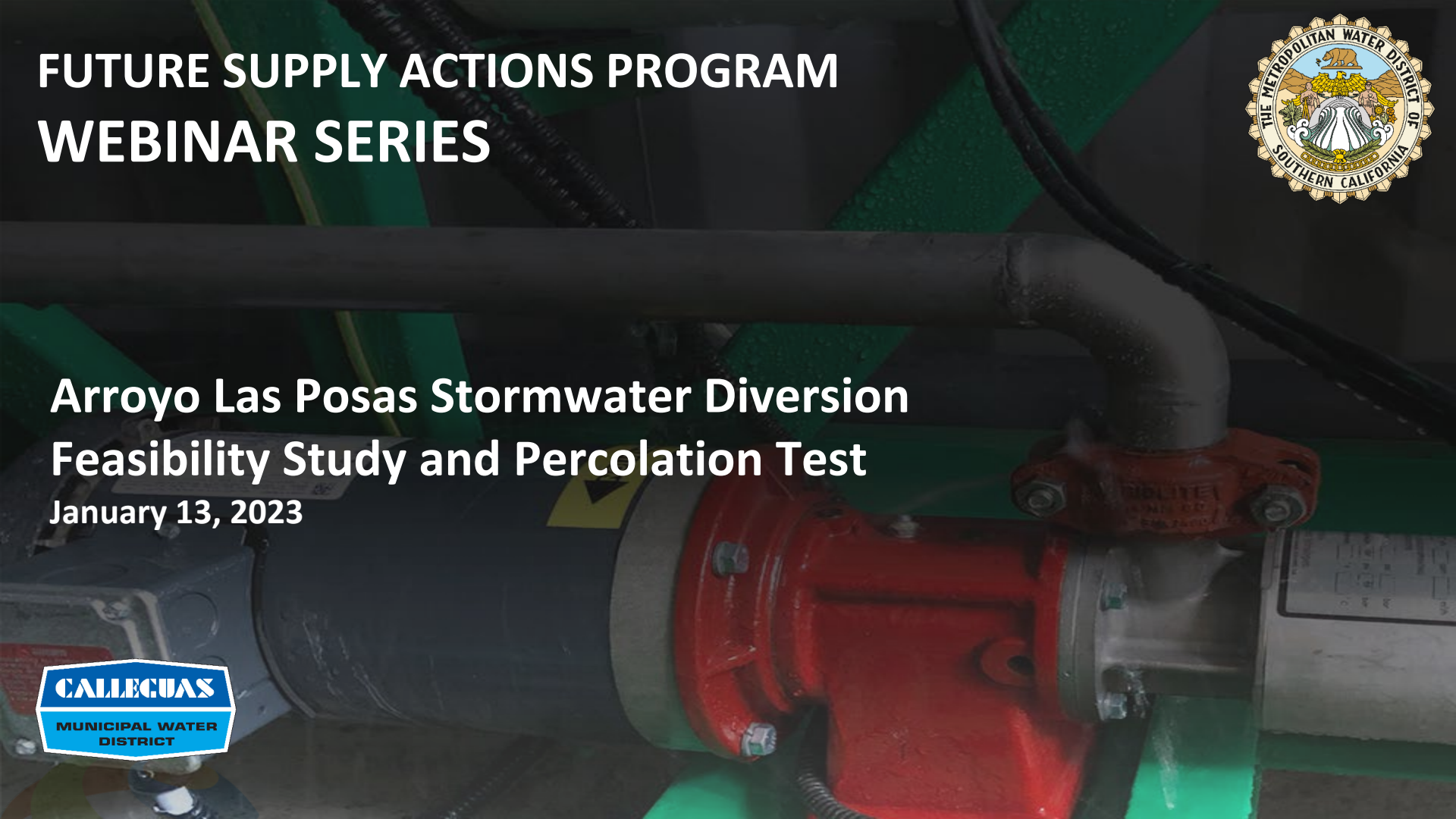
FUTURE SUPPLY ACTIONS PROGRAM
WEBINAR SERIES



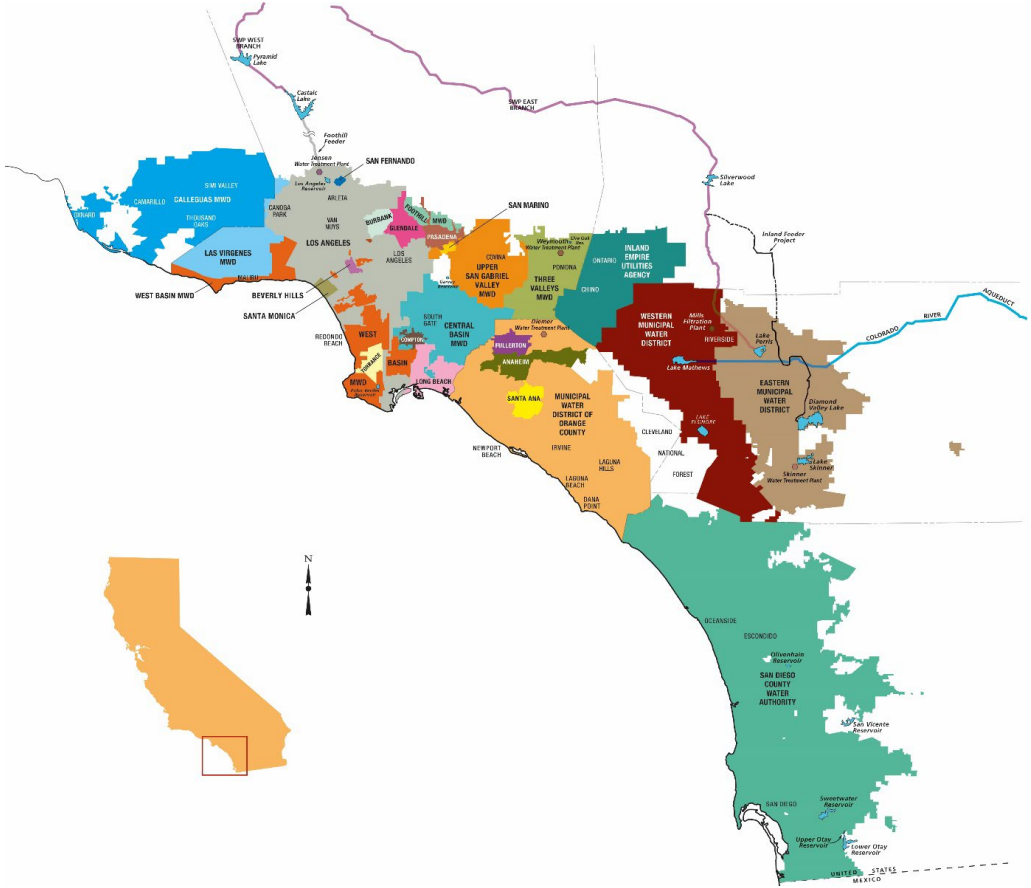
Arroyo Las Posas Stormwater Diversion Feasibility Study and Percolation Test

