



Numerical modelling of ground subsidence in the city of Lisbon

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The construction or enlargement of underground systems can be one of the causes for ground subsidence in urban areas. In the Lisbon (Portugal) area a ground subsidence has been observed during the last years, with a displacement velocity up to -27 mm/year, after the subway construction works between 1988 and 2002.

Recently, the Synthetic Aperture Radar Interferometry (InSAR) has been applied to this case study to monitor the evolution of ground subsidence with time. A time series of 46 ERS SAR images, acquired between May 1995 and January 2001, has been interferometrically processed using the Persistent Scatterers (PS) technique and ground deformation velocities have been consequently estimated at the location of PS of being about 5 mm/year. The interferometric SAR (InSAR) estimates have been then compared with topographic measurements of ground subsidence carried out in 1976, 1996 and 2010, showing a good agreement both in terms of spatial distribution of the ground deformation patterns and their temporal evolution.

In this work, a coupled hydro-mechanical finite element analysis has been carried out aimed at simulating the ground subsidence as a consequence of the soil consolidation process resulting from the underground excavation process and related dewatering. The numerical model is based on the geological setup defined according to several borehole and groundwater data available for the study area, whereas the soil properties have been assigned based on the laboratory testing performed on soil samples taken down different boreholes. The subsidence process has been then simulated by means of the variation of the groundwater level as inferred by the measurements gathered in the recent years. The numerical results are observed to be in agreement with the ground surface monitoring data, in terms of both displacement field across the study area and the evolution of the vertical displacement with time for some specific monitoring point.