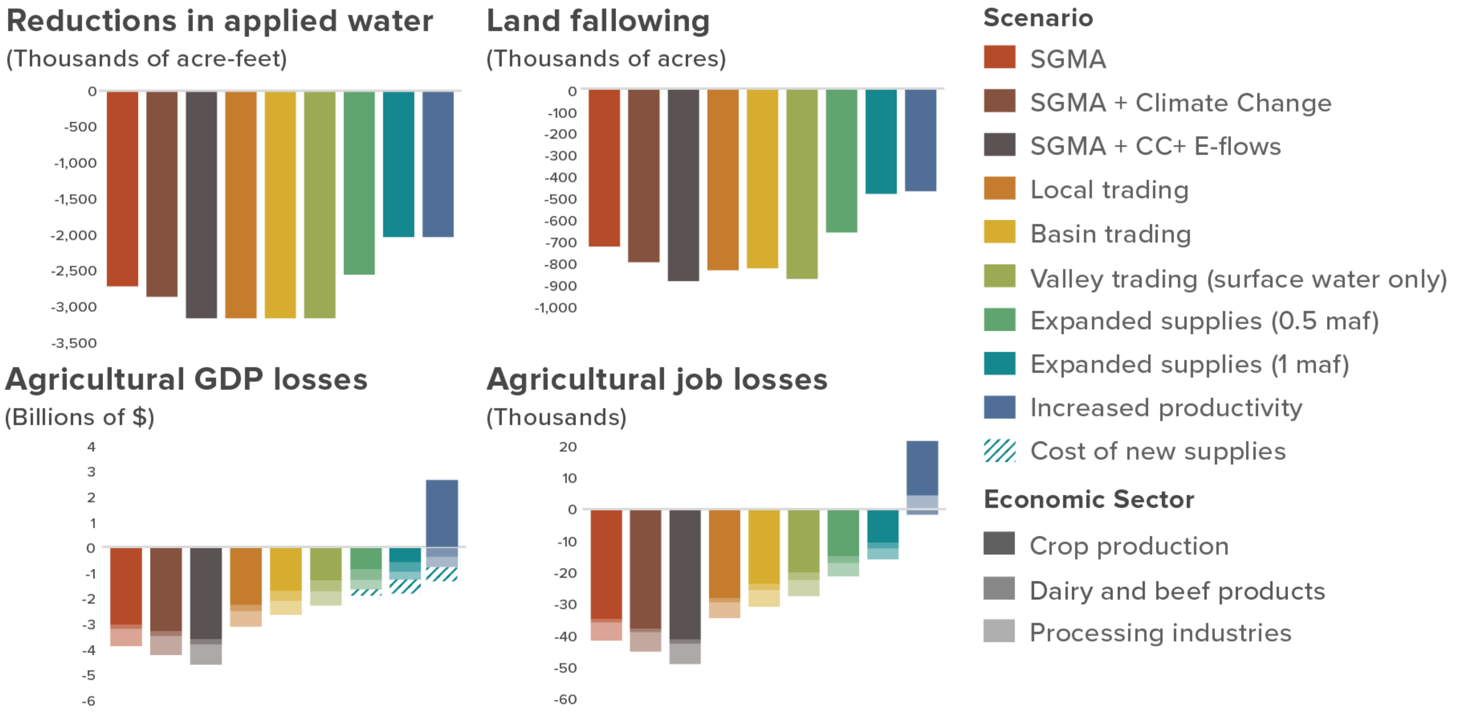


Source: DWR Bulletin 118

Ending Groundwater Overdraft and its Costs

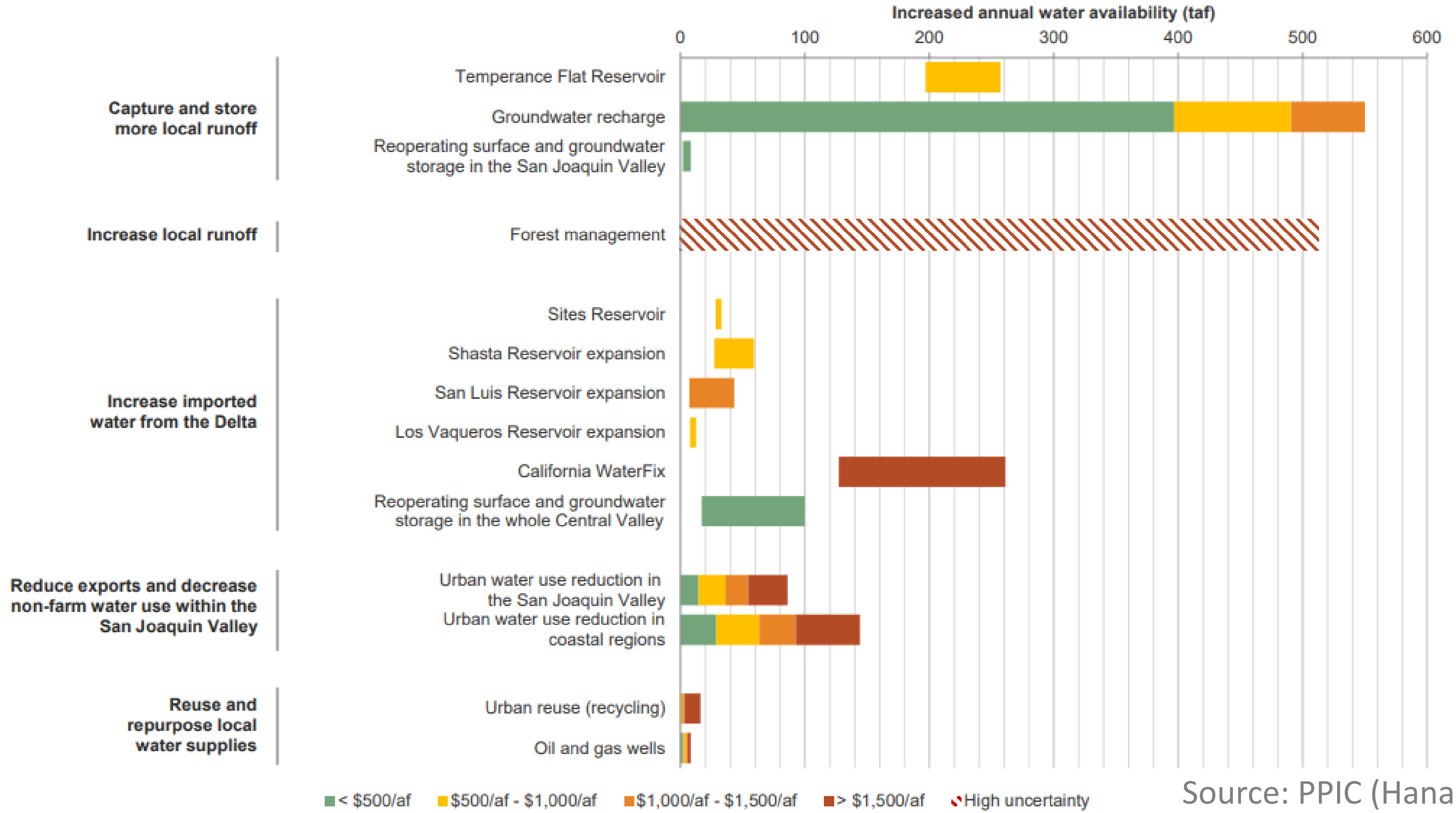
- Requires both demand management and supply augmentation
- Land idling has economic impacts
- Markets and recharge among the most promising solutions
- From 500 to 900 thousand acres of permanently idled cropland





Hanak et al. (2019) and Escriva-Bou et al. (2023)

