A percolation monitoring program using distributed temperature sensing

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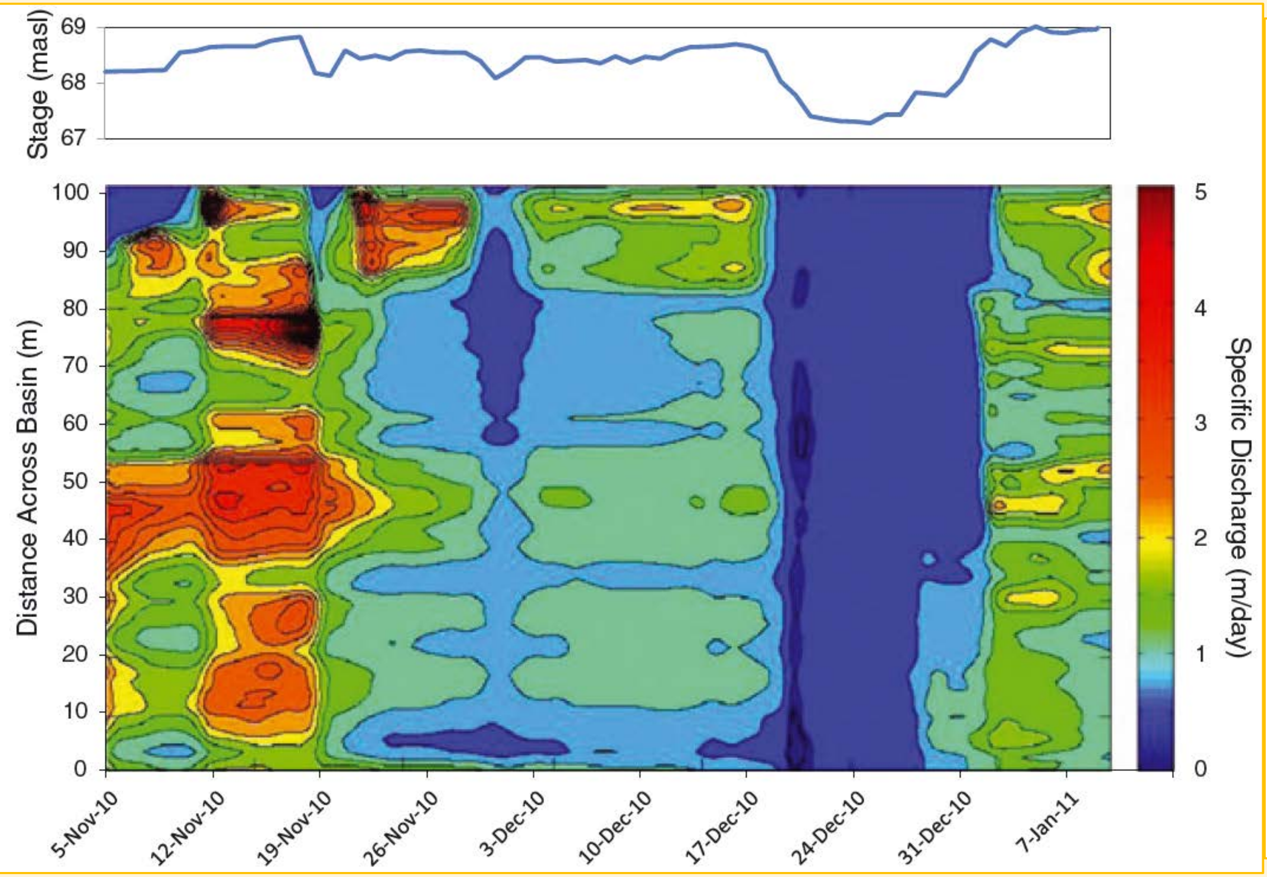
Outline

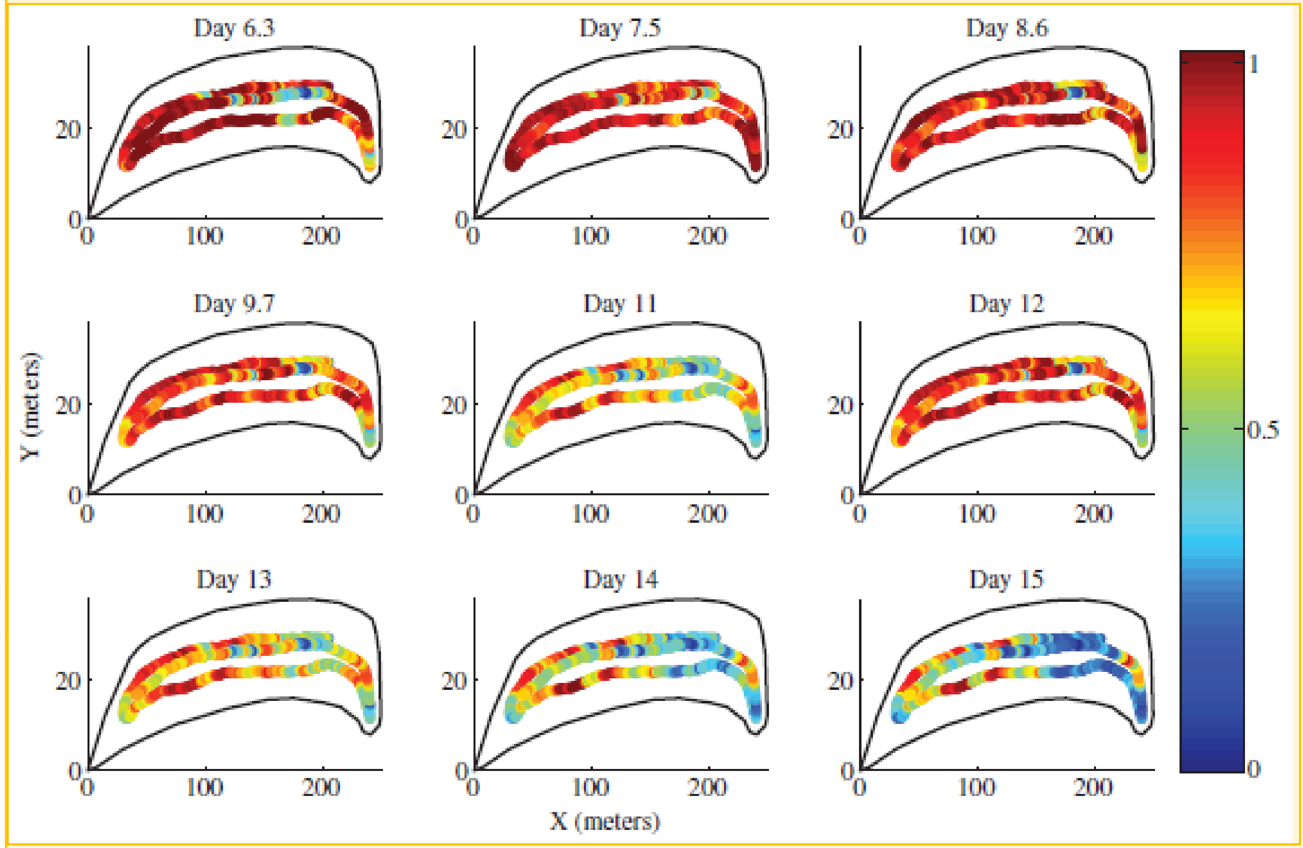
- Background
- Objectives
- Program Description
- Case Study: OCWD’s La Palma Recharge Basin, Anaheim, California
- Lessons Learned
- Summary

