Managed Aquifer Recharge – Evaluation of Potential Recharge Site, Central Valley, California

Background

The Central Valley, located in the heart of California, supplies 40% of the US's food on less than 1% of the US farmland. While the arid, Mediterranean climate of the Central Valley is ideal for year-round agricultural production, groundwater extraction is necessary to meet the water needs of growers and municipalities. Excessive groundwater use over the past century has lowered the groundwater levels across the Central Valley, with deleterious effects on groundwater availability and quality. Managing and reversing the declining water levels requires a multifaceted approach, and one promising method is managed aquifer recharge (MAR).

Figure 1. One of the first versions of tTEM, with the field crew from Aarhus University and Stanford.

Why choose tTEM

The towed time-domain electromagnetic (tTEM) system is specifically designed for imaging the upper 130 m of the subsurface with high lateral resolution, making it a perfect solution for recharge problems in the Central Valley. The tTEM images the electrical resistivity of the subsurface, which is determined by the types of sediments in the ground. Combining the tTEM measurements with a small number of direct sediment type measurements (e.g. from cone penetrometer testing (CPT)) allows to convert the tTEM resistivity models into 3D sediment type maps. These sediment type maps is then used to determine the suitability of a field for recharge.

Figure 2. Collecting tTEM data in the orchards.

Results

In 2017, Stanford University (California) in collaboration with Aarhus University (Denmark) and the Tulare Water District (California) acquired tTEM data at multiple almond and pistachio orchards as well as on potential recharge sites. The survey was the first demonstration of the use of tTEM in the United States.

The resistivity models of the subsurface from one of the almond groves are shown in Figure 3. In 2019, CPT data was collected at five locations within this almond grove, and the two different datasets were used to develop a transform to convert the resistivity models derived from the tTEM to models of sediment type (coarse fraction), and in turn used to identify the recharge flow paths.

Based on this spatial information, the infiltration plans could be optimized.

Scientific papers

The scientific results of the surveys are in two scientific papers. The first paper describes the geophysical survey and how the data can be transformed into lithology. The second paper describes the setup of a groundwater model with lithology input from the tTEM survey. If you do not have access to the papers write to contact@temcompany.com and we will send them to you. The papers are:

Assessment of Managed Aquifer Recharge Sites Using a New Geophysical Imaging Method, Vadose Zone Journal, Behroozmand et al (2019) https://doi.org/10.2136/vzj2018.10.0184

Managed aquifer recharge site assessment with electromagnetic imaging: Identification of recharge flow paths, Vadose Zone Journal, Pepin, et al., (2022) https://doi.org/10.1002/vzj2.20192

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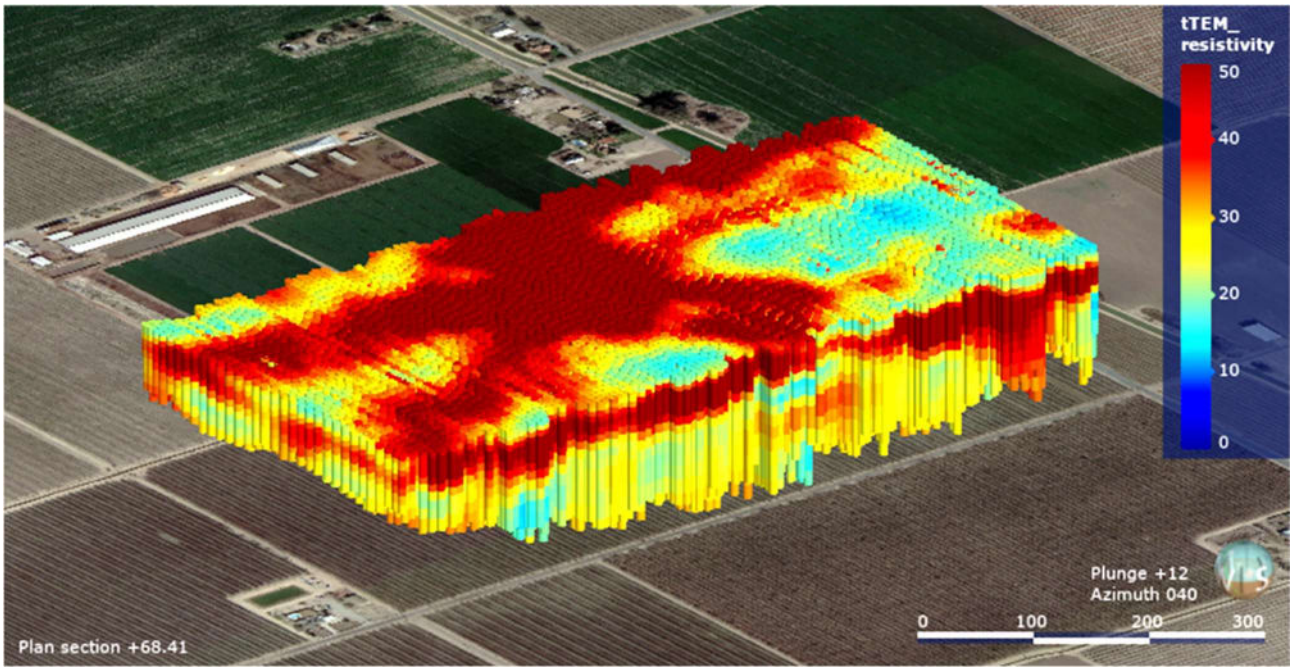

Figure 3. Resistivity model resulting from inversion of the tTEM data, underlain by a satellite image of the study area. Warm colors (reds) correspond to high resistivity values; cool colors (blues) correspond to low resistivity values.