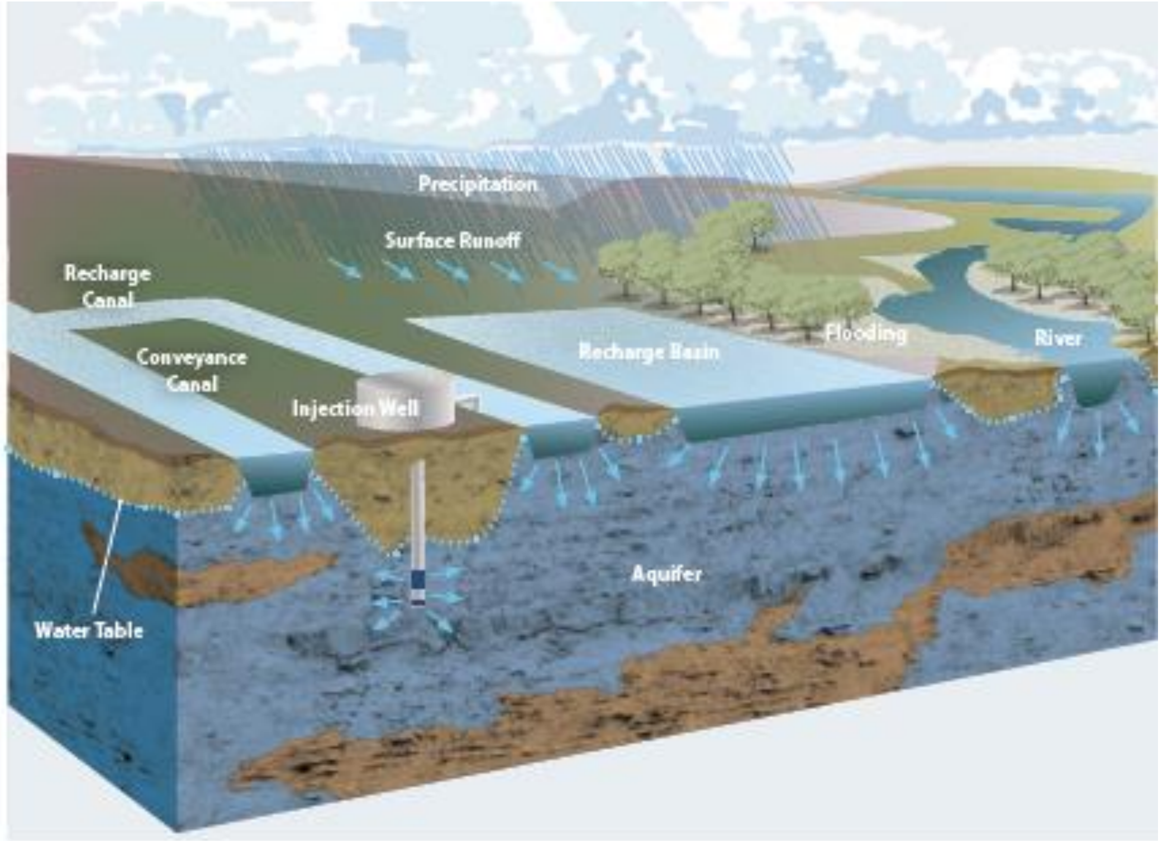
Demand Management and Supply Augmentation Options in San Joaquin Valley



Source: PPIC (Hanak et al. 2019)