Background

- Recharge basin percolation rates decline over time…
- Prior recharge basin Distributed Temperature Sensing (DTS) research:

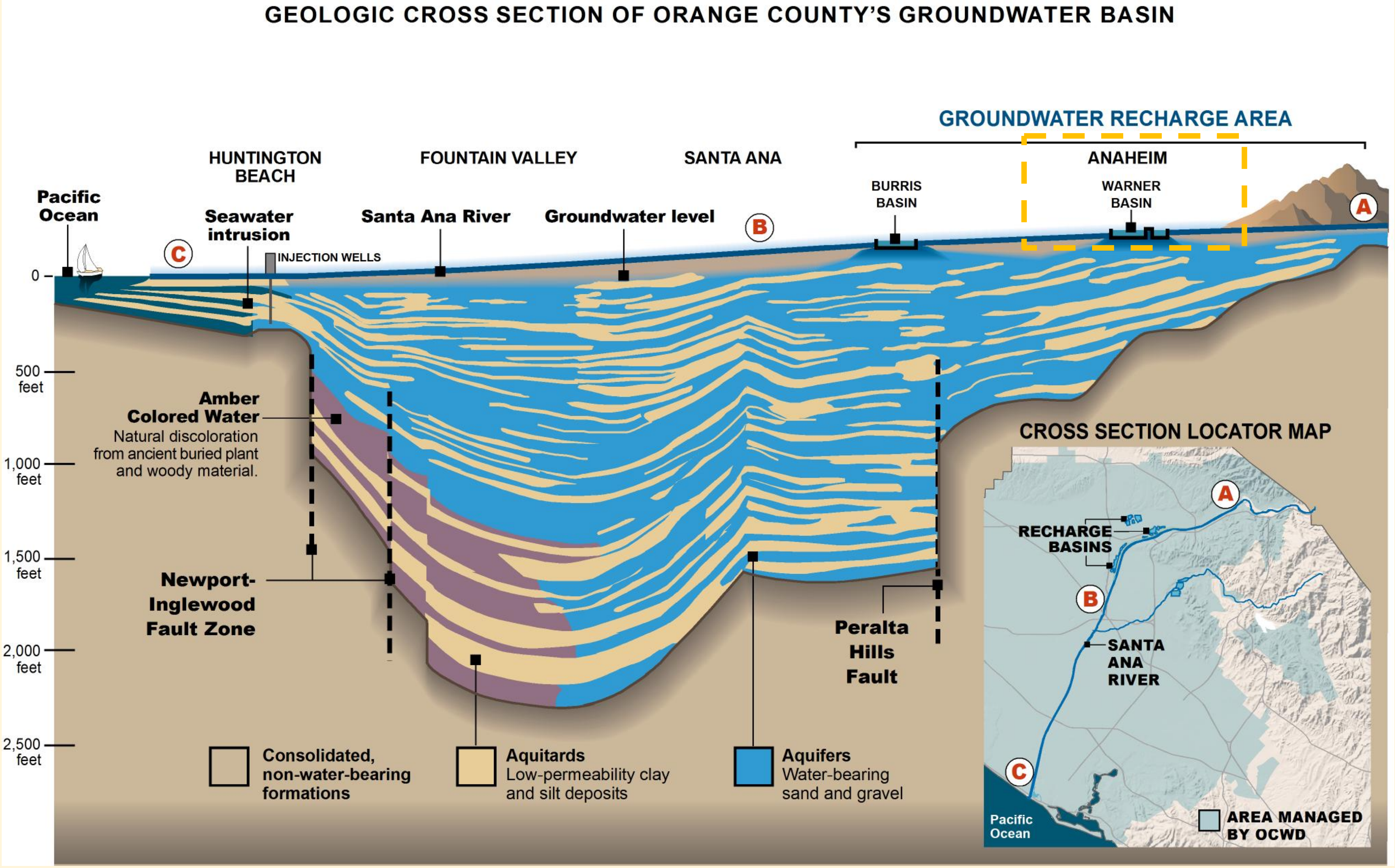


(Becker et al., 2013)



(Mawer et al., 2016)

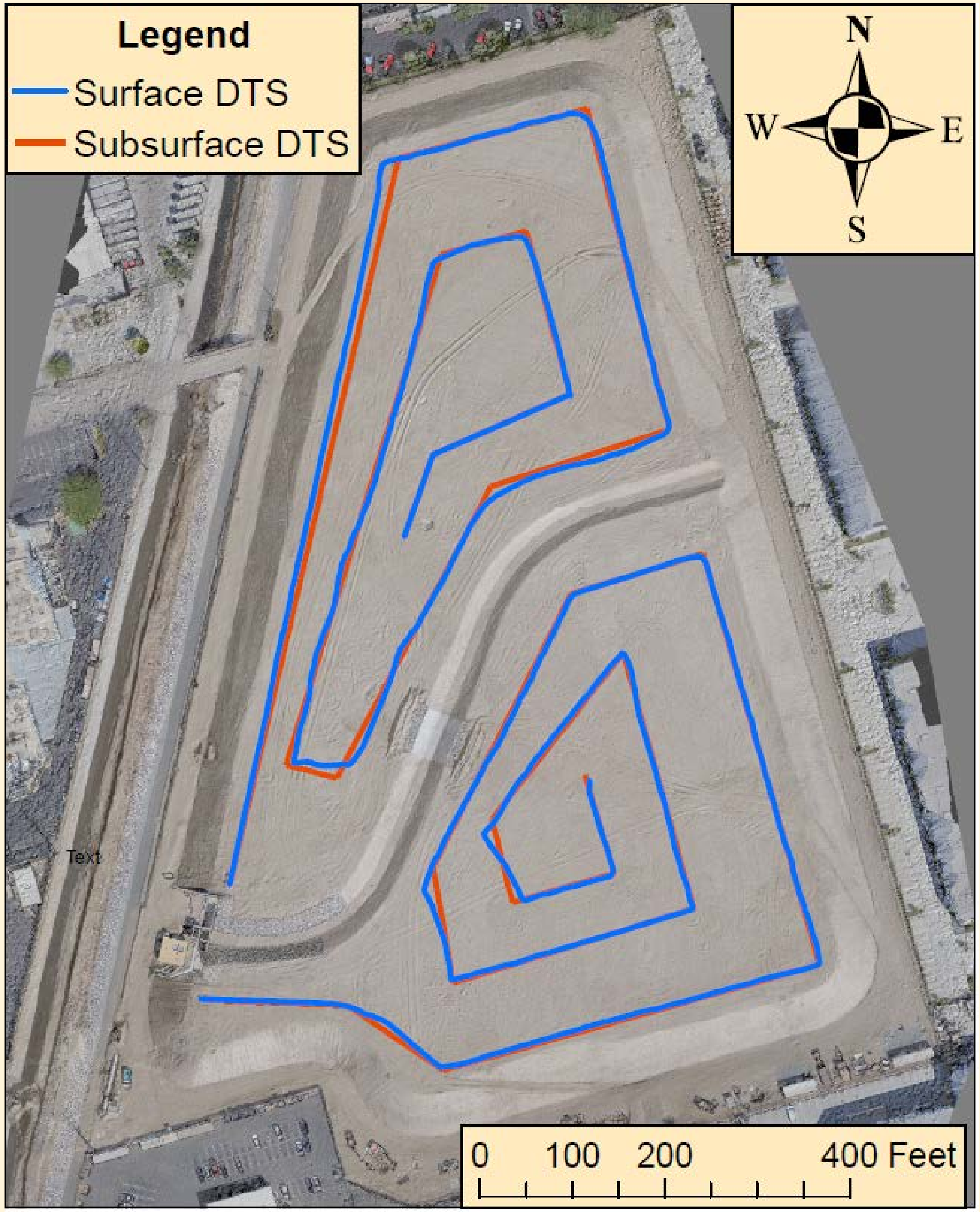
Case Study: La Palma Recharge Basin - Setting



