Monitoring severe aquifer-system compaction and land subsidence in Taiwan using multiple sensors: Yunlin, the southern Choushui River Alluvial Fan


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Abstract

During 1992–2007, excessive pumping of ground water caused large-scale aquifer-system compaction and land subsidence in the Choshui River Alluvial Fan, especially in the area of Yunlin county. The subsidence impedes surface-water runoff and endangers the operation of Taiwan High Speed Rail. Leveling, Global Positioning System (GPS), multi-level compaction monitoring well, and Differential Interferometric Synthetic Aperture Radar (DInSAR) are used to study the extent of subsidence in Yunlin and its mechanism. These sensors complement each other in spatial and temporal resolutions. A leveling network totaling 434 km in length was deployed to derive subsidence at every 1.5 km along the routes, and the result is accurate to few mm and shows a basin-like subsidence pattern centering at Tuku Township. Four multi-level compaction monitoring wells, co-located with GPS pillars, detect compactions at different depths, showing that the aquifer-system compaction (the cause of subsidence) occurs mostly below depths 200 m, where reduction of groundwater pumping is most needed. The vertical displacements from GPS and leveling agree to within 1 cm, and are larger than the cumulative compaction detected by the compaction monitoring wells, suggesting that compaction also occurs below 300 m (the depth of the wells). The vertical displacements derived using DInSAR and 8 ENVISAT SAR images agree with the leveling result to 1–2 cm.
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Abstract During 1992–2007, excessive pumping of groundwater caused large-scale aquifer-system compaction and land subsidence in the Choushui River Alluvial Fan, especially in the area of Yunlin county. The subsidence impedes surface-water runoff and endangers the operation of Taiwan High Speed Rail. Leveling, Global Positioning System (GPS), multi-level compaction monitoring well, and Differential Interferometric Synthetic Aperture Radar (DInSAR) are used to study the extent of subsidence in Yunlin and its mechanism. These sensors complement each other in spatial and temporal resolutions. A leveling network totaling 434 km in length was deployed to derive subsidence at every 1.5 km along the routes, and the result is accurate to few mm and shows a basin-like subsidence pattern centering at Tuki Township. Four multi-level compaction monitoring wells, co-located with GPS pillars, detect compactions at different depths, showing that the aquifer-system compaction (the cause of subsidence) occurs mostly below depths >200 m, where reduction of groundwater pumping is most needed. The vertical displacements from GPS and leveling agree to within 1 cm, and are larger than the cumulative compaction detected by the compaction-monitoring wells, suggesting that compaction also occurs below 300 m (the depth of the wells). The vertical displacements derived using DInSAR and ENVISAT SAR images agree with the leveling result to 1–2 cm.

Keywords Choushui River Alluvial Fan · DInSAR · GPS · Leveling · Monitoring well