

Monitoring Groundwater Dynamics and Flow Directions in Yunlin, Taiwan Using Seismic Interferometry and Ambient Noise Analysis

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The Yunlin region, a primary agricultural hub in western Taiwan, heavily relies on groundwater extraction due to insufficient surface water supply. Overexploitation combined with vulnerable hydrogeological conditions has historically driven significant land subsidence. While regulatory measures by the Water Resources Agency have mitigated the overall rate of land subsidence in recent years, the subsidence center has shifted toward the Taiwan High Speed Rail (THSR) corridor.

To enhance groundwater recharge strategies and mitigate hazards associated with ongoing land subsidence along critical infrastructure, this study applies a non-invasive, continuous seismological approach to track temporal changes in subsurface hydrology. We employ Seismic Interferometry using continuous ambient noise recorded across single-station and dual-station configurations. By computing cross-correlation functions (CCFs) between station pairs, we reconstruct the ambient seismic wavefield and analyze relative seismic velocity variations (dv/v). Furthermore, the asymmetrical coherence responses along the causal and acausal axes of the CCFs are utilized to determine the directivity and propagation of signal sources within the wavefield, thereby inferring directional shifts in subsurface water transport.

By tracking time-variable seismic velocity and ambient noise directivity, this approach enables the dynamic monitoring of groundwater flow patterns over time. The expected outcomes will delineate key groundwater recharge zones and isolate extraction-affected zones (defining the spatial sphere of influence of pumping wells). Ultimately, these high-resolution spatio-temporal insights will help identify optimal groundwater recharge sources and locations, providing scientific guidance for sustainable water resource management and land subsidence prevention in Yunlin.

Keywords: Seismic Interferometry, Ambient Noise Cross-Correlation, Relative Velocity Variation (dv/v), Groundwater Recharge, Land Subsidence