La Palma Recharge Basin

- Ground Water Replenishment System (GWRS) water supply, <1 mg/L TSS.

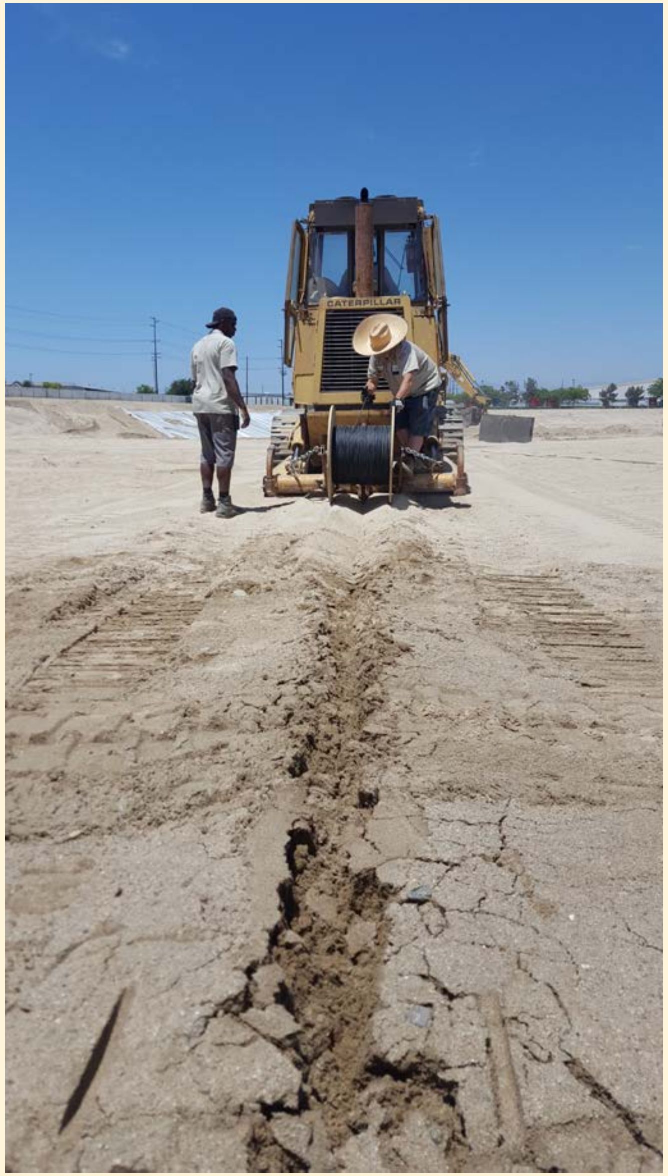
- 1st recharge basin monitored with DTS since first fill.