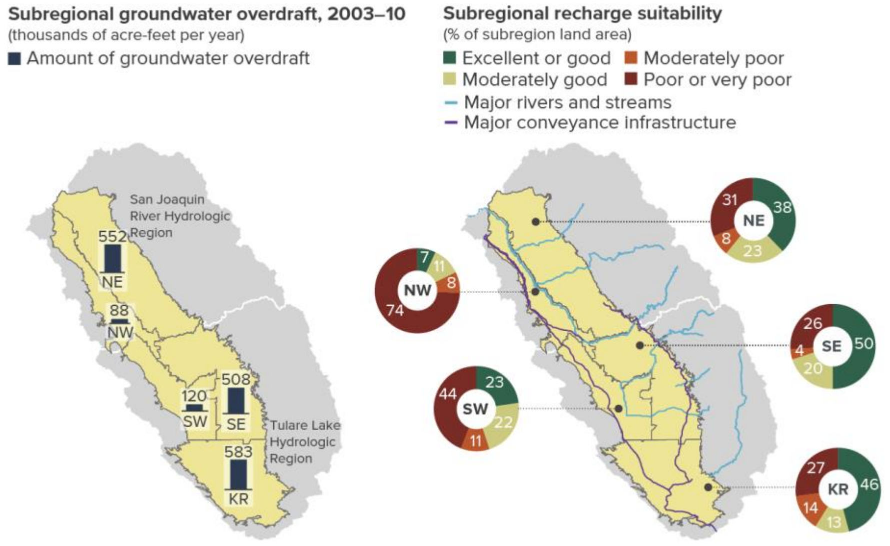
Aquifer Recharge and Flood Water Availability

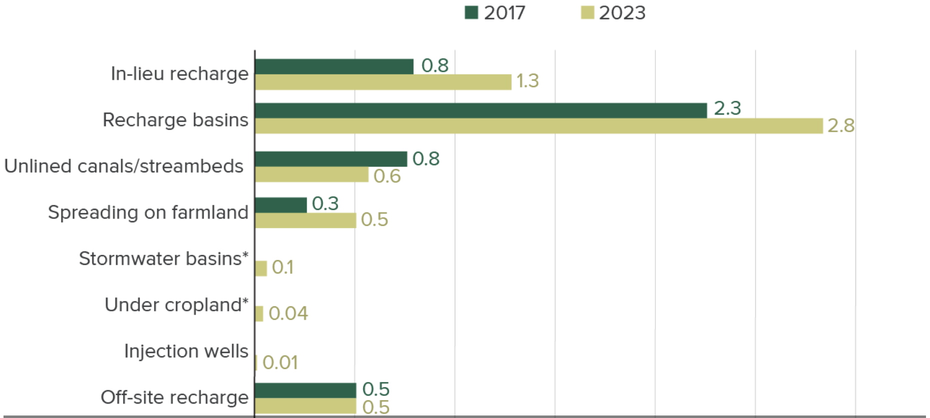
- Diversion to riverbeds and canals
- Farmland and open space
- In-lieu recharge (more surface wet years)
- Dedicated recharge basins
- Stormwater basins
- Well injection (Aquifer Storage Recovery)
- Water under cropland
- Off-site recharge



Source: DWR (2018)

An average of 2.6 MAF average of in years with high magnitude flows from the Central Valley to the Delta (Kocis and Dahlke 2017), DWR (2018) ~ 0.9 MAF





