Measurement of land subsidence using interferometry, Coachella Valley, California

M. SNEED
US Geological Survey, 3020 State University Drive East, Suite 4004, Sacramento, California 95819, USA
micsneed@usgs.gov

Abstract Interferometry of satellite radar data collected from 2003 to 2009 was used to determine the location, extent and magnitude of land subsidence associated with groundwater-level declines in the Coachella Valley, California, USA. Groundwater has been a major source of agricultural, municipal and domestic supply in the valley since the early 1920s, resulting in water-level declines of as much as 30 metres by 2009. Differential subsidence has damaged buildings, roads, water conveyance canals and other infrastructure near La Quinta, in the southwestern part of the valley. Comparison of interferometry data for 2003–2009 to previously reported data for 1996–2000 indicates that subsidence rates have increased by at least a factor of two since 2003 in the urban areas of Palm Desert, Indian Wells and La Quinta. Water levels in most wells in these areas declined to their lowest recorded levels on an annual basis during 2003–2009. The correlation between the deformation time series derived from interferometry and water levels in nearby wells indicates that the preconsolidation stress may have been exceeded and the subsidence likely is mostly permanent. Water-level recoveries during 2009 have reduced the subsidence rates in Indian Wells and La Quinta. The subsidence measured using interferometry is limited to the western margin of the valley although water levels have reached historic lows throughout most of the valley, suggesting that fine-grained compressible sediments have been preferentially deposited in this part of the valley. Subsidence terminates abruptly to the northeast of Palm Desert, suggesting an abrupt change in lithology or differing effective thicknesses of compressible deposits, possibly caused by faulting, that controls the occurrence and extent of subsidence. Co-located continuous-GPS and groundwater-level time series, additional interferograms and detailed geological and water-level information may provide further insight into the physical controls on subsidence processes in the Coachella Valley.

Key words land subsidence; differential aquifer-system compaction; InSAR; geological controls