Thirty years of land subsidence studies in Las Vegas, Nevada, USA: From leveling to cross-examination of ERS and Envisat data with PSInSAR

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Abstract

Subsidence due to heavy groundwater pumping in Las Vegas has been geodetically monitored since 1935, and several generations of subsidence maps have depicted more than 1.7 m of aquifer deformation that is continuing. Based on re-leveling 75 first-order benchmarks in 1980, a subsidence map for the period 1963–1980 showed three principal, concentric subsidence bowls. In 1991, this map was slightly revised using second- and third-order benchmark data and additional vertical-control lines established across faults in 1978, and the 1963–1987 subsidence map appeared to confirm earlier deformation patterns. In 1999, we first examined the spatial pattern of subsidence in Las Vegas using conventional InSAR and discovered it to be significantly different than previously shown, thus resulting in substantial revision of the earlier maps. A stacked set of three interferograms between 1992–1997 revealed the existence of four subsidence bowls and clearly demonstrated that deformation is controlled by basin faults to a much greater degree than we previously believed, with some faults forming subsidence barriers. A new subsidence map for 1963–2000 was generated based on the InSAR spatial deformation pattern and incorporation of all conventional leveling data. In addition to the application of conventional InSAR, we have recently conducted studies in the use of the permanent scatterer (PSInSAR) methodology to examine time-series and range-change trends between 1992–2005. Combining 50 ERS–1 and −2 scenes and 19 Envisat scenes, we have identified more than 15 million PS targets in Las Vegas. Using the PS method, we are able to resolve surface motion at a resolution of about 0.5 mm/yr on individual targets, allowing us to detect continuing subsidence as well as zones of LOS shortening that may be associated either with uplift from artificial recharge or with horizontal strain and fissuring. This study was supported by ESA Category–1 Project C1P.2636.