January 13, 2023

Agenda

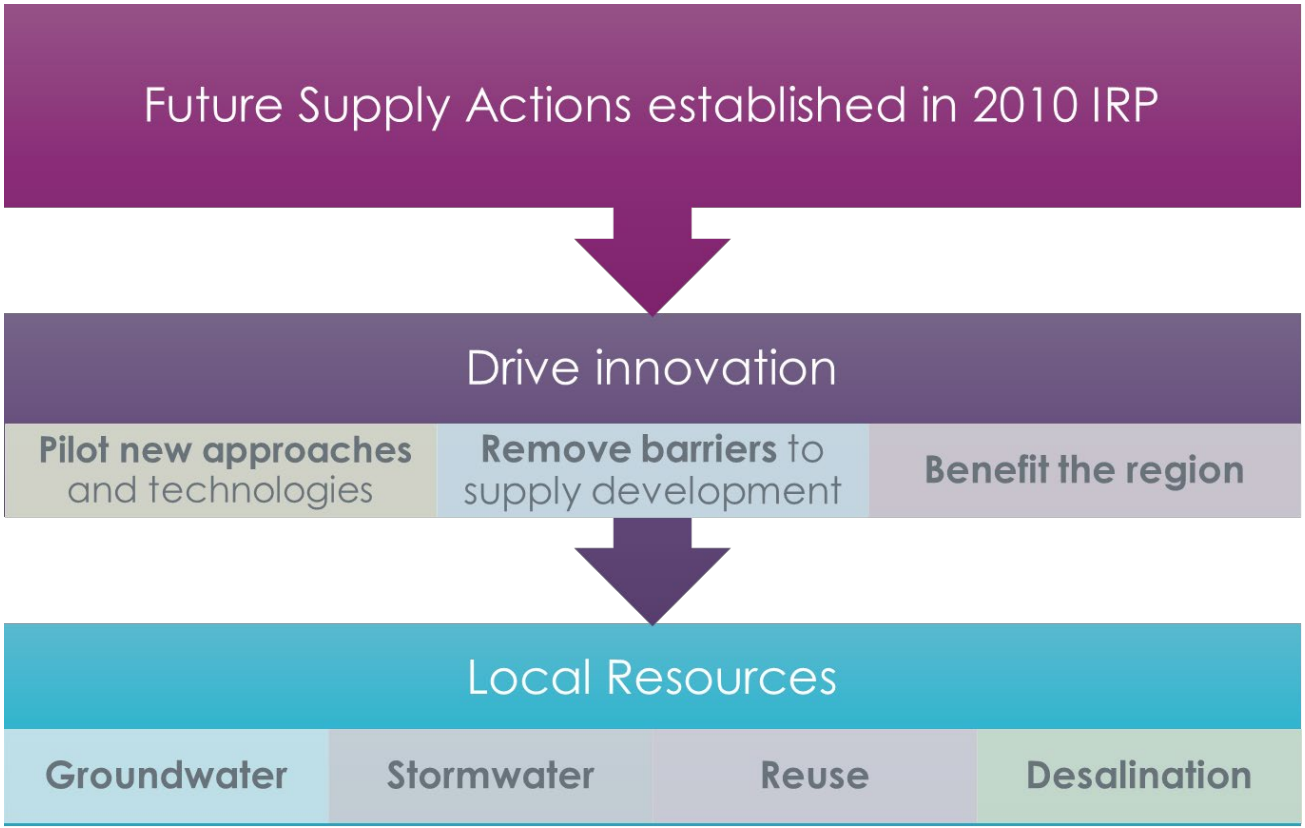
The Metropolitan Water District of Southern California

- Nation's largest wholesale water provider
- Service area: 19 million people/5,200 square miles/parts of six counties
- 26 member agencies
- Supports $1 trillion regional economy
- Imports water from Northern Sierra and the Colorado River, invests in local projects