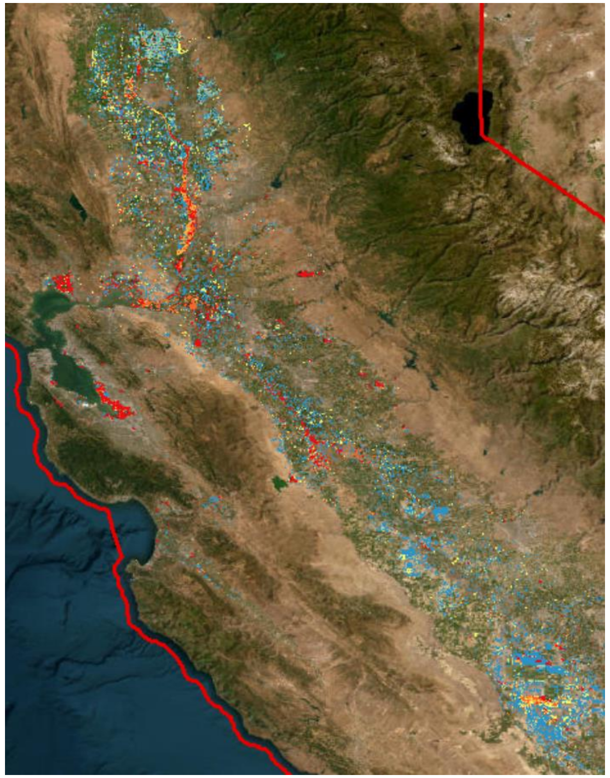
Source: Peterson et al. (2024) PPIC

Managed Aquifer Recharge in the San Joaquin Valley

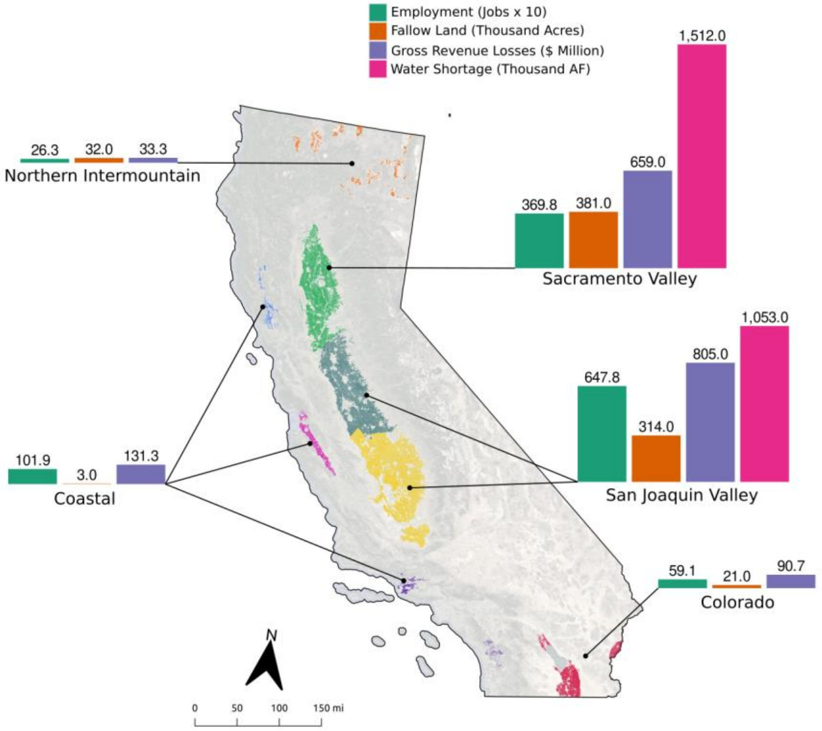
- Between 2017 and 2023 recharge expanded by about 1.3 MAF
- Accounting and credit systems locally, the 2023 Executive Order, and support for temporary equipment bolstered recharge
- Challenges remain:
  - Infrastructure
  - Costs can be significant
  - Saturation and flood risks
  - Permitting
  - Accounting and credit

Promising Research Solutions: Drought and Flood Assessments

- Drought and flood impact assessments
- Using hydrologic and economic models, remote sensing and machine learning
- Useful to identify vulnerable areas during droughts and floods, quantify economic impact
- Flood waters recharge potential and early prediction of fallowing



Mapping days of inundation and economic impact (forthcoming)