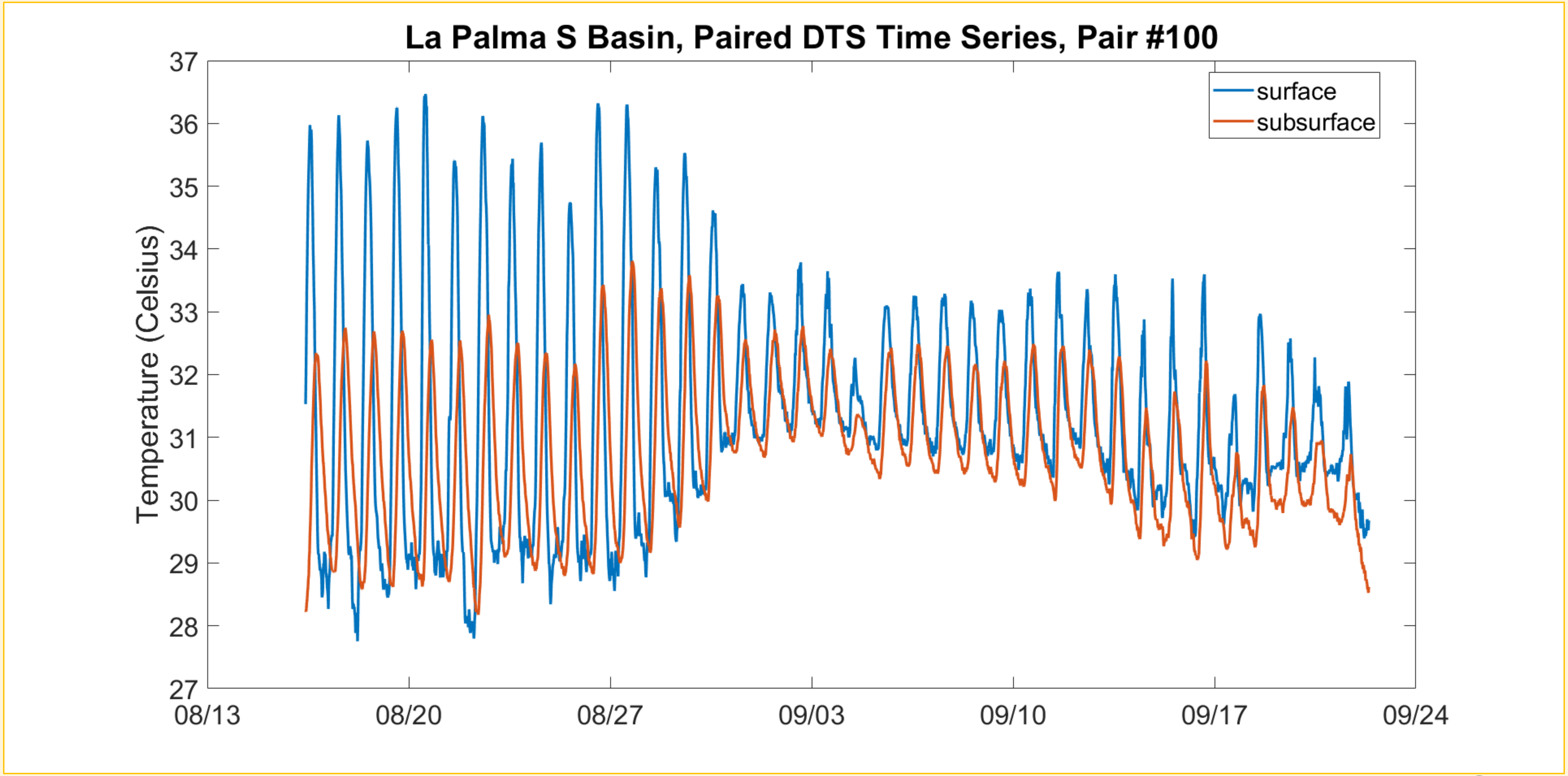
Objectives

- Develop a user-friendly, yet robust program (in MATLAB®) to monitor percolation performance, spatially and temporally.
- Identify factors attributed to lower percolation rates, for example:
    1. Sediment clogging
    2. Sediment compaction
    3. Sediment heterogeneity
- WHAT, WHEN, WHERE, WHY... important info for recharge basin O&M.