Metropolitan's Role for Southern CA

Future Supply Actions Funding Program



Current Program

Member Agency

- 14 studies
- $3.1 million

Water Research Foundation

- 6 potable reuse studies
- 1 agricultural reuse study
- $975k

SPEAKER SPOTLIGHT

Jeewoong June Kim

Engineering Manager

the County of Ventura Public works Agency Water and Sanitation Department

Craig Ulrich

Research Geophysicist

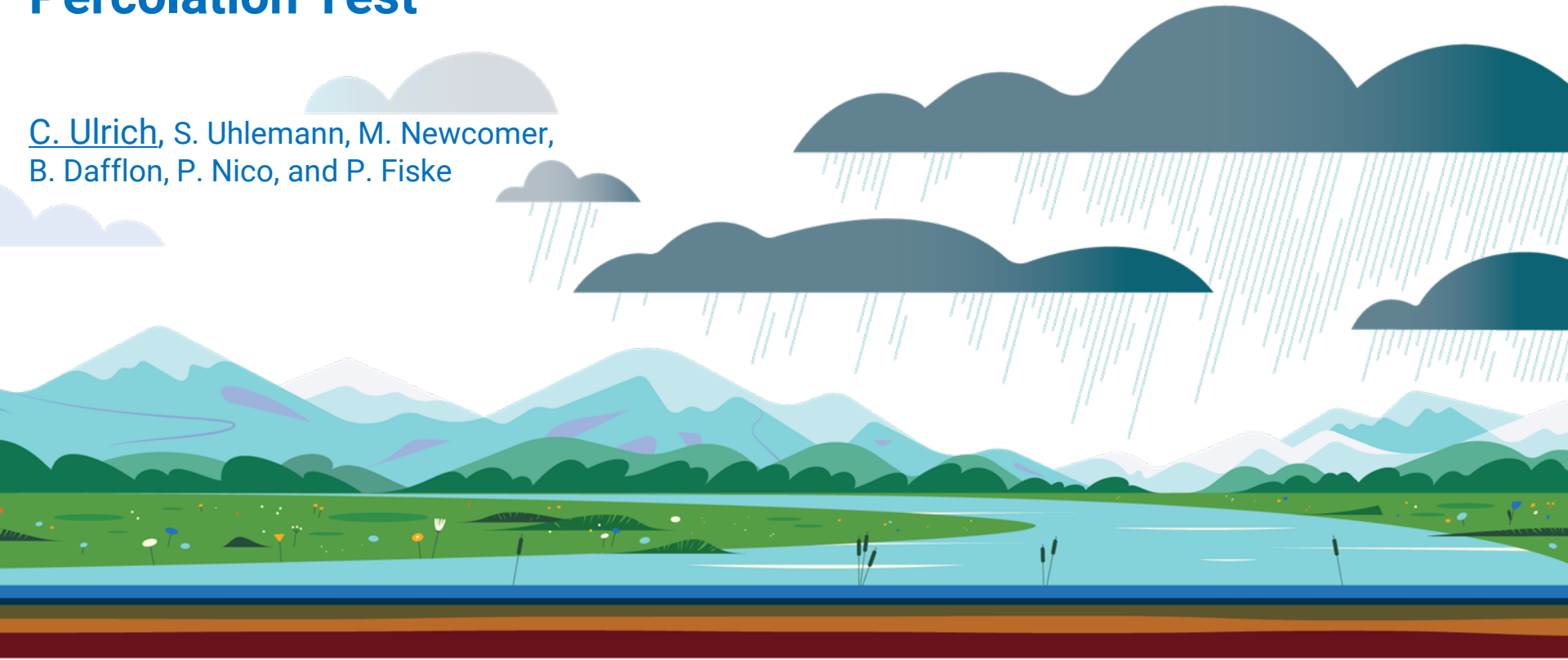
Lawrence Berkeley National Laboratory

BERKELEY LAB

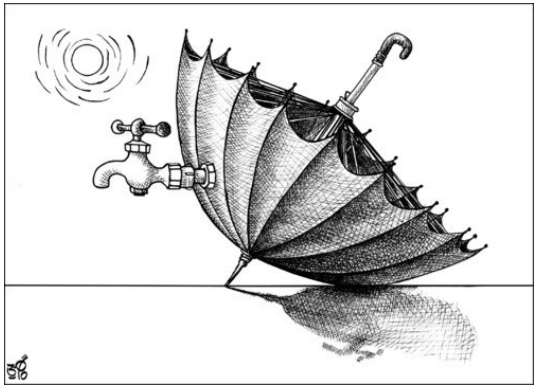
EARTH & ENVIRONMENTAL SCIENCES

Arroyo Las Posas Stormwater Diversion Feasibility Study and Percolation Test

C. Ulrich, S. Uhlemann, M. Newcomer, B. Dafflon, P. Nico, and P. Fiske



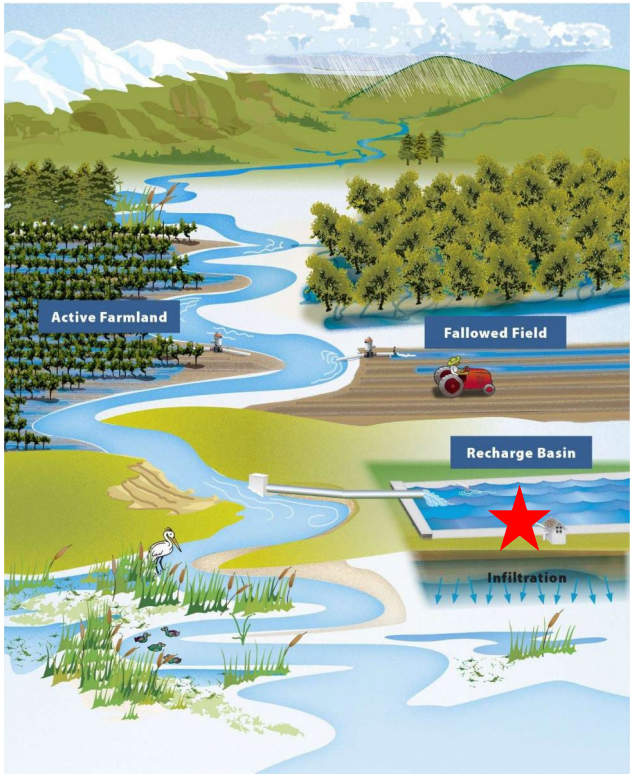
California's New Challenge…..Diverting High Flows for Recharge



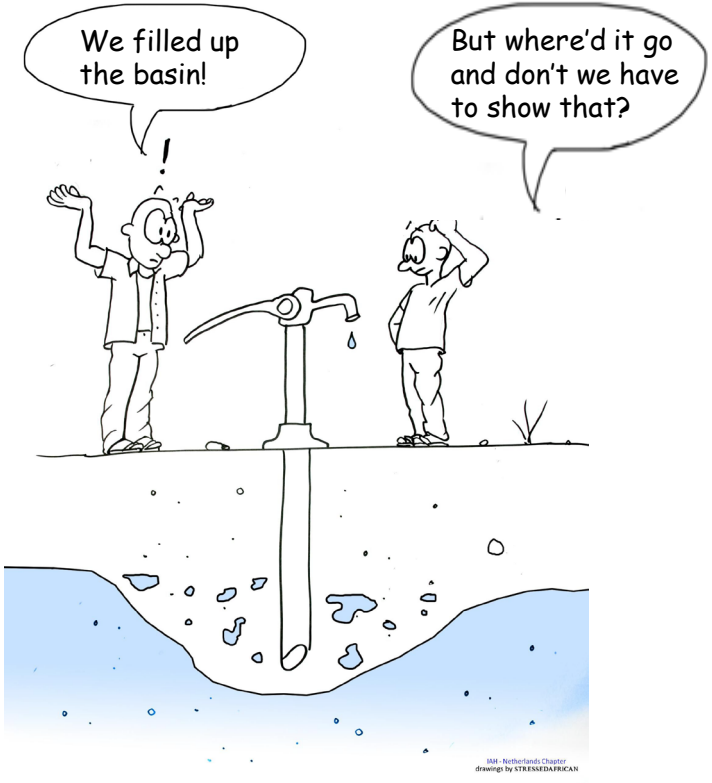
How do we manage water supply with <u>decreasing</u> annual snowpack storage?

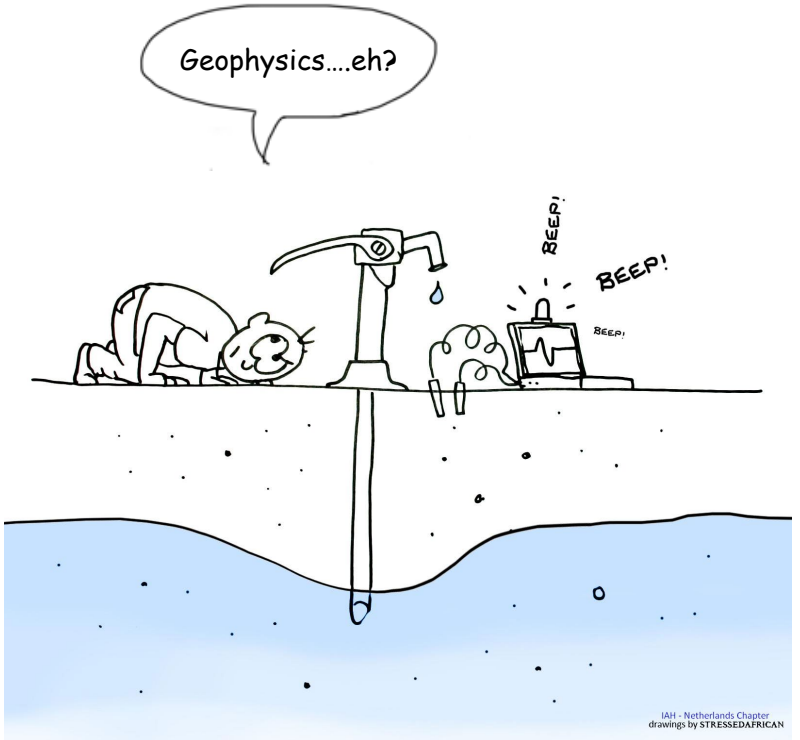
<u>Managed Aquifer Recharge</u>

<u>But how do we optimize & quantify it?</u>



Where does the water go?





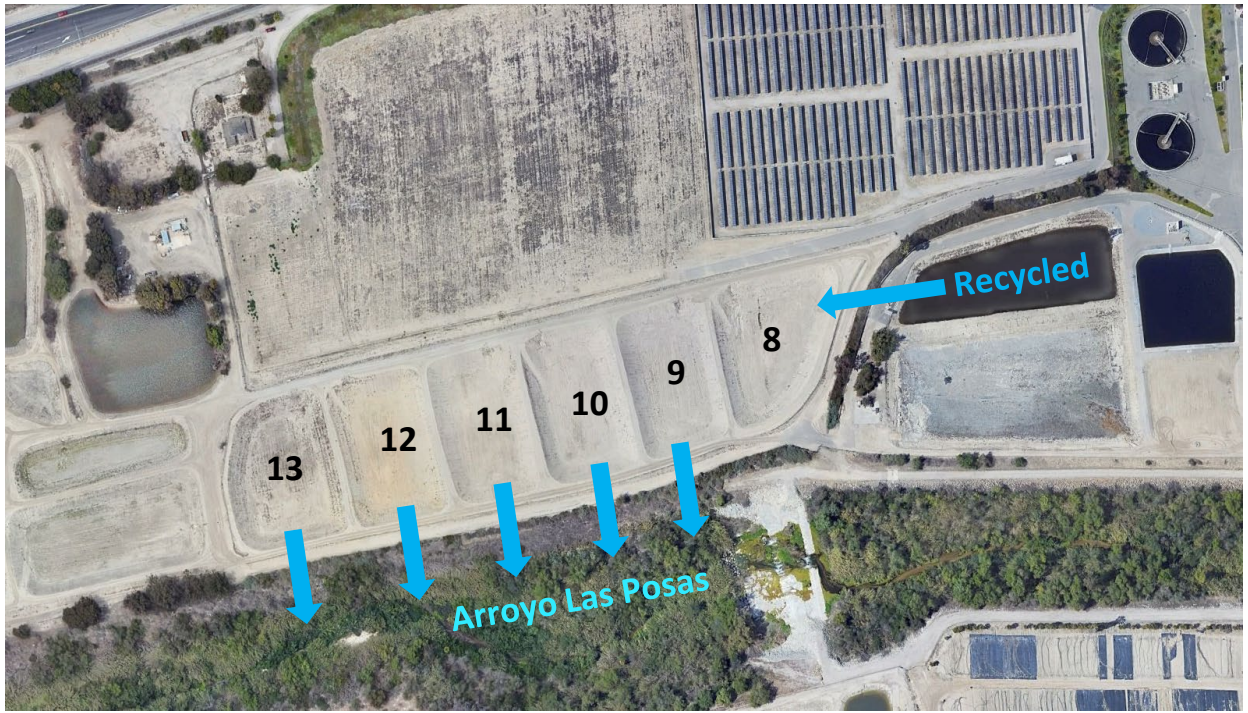
Project Goals

Project Goals:

1. **Characterize and quantify recharge in ponds with contrasting soil types.**
2. **Investigate potential leakage into adjacent river.**
3. **Evaluate potential basin modifications for improved basin performance.**
4. **Determine if this approach transferable to other sites.**

Pilot study to simulate diverted river water using recycled water.