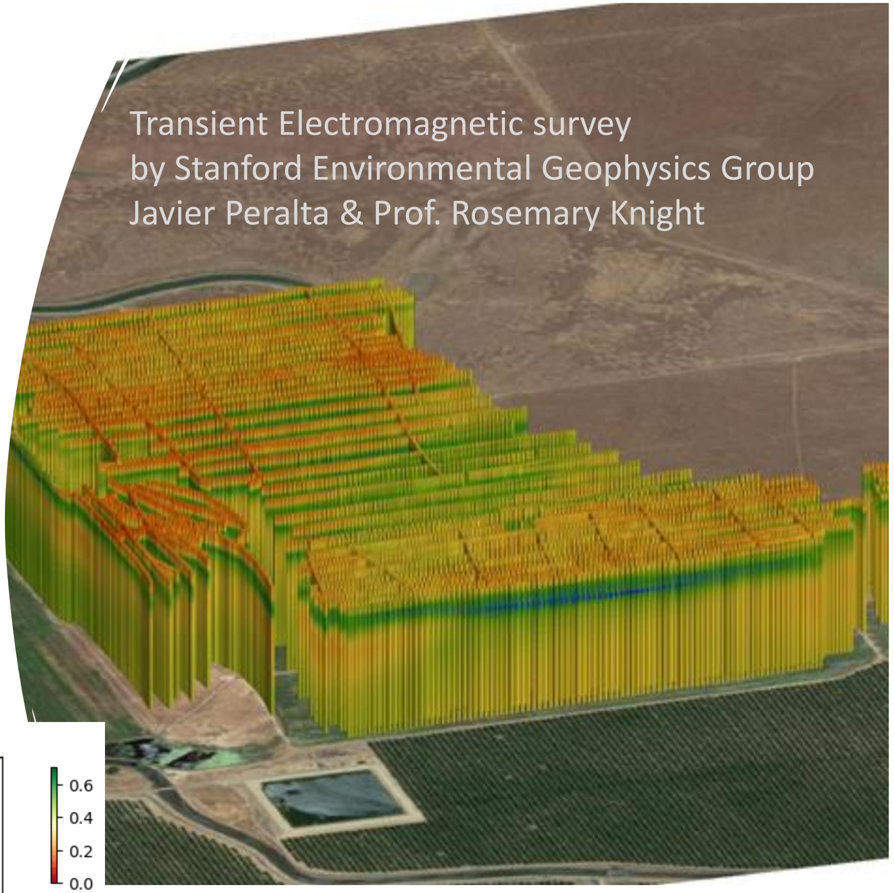


Impact of the 2020-2022 drought (Medellin-Azuara et al. 2022)

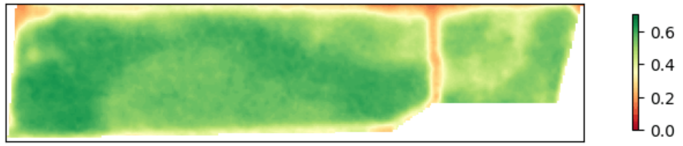
Promising Solution: Markets, Measurement, Management

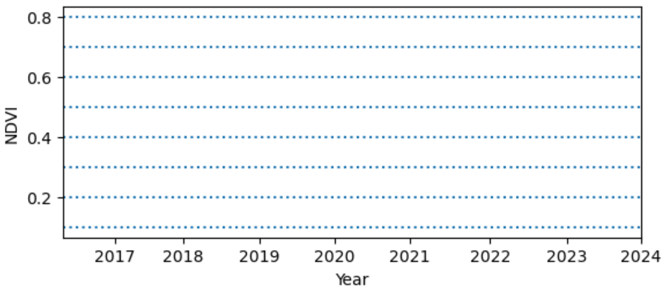
UC Merced Experimental Smart Farm: Harmon and Viers