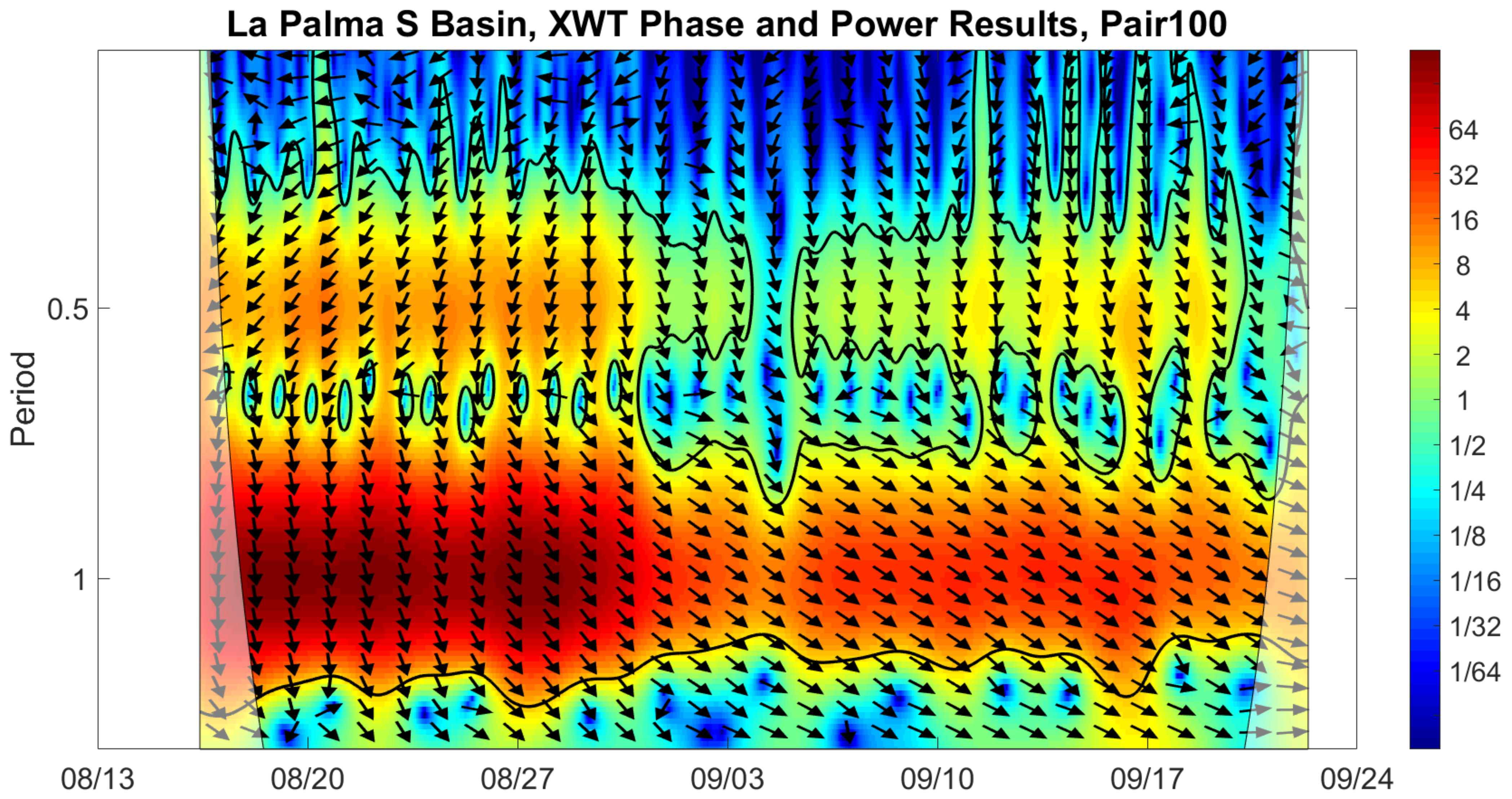
Fiber Optic DTS Installation



Step 1: Input Temperature-Time Series Data

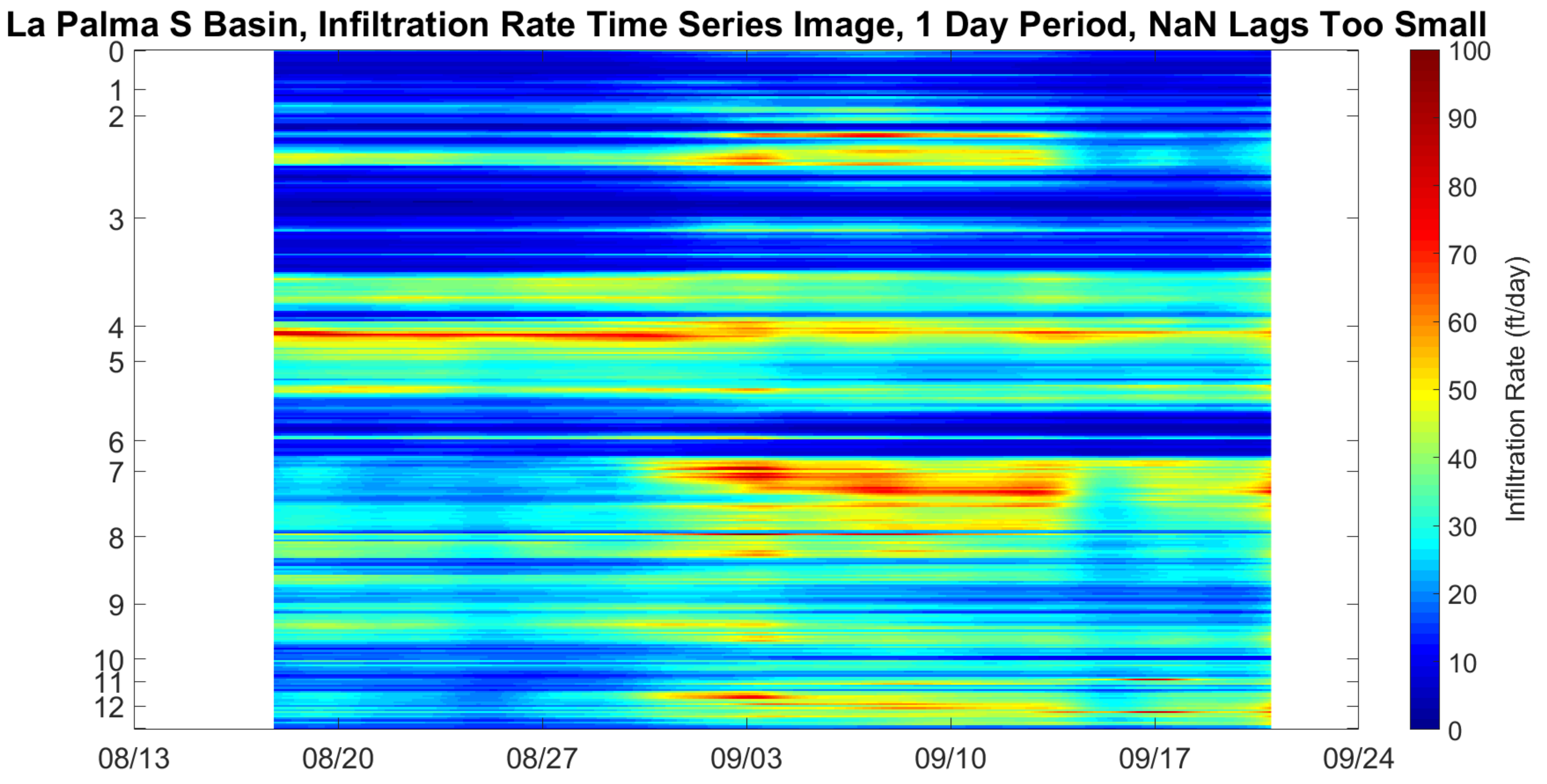


Step 2: Extract Phase (Time) Lag from Signals

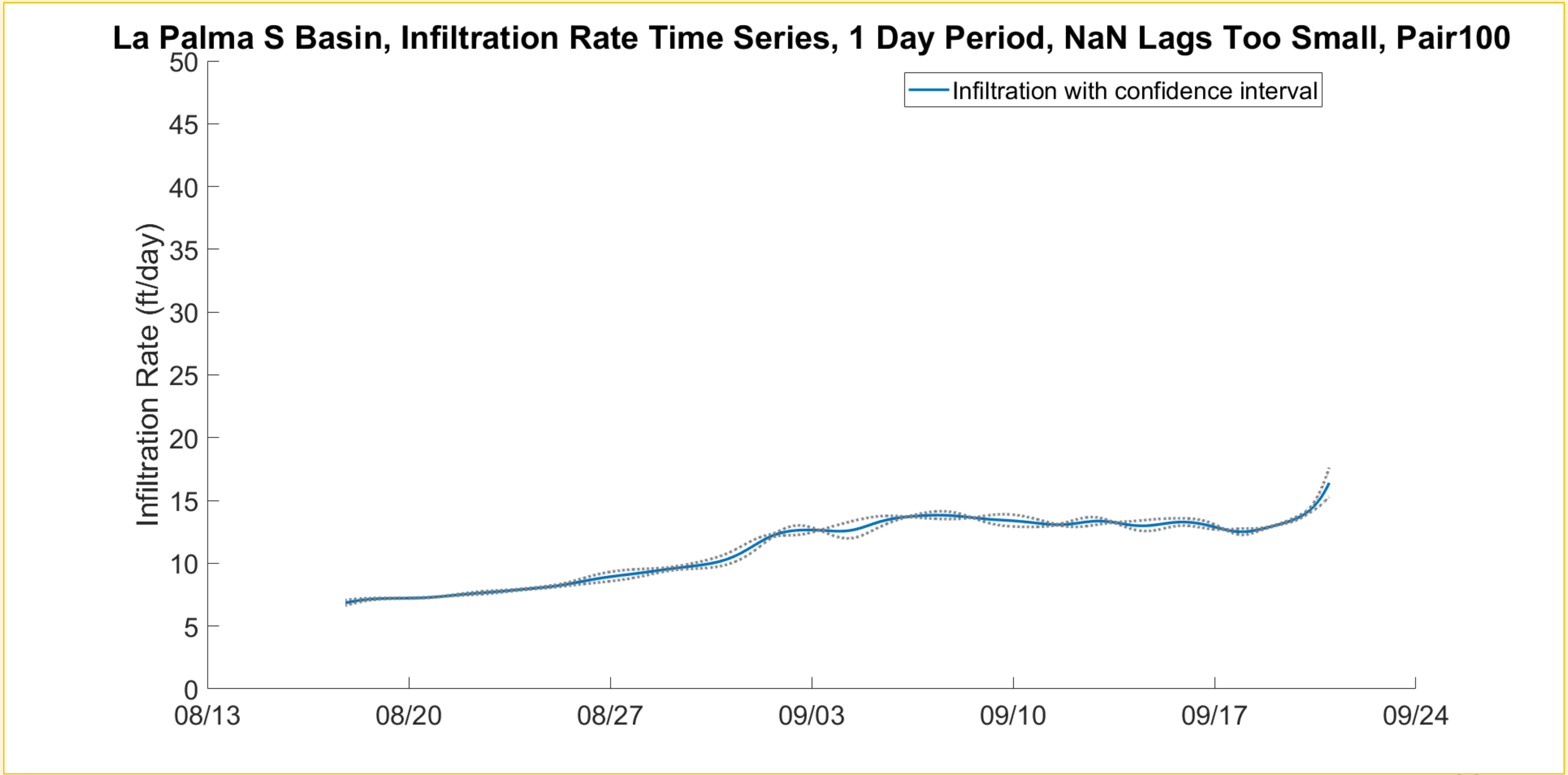


(Grinsted et al., 2004) (Torrence and Compo, 1999)

