Monitoring Water Infiltration in Shallow Karst Features Using Time-Lapse Electrical Resistivity Surveys with Permanently Installed Electrodes

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Introduction

Understanding how water infiltrates the subsurface and recharges subsurface aquifers is important for protecting groundwater resources. In this study, we deploy time-lapse electrical resistivity surveys with permanently installed electrodes to monitor the water infiltration process in the Royal Springs groundwater basin in central Kentucky.

Research Question

What are the near surface properties of the epikarst environments, and how do these properties influence infiltration rates into the subsurface during and post storm events?

Field Site

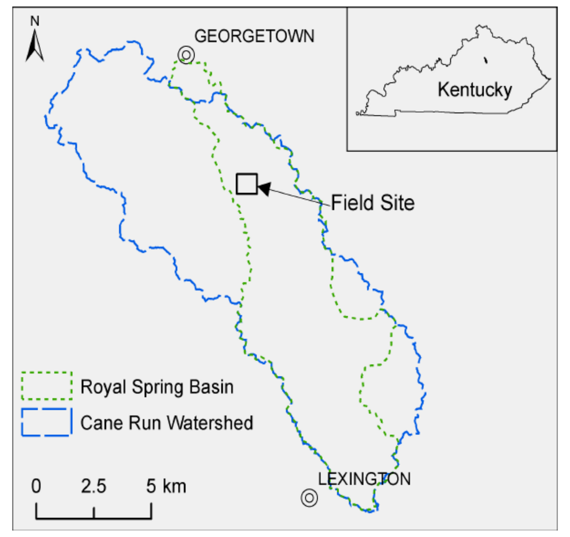

Figure 1: Locator map of well 22 field site at the Kentucky Horse Park in central Kentucky

Research Procedure

- Self-made permanent electrodes were made to be installed in the subsurface at well site 22 for up to two years.
- Shallow trenches were dug, then electrodes were placed in a 6x6 grid with 5 ft spacing.
- Electrodes were then buried along with the wires and contact resistance tests were done to ensure all electrodes are working properly.
- Radial dipole-dipole surveys were conducted and then processed in EarthImager3D.

Construct and Deploy Electrodes

Figure 2: A 10 inch stainless steel camping stake is wrapped with six inches of exposed 18 AWG copper wiring. The wire is wrapped around the upper section of the stake. The stake is then secured using RTV silicone and heat shrink tubing is applied to ensure that the wire connection remains tight.

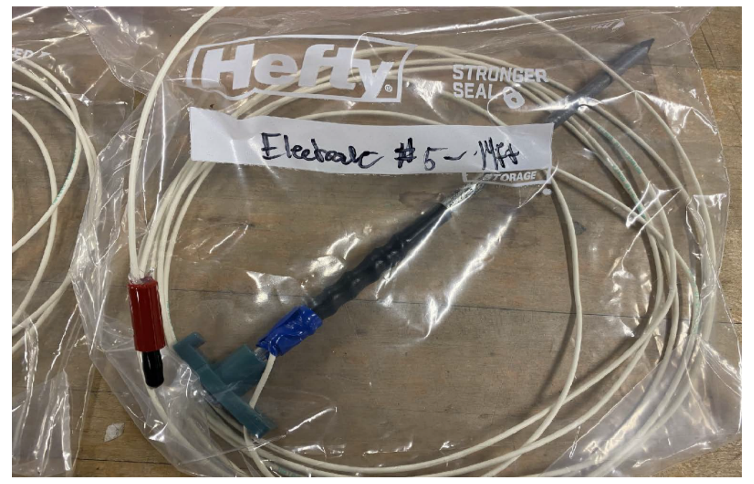

Figure 3: A completed electrode showing the stake connected to the wire with a banana plug connected to the other end of the wire.

Figure 4: Electrodes were then placed in the 6x6 grid with 5ft spacing and buried into the subsurface.

Figure 5: Once electrodes were buried, the cables were ran underground and gathered at well 22 and plugged into the switch box

Radial Dipole-Dipole Survey Data Processing

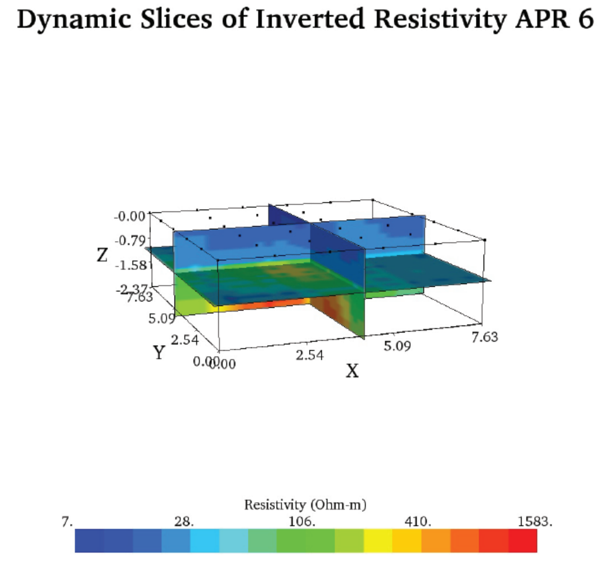

Figure 6: Dynamic slice model of inverted resistivity from the April 6 radial dipole-dipole survey