Study Site at the Moorpark Water Reclamation Facility



- Characterize ponds 8 -13.
- Select ponds with contrasting soils for recharge experiments.
- Investigate recharge loss back into the stream.

Multi-method study using geophysics, hydrologic property sensors, and soil cores

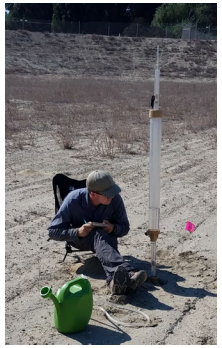
Soil Cores

DTP

ERT

Deep Soil Moisture

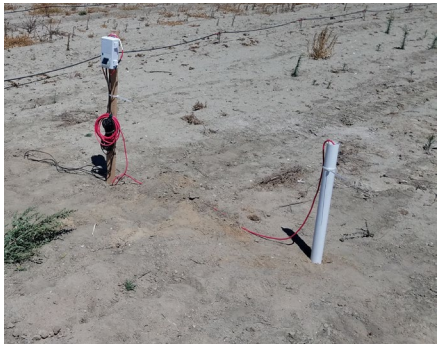
Hydraulic K



Flow Rate & Volume

Daily Evap

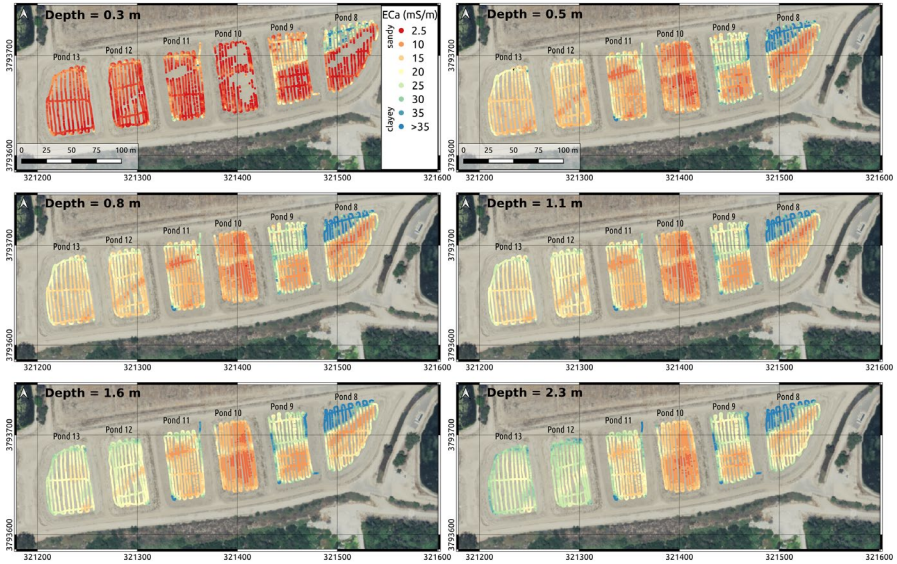
Soil Moisture & Water Level



EM

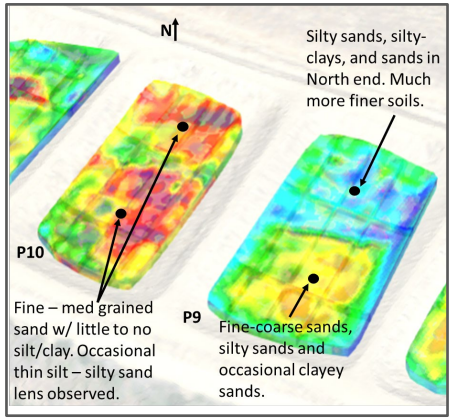
Pond Characterization

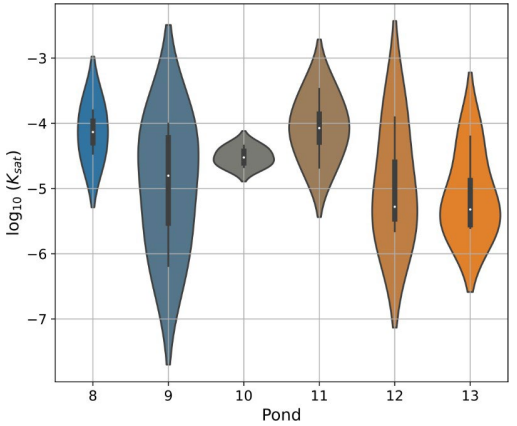
Pond characterization and selection

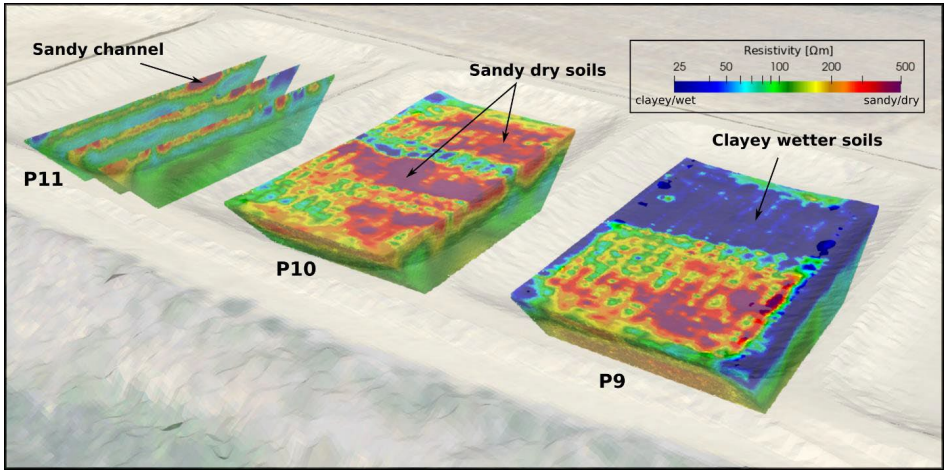


- EM/ERT results show spatially variable soil texture of clays to sands.
- Linear sand features appear to connect pond 10 – 13.
- EM data used to guide soil cores, pond selection and further characterization with ERT and permeameter.

3D ERT and 15m deep soil cores (blk circles).







Controlled Recharge Experiment

Recharge Experiment Flooding

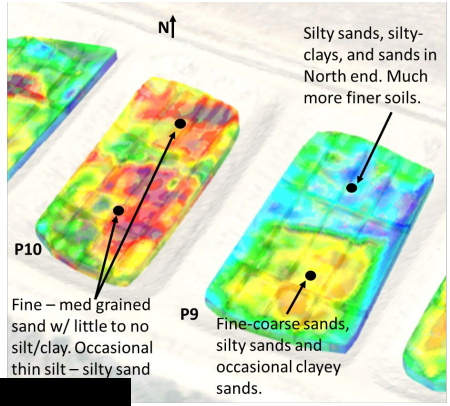
Pond 10 = 407k gallons (1.5 AF)

Pond 9 = 230k gallons (0.85 AF)