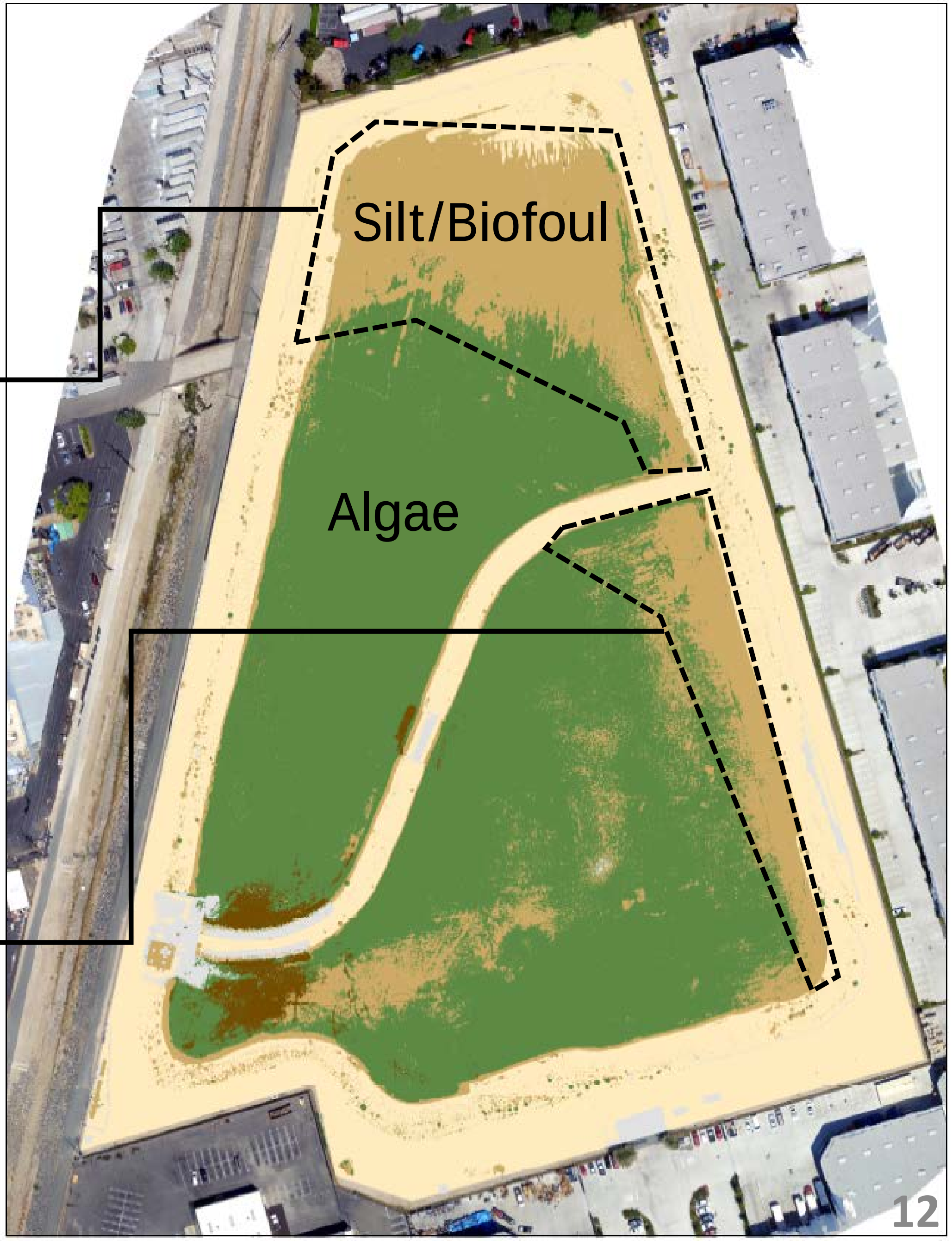
Step 3: View Basin-Wide Infiltration Time Series



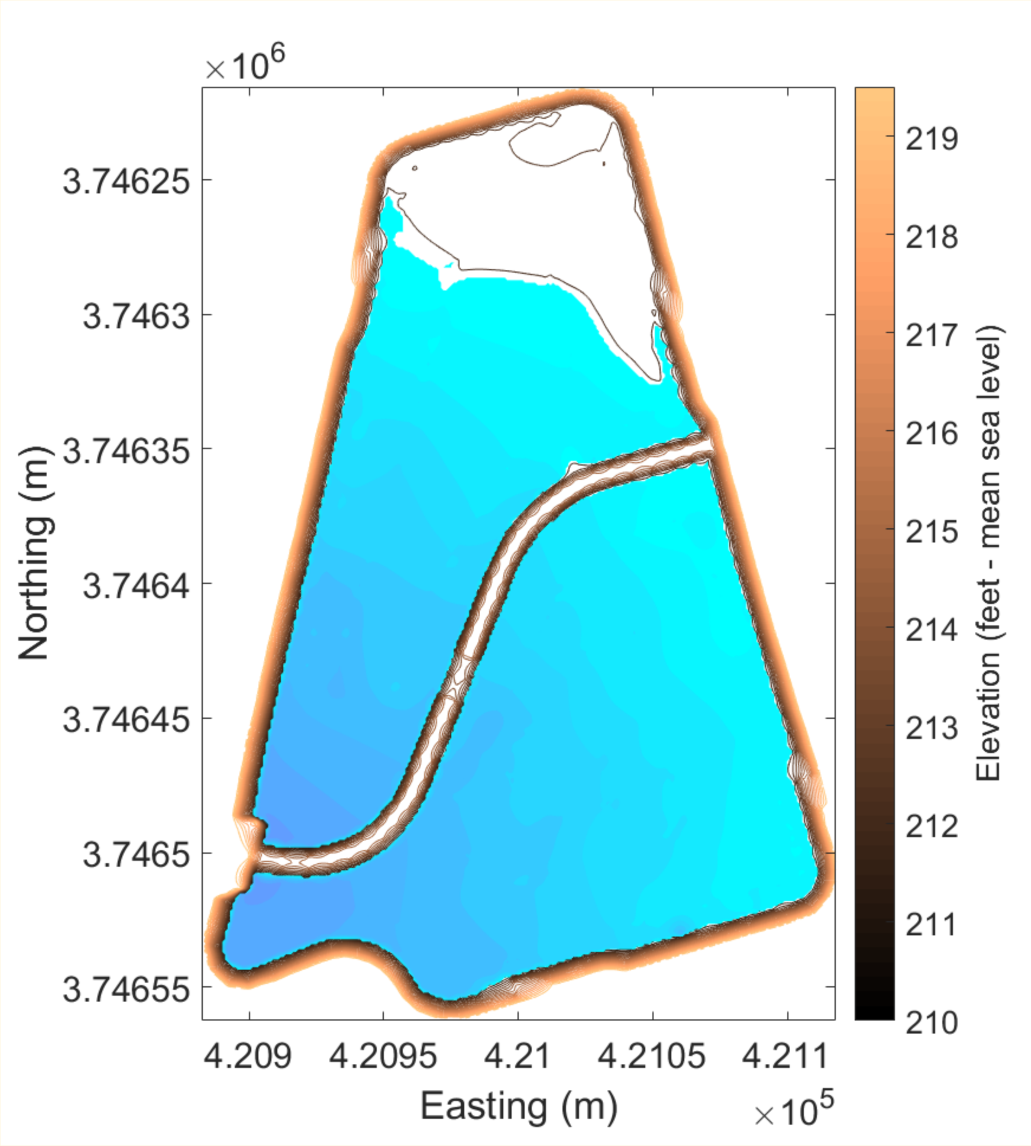
Step 4: View a Location’s Infiltration Time Series