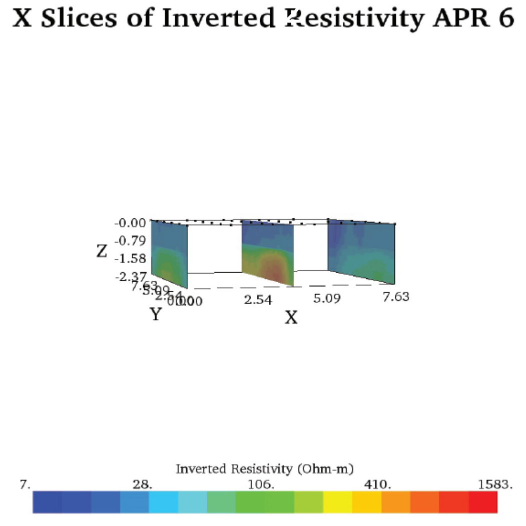

Figure 7: Static slice model of inverted resistivity from the April 6 radial dipole-dipole survey

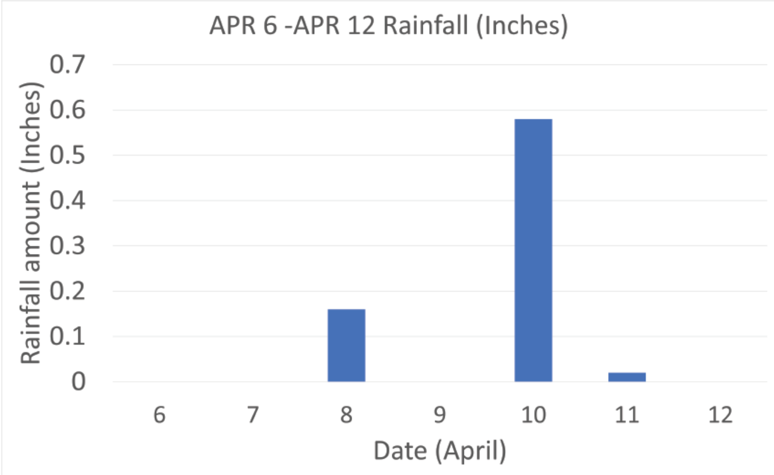

Figure 8: Daily rainfall data for April 6- April 12, 2021 at the Bluegrass International Airport (source: weather.gov)

Percent Change of Resistivity

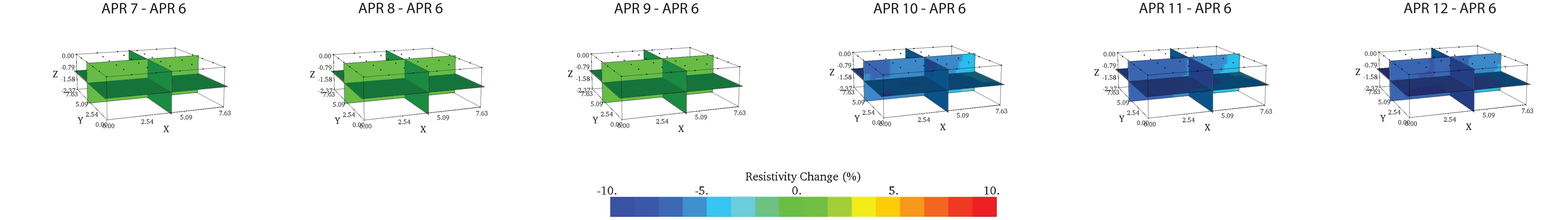

Figure 9: Dynamic sliced models of percent resisitivity changes from April 6 - April 12. Percent change in resistivity is shown from -10% - 10%, with negative percent change meaning a decrease in resistivity and a positive percent change showing an increase in the resistivity. Percent change is shown compared to the background data recorded on April 6.

Results and Discussion

- The April 6 survey data show that the resistivity value increases with depth suggesting that the subsurface is becoming dryer at depth and may indicate possible compositional changes.
- The high resistivity contrast at ~6 ft depth may indicate the soil-rock interface. The soil-rock interface at well 22 is 7 ft deep.
- No resistivity changes in the first three days. The small amount of rainfall in April 8 caused little change in resistivity.
- A decrease in resistivity begins on April 10. Rainfall amount of 0.6" was recorded at the Bluegrass International Airport on April 10.
- Additional, but small, amount of rainfall on April 11 further reduced resistivity.
- The resisitivity decrease is not uniform. The left part (shown in figure 9) has a larger decrease than the right part

Future Work

- A second site was just completed next to a sinkhole. We will conduct more time-lapse surveys for both sites pre, during, and post storm events

Acknowledgments

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