Secure Water Future



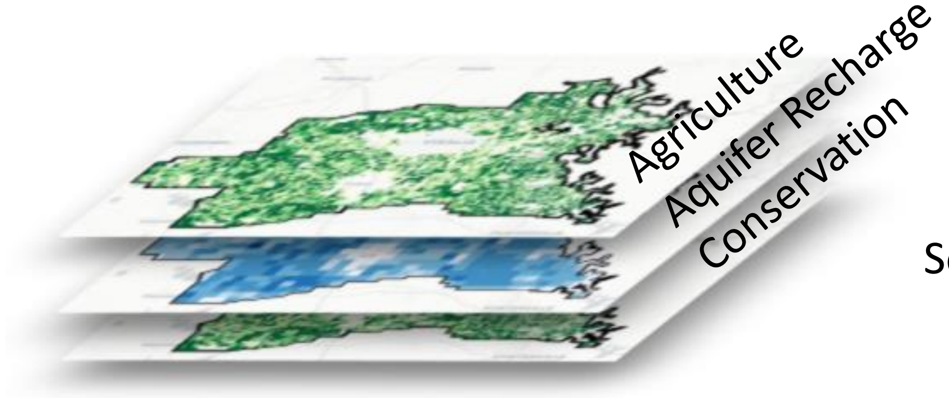
Recharge Experiments: PI Harmon



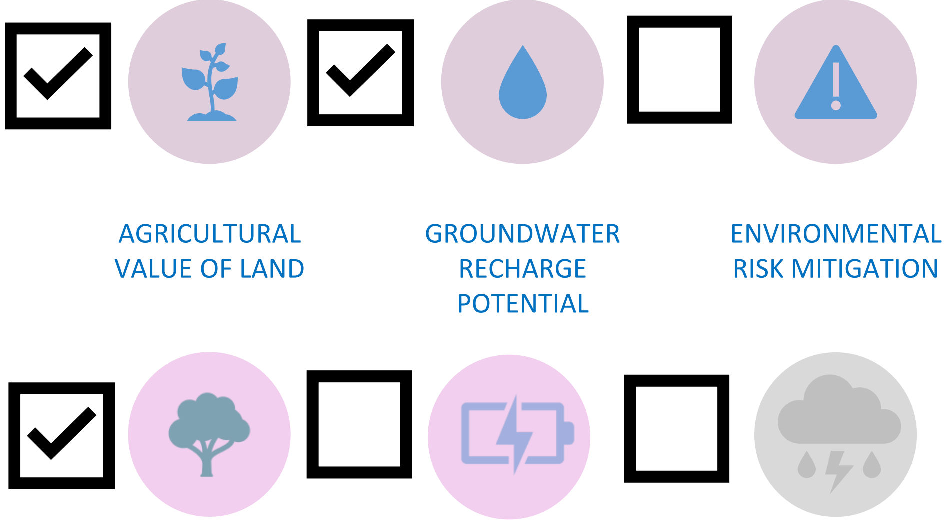


Promising Research Solutions: Multi-Benefit Land Repurposing

Identify suitability for recharge, agriculture, environmental and flood risk mitigation, and renewable energy