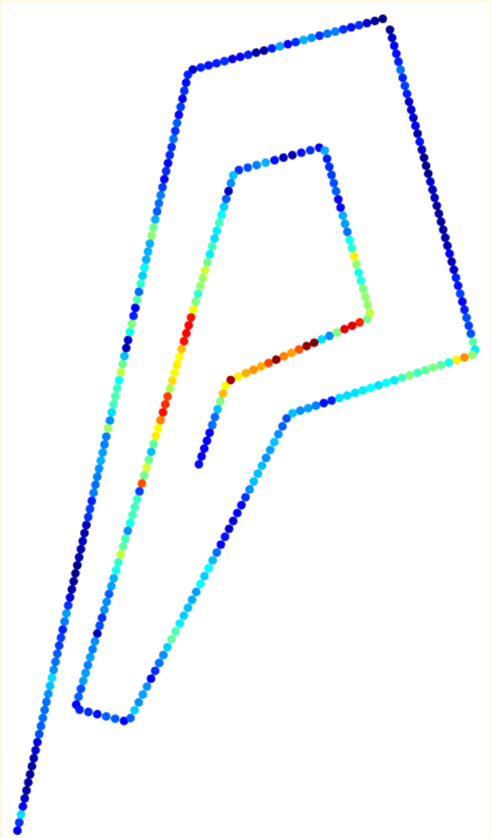


Clogging



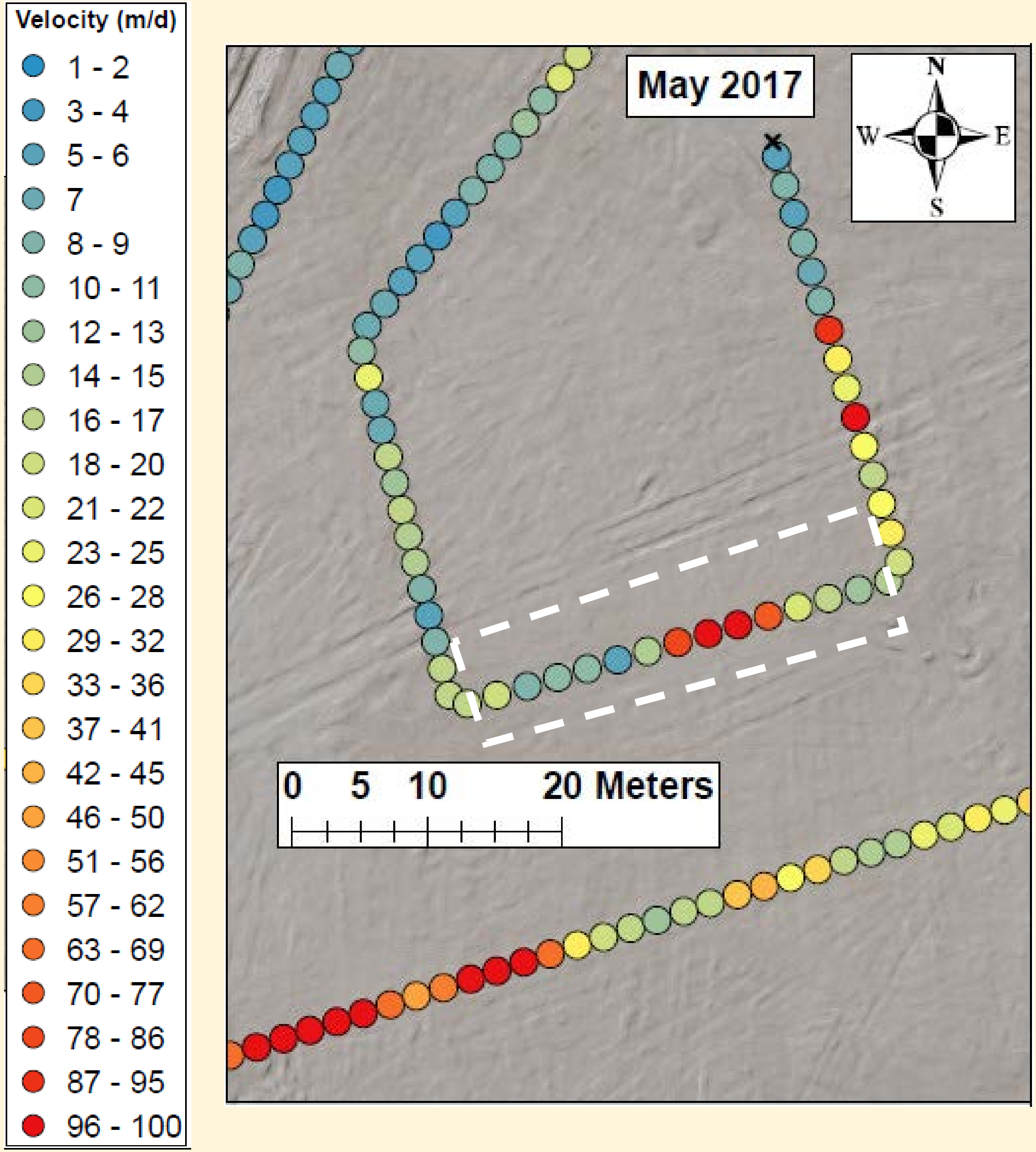
A Clogging Mechanism: Moving Water Edge



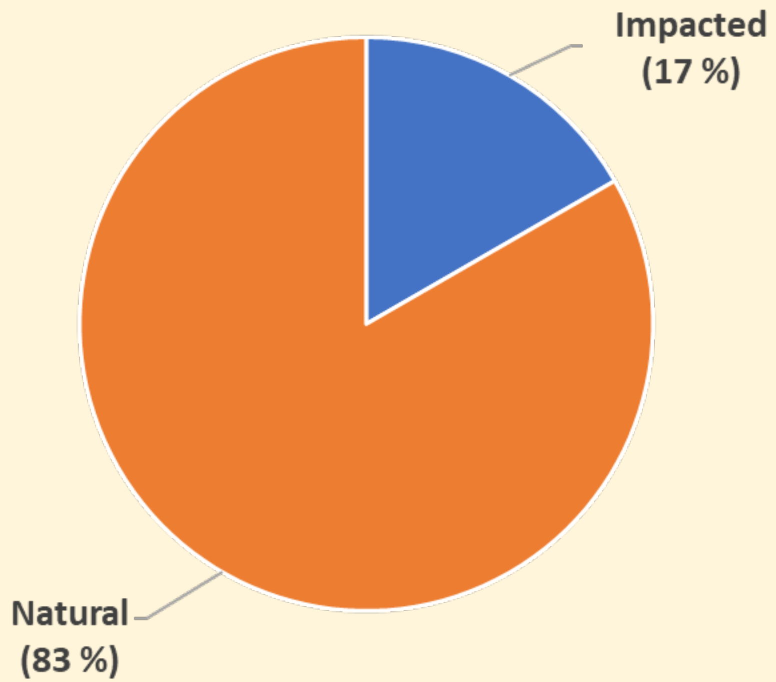


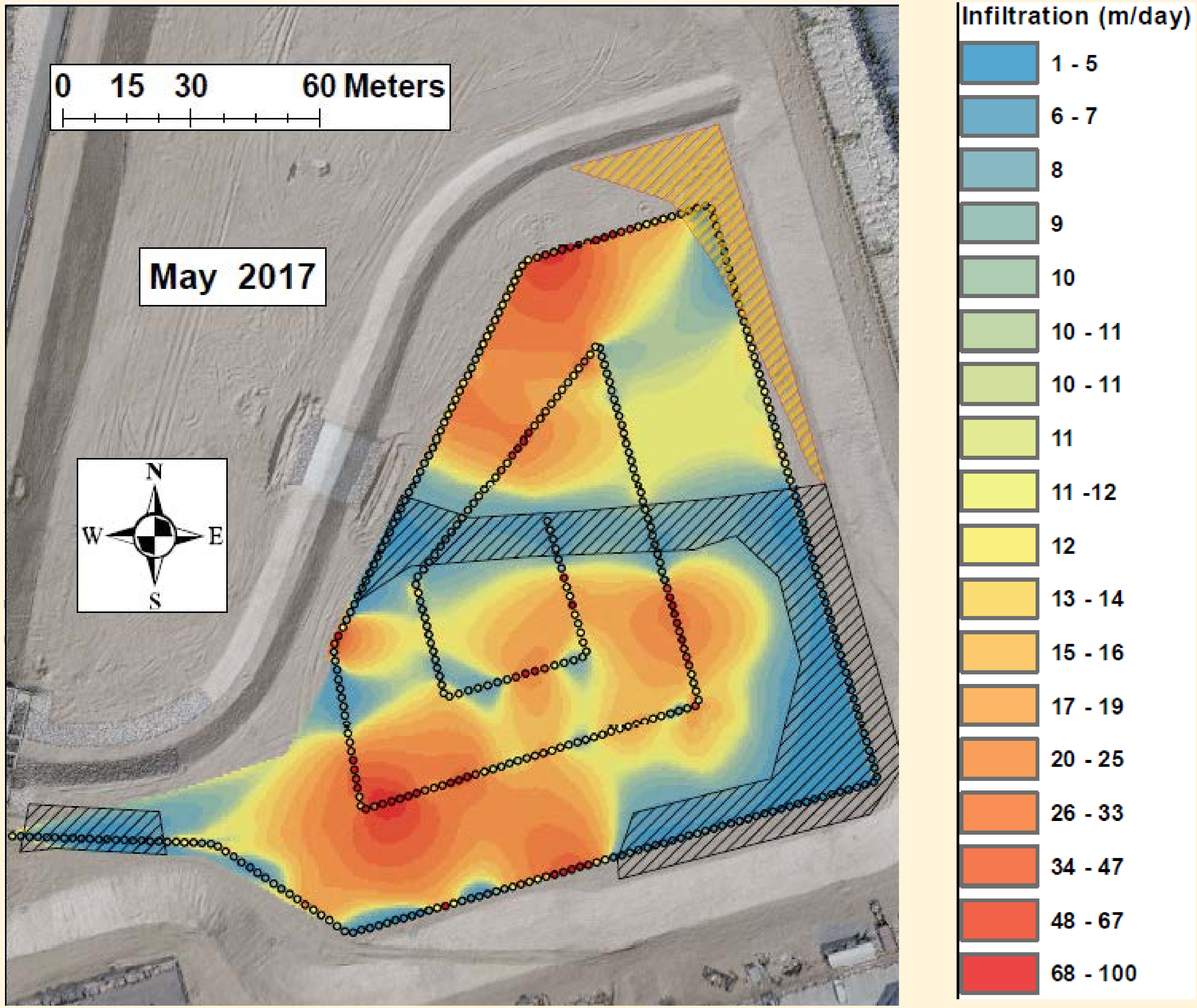
(Siriwardene et al., 2007)

Heterogeneity



Compaction (& Fill)





Lessons Learned

<u>Fiber Optic DTS Logistics:</u>

- Install rugged fiber optic DTS cable.
- Calibration is important.
- Determine optimal sensor (cable) depths.

<u>Recharge Basin Operations:</u>

- Preferential silt deposition occurs where water edge oscillates.
- Compaction during basin construction limits percolation.
- Sediment heterogeneity can be sensed at high resolution

Summary

- Able to identify **where**, **when** and **what** factors cause relatively low percolation rates:
  - Siltation,
  - Compaction,
  - Heterogeneity
- Useful information for optimizing a basin's percolation performance.
- Applications:
  - Groundwater recharge basins
  - Wastewater percolation basins
  - Rivers and lakes
  - Dams

References

- Becker et al., 2013. Measuring artificial recharge with fiber optic distributed temperature sensing. *Groundwater*. Vol. 51, No. 5, pp. 670-678.
- Grinsted et al., 2004. Application of the cross wavelet transform and wavelet coherence to geophysical time series. *Nonlinear Processes in Geophysics*. Vol. 11, pp. 561-566.
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- Torrence and Compo, 1999. A practical guide to wavelet analysis. *Bulletin of American Meterological Society.* Vol. 79, pp. 61-78.