Recharge Experiment ERT Timelapse

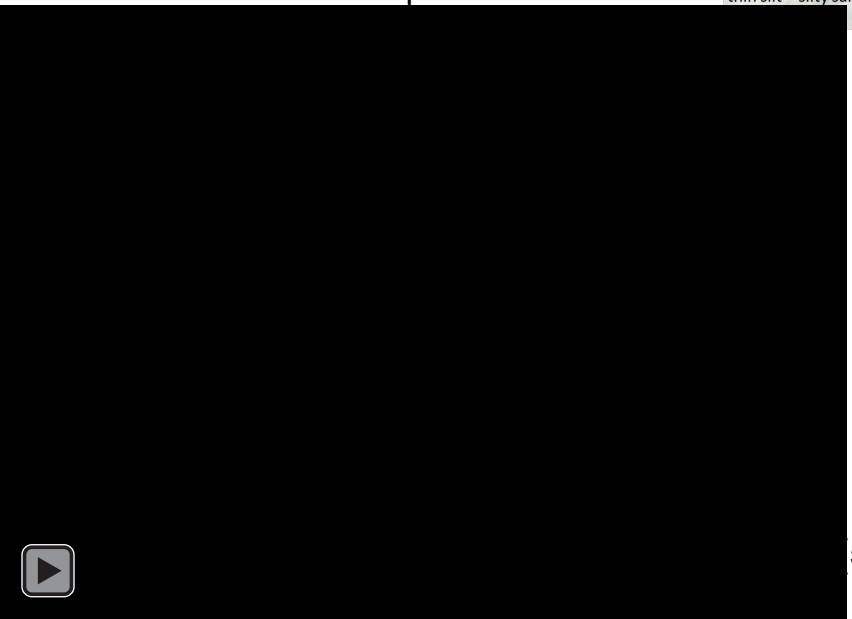
Pond 10 = 407k gallons (1.5 AF)

- Provides a conceptual understanding of subsurface water flow.
- Nearly 2x faster infiltration than Pond 9.
- Provides insights about recharge zonation within each pond.



Pond 9 = 230k gallons (0.85 AF)

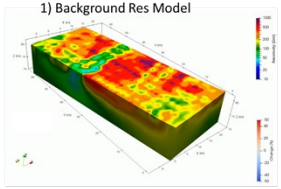
- Northern end with silty clay surface soils has little to no infiltration.
- Majority of infiltration happens in the southern end.
- Visual insights provide potential basin management.

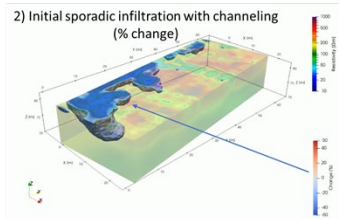


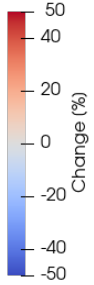
50ft)

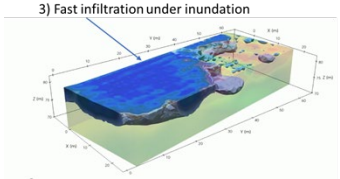
Recharge Experiment ERT and Soil Moisture Summary

