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Estimating aquifer storage parameters based on seasonal ground deformations detected by radar interferometry

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Interferometric Synthetic Aperture Radar (InSAR) technique is widely used in detecting and monitoring deformation resulting from natural hazards such as earthquakes, volcanoes, landslides, etc. Periodic, sub-cm scale InSAR measurements of deformation over large areas can provide valuable information in hydrogeological applications especially in mapping, monitoring and simulating groundwater flow, aquifer-system compaction and land subsidence. Recently, InSAR data were utilized to simulate future land subsidence for regulating groundwater extraction by coupling groundwater flow and compaction models. In areas with significant groundwater pumping, the InSAR signal records changes in land deformation due to periodic aquifer-system compaction and rebound, caused by seasonal changes in pumping. Small-magnitude, recoverable, seasonal deformations were detected using InSAR for a case study in the Netherlands, where groundwater is pumped periodically. Using these observations combined with groundwater measurements and modeling, elastic and inelastic storage coefficients of the aquifer material were estimated based on consolidation theory. Elastic deformations were observed at most of the permanent scatterer locations, where deformation mimics the seasonal groundwater pumping trend. Based on the results, the role of InSAR deformation observations in improving and calibrating groundwater models is discussed.
InSAR deformation observations are promising in terms of investigating the mechanism of the aquifer system response to pumping and in terms of estimating the spatial heterogeneity of the aquifer material.