



Identification of Tectonic Anomalies Prior to the Meinong Earthquake in Taiwan Using a Support Vector Regression–Based Groundwater Level Model

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Taiwan is located along the circum-Pacific seismic belt and is frequently affected by destructive earthquakes. Identifying reliable preseismic anomalies is therefore crucial for seismic hazard mitigation. Previous studies have demonstrated that groundwater levels are influenced not only by nontectonic factors—such as precipitation, atmospheric pressure, tides, and temperature—but also by stress redistribution associated with earthquake preparation processes. However, robust quantitative methods capable of separating nontectonic influences from tectonic anomalies remain limited. In this study, the 2016 Meinong earthquake in southern Taiwan was investigated as a case study. Support vector regression (SVR) models were developed using meteorological variables and groundwater level observations to construct predictive models of groundwater fluctuations and to identify preseismic anomalies related to crustal stress accumulation. Groundwater monitoring stations located west of the epicenter were first selected based on their clear coseismic responses and strong spatial correspondence with observed surface deformation. Using air temperature, precipitation, and atmospheric pressure as explanatory variables, the SVR model and the Akaike Information Criterion (AIC) were applied to determine optimal lag structures and to establish pre-earthquake groundwater prediction models. The trained models were then used to simulate groundwater levels over the two years preceding the earthquake, and residual analysis was performed to identify anomalous signals. Among the 12 analyzed stations, 9 exhibited coefficients of determination (R^2) ranging from 0.18 to 0.79. Stations situated in coastal fine-sand aquifers showed substantially higher predictive performance ($R^2 = 0.42$ – 0.79) than those located in mountainous regions ($R^2 = 0.18$ – 0.49). Six stations displayed pronounced negative residual anomalies exceeding two standard deviations approximately one year prior to the earthquake, followed by a gradual recovery toward the event. This temporal pattern is consistent with deformation trends observed at nearby surface monitoring stations. In addition, three stations exhibited short-term residual anomalies exceeding two standard deviations within approximately one month before the earthquake. These results demonstrate that groundwater level anomalies derived from physically informed predictive models can be systematically linked to

surface deformation and short-term precursory processes preceding earthquakes. Our findings highlight the potential of groundwater monitoring as a complementary indicator for earthquake precursor detection and seismic hazard assessment.