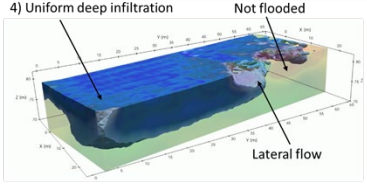
Pond 10

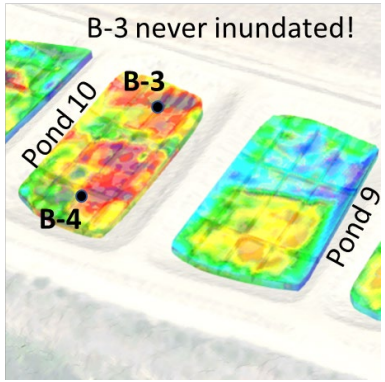


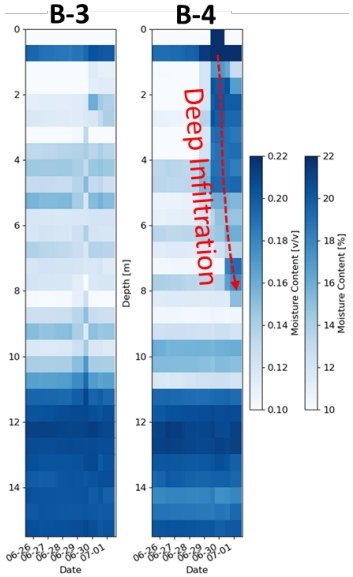




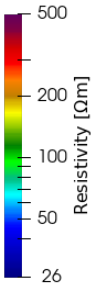


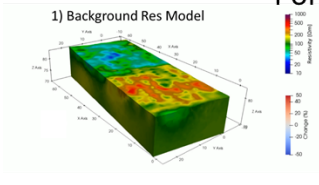


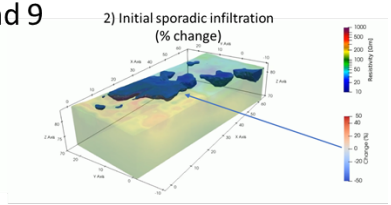


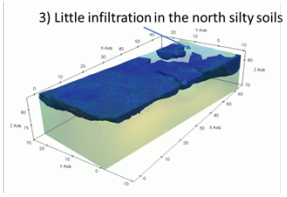


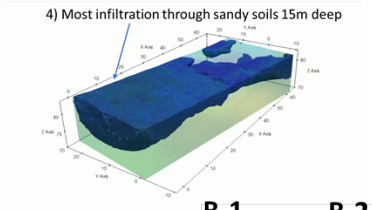
Pond 9

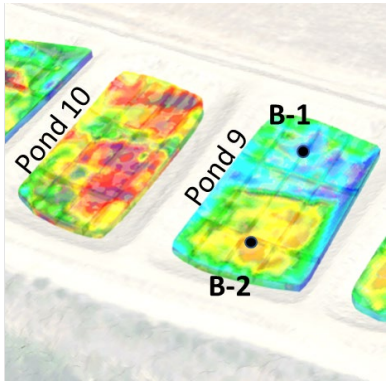


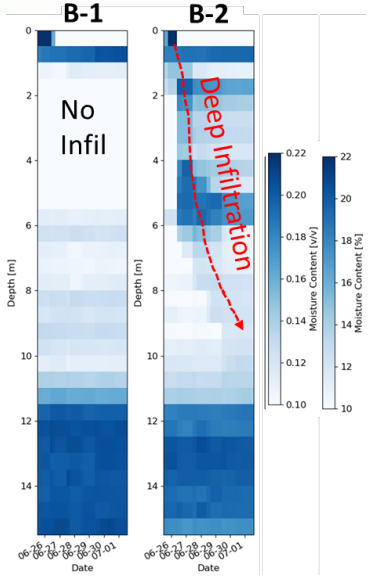




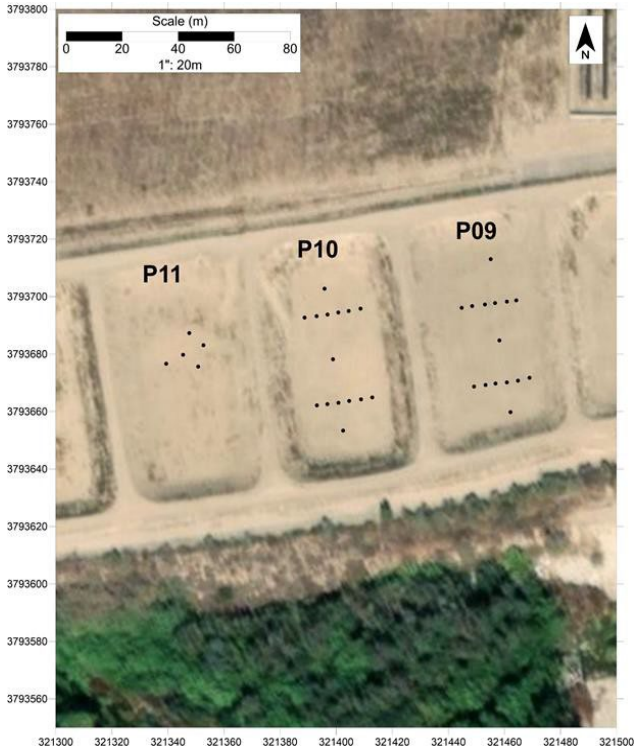


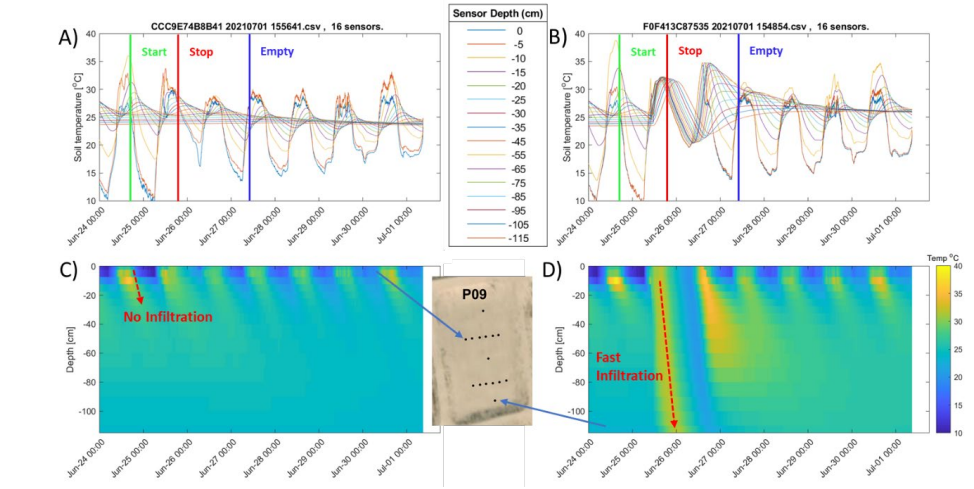


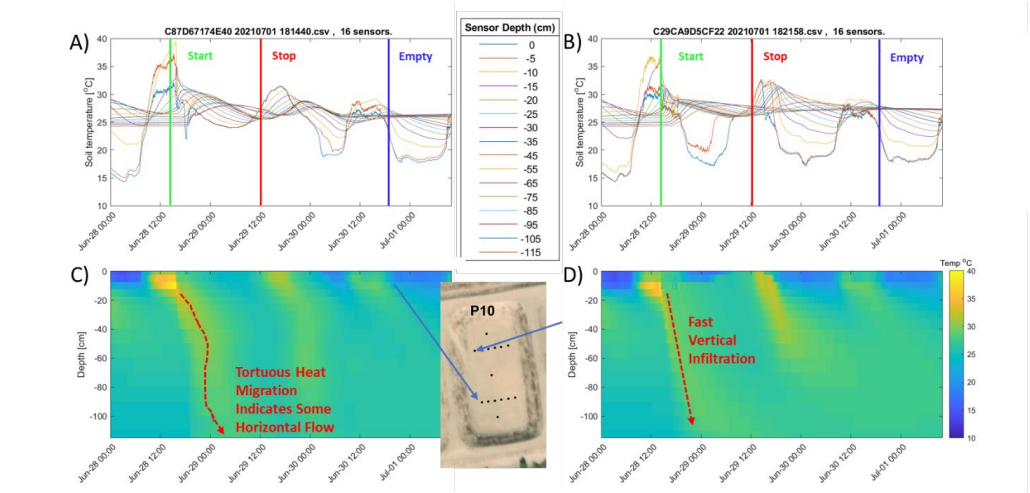




Recharge Experiment DTP Summary

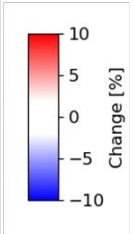


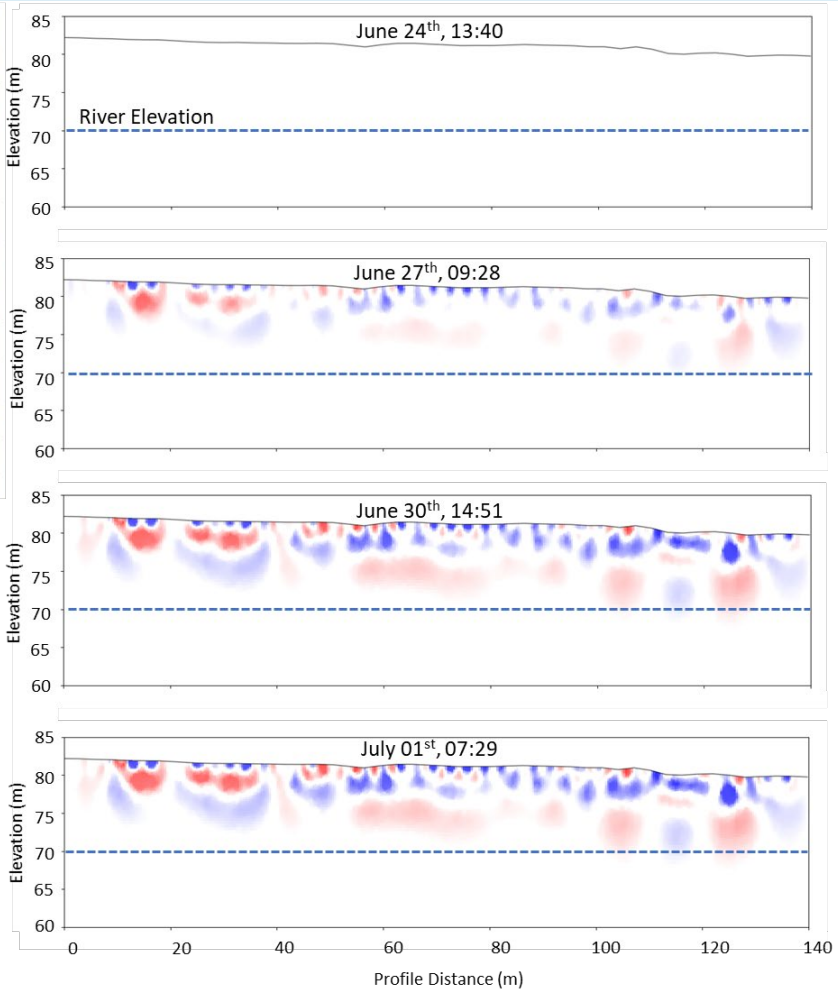




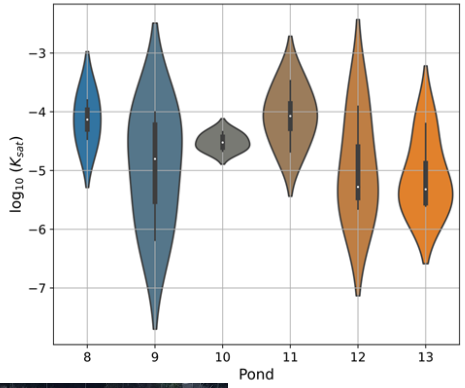
Leakage into the River?

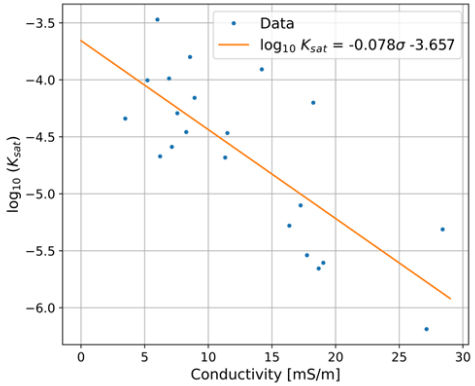
- Timelapse streamside ERT collected before, during and after recharge in both ponds.
- River elevation is at 70m elevation in the ERT cross sections.
- 4 ERT timestamps show no clear indication of flow into the river.
- Results confirm applied water is likely moving down into the aquifer.

