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Hydromechanical control of near-surface seismic velocity changes revealed by ambient seismic noise monitoring during groundwater pumping

Richard Kramer[1], **Han Bai**[2,3], Xuan Feng[2], Clément Estève[3], Yang Lu[4], and Götz Bokelmann[3]
[1]Swiss Seismological Service, ETH Zurich, Zurich, Switzerland
[2]College of Geo-Exploration Science and Technology, Jilin University, Changchun, China (baihan23@mails.jlu.edu.cn)
[3]Department of Meteorology and Geophysics, University of Vienna, Vienna, Austria
[4]Department of Geosciences and Geography, Institute of Seismology, University of Helsinki, Helsinki, Finland

Climate change and increasing water demand highlight the need for robust, spatially resolved monitoring of groundwater systems during pumping operations. Here we use ambient seismic noise for monitoring seismic velocity changes during a series of controlled groundwater pumping tests near Nickelsdorf, Burgenland (Austria; Kramer et al. 2026). Seismic noise was continuously recorded for about three months, covering periods before, during, and after pumping. We exploit train-dominated signals recorded during the experiment to reconstruct noise cross-correlations and estimate relative velocity changes (dv/v) from ballistic waves in multiple frequency bands. The dv/v time series show percent-level variations that closely follow the timing of the pumping and recovery phases and correlate with water-level fluctuations observed in the wells. To characterize the spatial structure of these changes, we invert dv/v along the profile. The inversion reveals both a smooth background trend along the profile and pronounced local anomalies near the pumping wells. We also introduce a hydromechanical dv/v–water-level coupling model that separates a slowly varying background response from well-specific local contributions and links near-surface seismic velocity changes to the underlying hydrological processes.

Kramer et al. (2026). *Monitoring Groundwater Pumping Using Time-Lapse Tomography from Ambient Seismic Noise.* Submitted to Water Resources Research.