Select priorities



AGRICULTURAL VALUE OF LAND

GROUNDWATER RECHARGE POTENTIAL

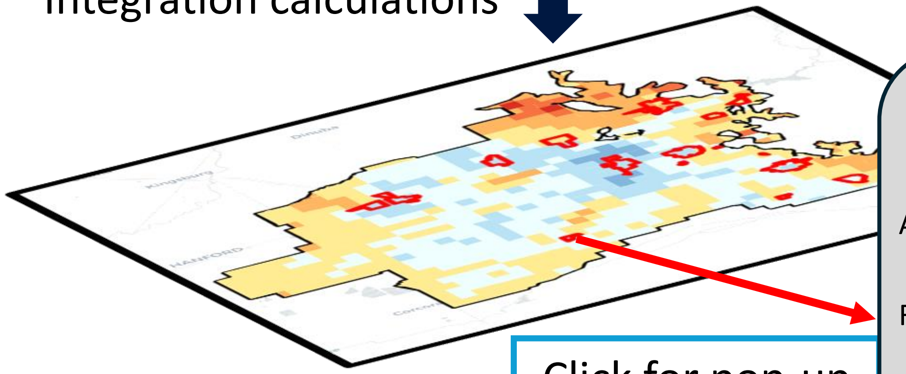
ENVIRONMENTAL RISK MITIGATION

CONSERVATION/ RESTORATION

RENEWABLE ENERGY POTENTIAL

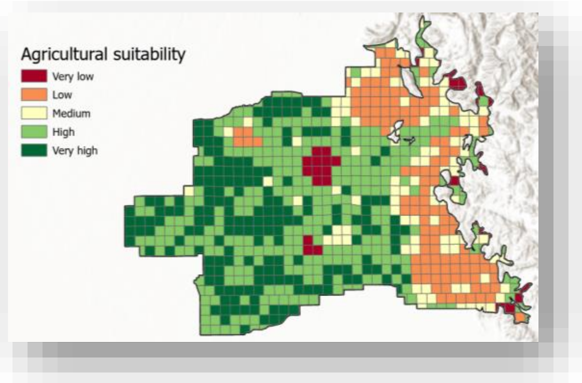
FLOOD MITIGATION

Integration calculations



Click for pop-up scorecard for each land unit

Category		MLRP Suitability
Agriculture		0.63
Recharge		0.38
Conservation		0.72

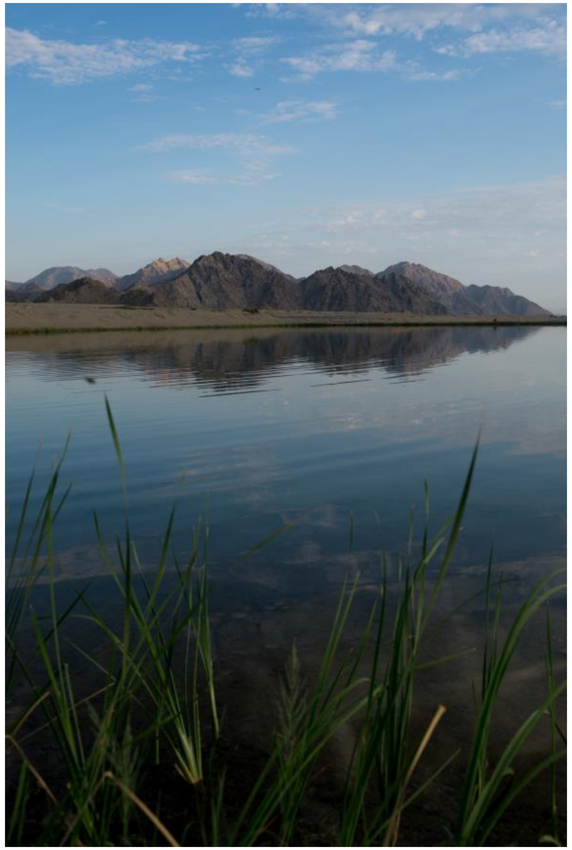


Tom Harmon (UC Merced), principal investigator.
Case Studies for Tule and Kaweah

Promising Management and Policy Solutions

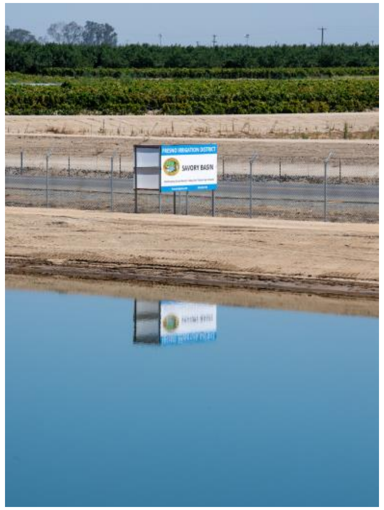
(Adapted from Peterson et al. 2024)

- State Level
  - Rules
  - Permitting
  - Transfers
- Local
  - Accounting and crediting systems
  - Infrastructure improvements
  - Engagement, planning and coordination
- Funding
  - Conveyance
  - Recharge basins
  - Research, technological tools



Santa Anna Recharge Pond

Sacramento Weir



Savory Pond Fresno

All photo credits: DWR

Concluding Remarks

- Groundwater recharge remains one of the most promising and less costly ways of securing climate resilience
- Permitting, rules, accounting and credit, are essential
- Infrastructure needs
- Research tools to facilitate recharge: measurement, repurposing, markets, accounting

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