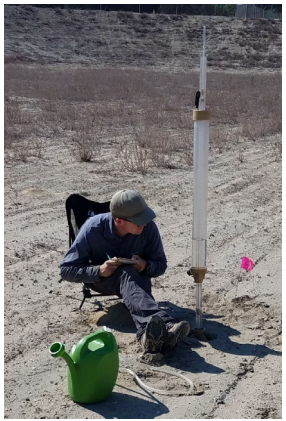


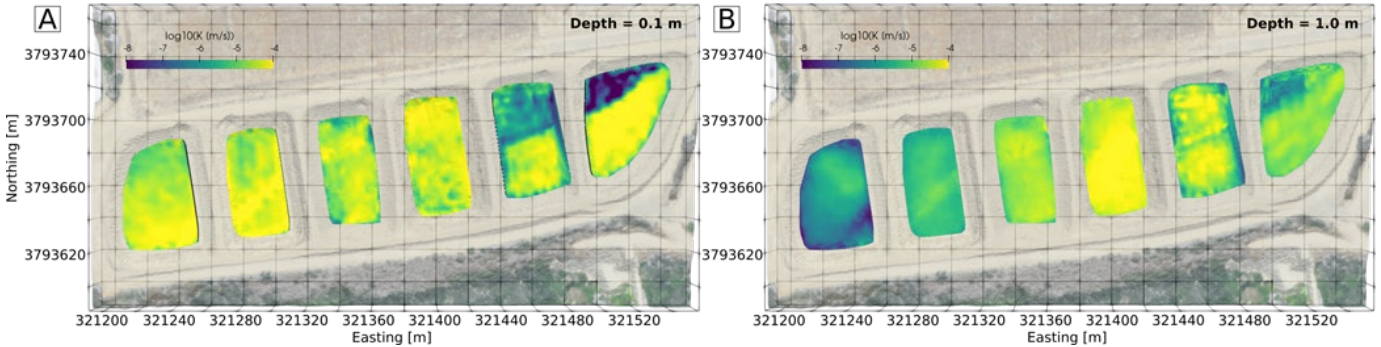


Spatial Estimates of Hydraulic Conductivity









- K_{sat} estimated from relationship between conductivity and measured K_{sat} (Guelph Permeameter).
- 3D models of K_{sat} used to model recharge distributed recharge rates.

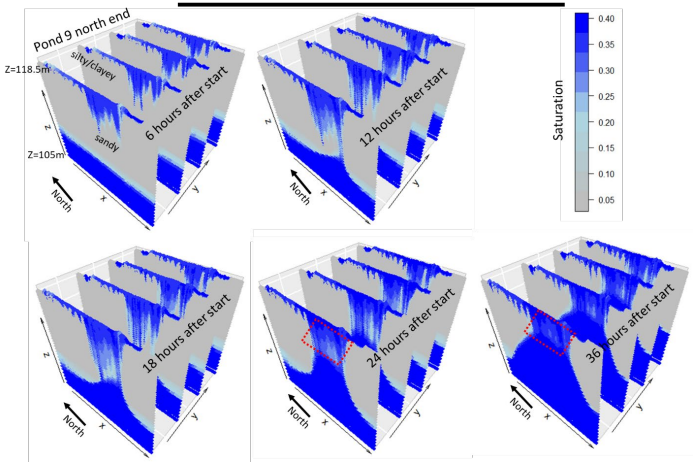
Multiple Methods to Estimate Recharge Rates

DTP Diurnal Heat Flux

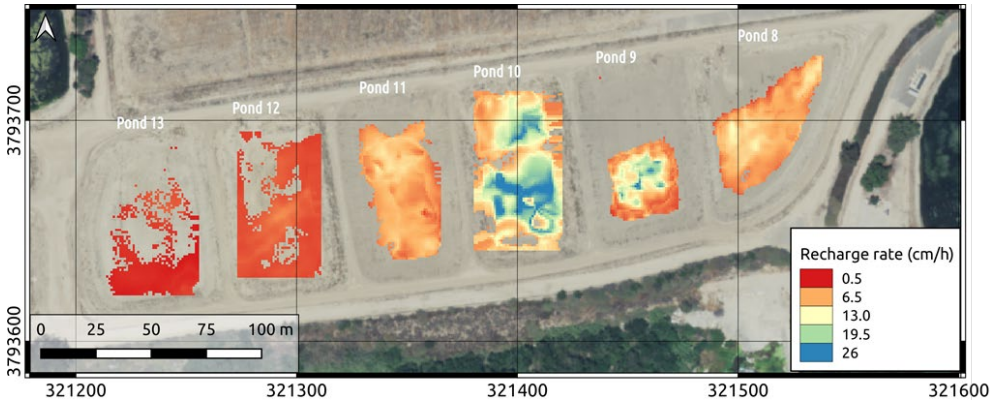
Vertical Ksat from VFLUX heat solver

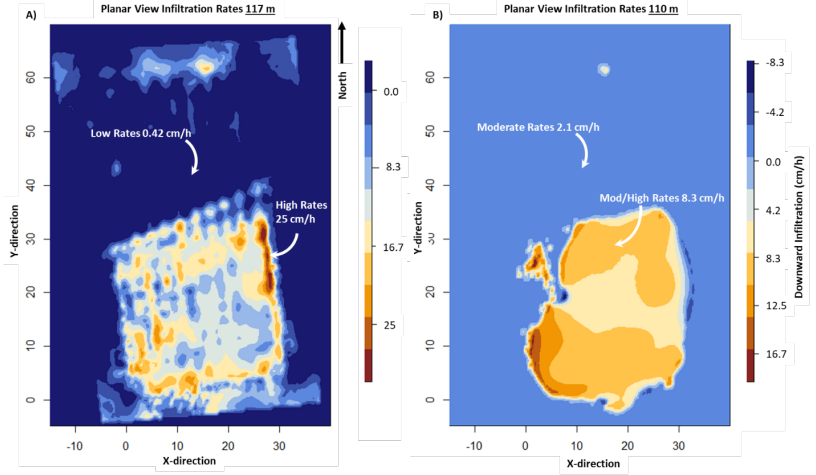
Sensor #	Max Infiltration (cm/h)	Location/soil type
P9E34D	0.72	P9 North end/silty clayey soil
P9F2FC	2.16	P9 South end/sandy soil
P9C3C0	1.15	P9 Center/sandy soil w/ some silty sands
P10F855	1.44	P10 South end/sandy soil w/some silty sands
P10D3F6	2.88	P10 Center/sandy soils

3D Min3P Model: Pond 9



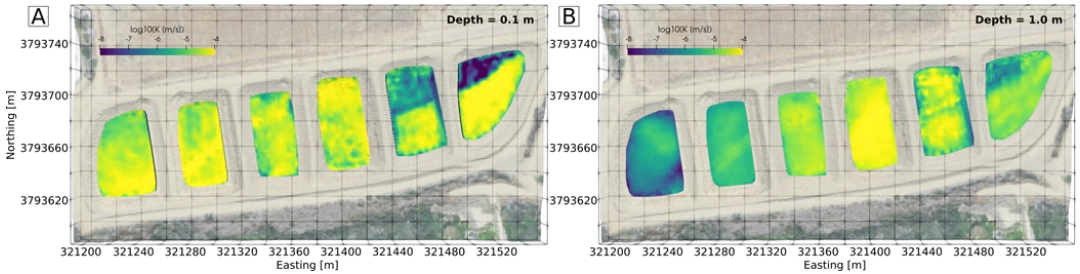
1D Hydrus Model



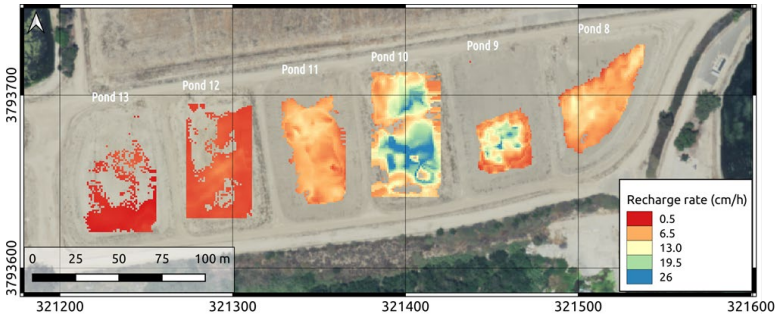


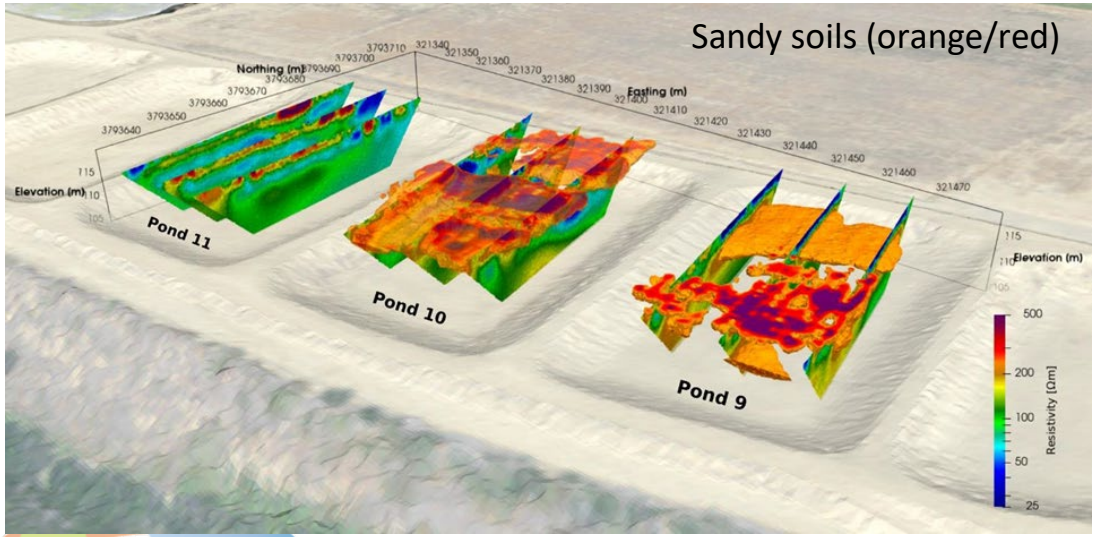
Potential Improved Recharge through Pond Modification

Hydraulic Conductivity



1D Hydrus Model

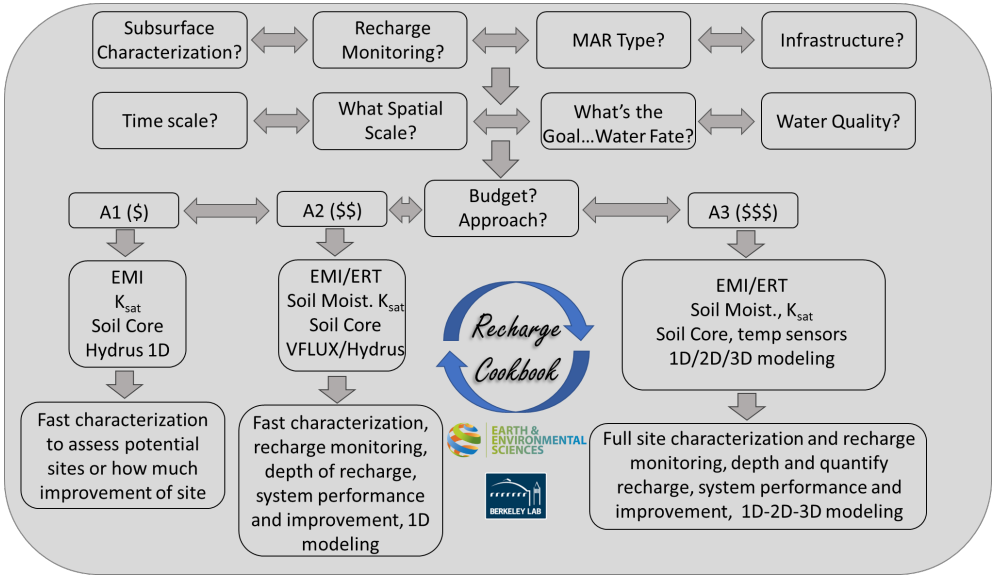




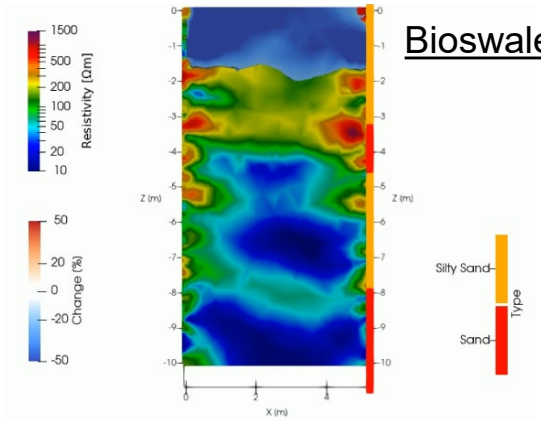
- Removing 2m clayey soil in Pond 9 could improve recharge by 185%!
- Ponds 12 and 13 become more clayey below 1m depth and could have drywells or French drains installed through the low perm soils to convey water into the sands below.
- This method highlights how strategically collected data can be used to characterize, quantify and optimize recharge.

Uhlemann, S., Ulrich, C., Newcomer, M., Fiske, P., Kim, J., & Pope, J. (2022). 3D hydrogeophysical characterization of managed aquifer recharge basins. Frontiers in Earth Science, 10, 942737.

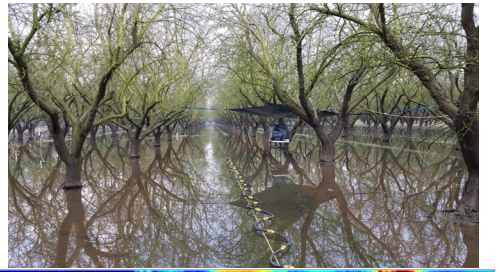
How transferrable is this approach?



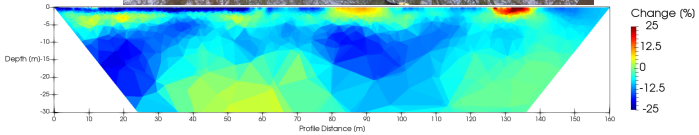
This approach has been tailored to small to large scales:



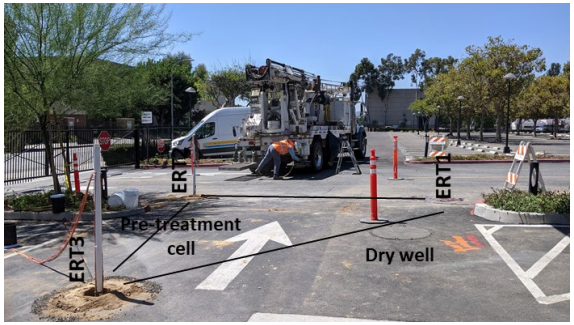
Bioswales

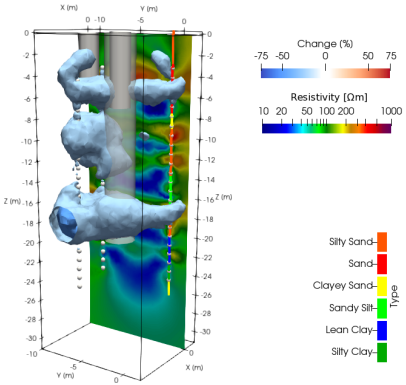


Orchards



Drywells





Key Takeaways

1. This ‘cookbook’ approach is dynamic and adaptive, and **easily transferable** to other sites.
2. Pond 9 modifications could **improve by 185%** and other options for ponds 12 and 13.
3. Identified **three methods for estimating spatial recharge rates** depending on need and budget.
4. Confirmed **deep recharge** to 15 m (50 ft) deep and **no leakage** back into the Arroyo Las Posas.
5. The Hydrus 1D approach is a low cost way to estimate recharge rates without needing to apply water.
6. All collected data can be inputs into hydrological models for planning and forecasting.
7. This approach gives the water manager visual input on basin performance but also hard data that can be used for reporting.
8. Recharge is complex and controlled by soil texture, and not simply vertical as is sometimes assumed.

Thank You

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VENTURA COUNTY

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

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