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Exploiting Sentinel-1 InSAR capabilities for studying the land subsidence process in an urban area

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Since the beginning of the 1960s, the urban area of Bologna has experienced land subsidence due to excessive groundwater withdrawals. Sinking reached its peak in the 70s of the last century when the subsidence rate attained the maximum value of about 10 cm/year, and significant damages to structures and infrastructures occurred. This process has been intensively monitored over the years, and extensive ground displacement data were collected employing various increasingly sophisticated techniques, ranging from topographic levelling to GNSS surveys and, since 1992, to satellite interferometry. Satellite data, in particular, allowed an accurate reconstruction of the land subsidence process. The available interferometric data are the results of three different SAR campaigns undertaken by local authorities in which the PSInSAR technique was adopted: 1992 – 2000 (ERS), 2002 – 2006 (ENVISAT) and 2006 – 2011 (RADARSAT). Within this work, a new InSAR survey from the free SENTINEL1 2014 – 2020 ascending and descending orbits data was undertaken by the UniBo spin-off “Fragile”. The software GMTSAR was used to process each interferogram and then a Small Baseline (SBAS) approach was followed to resolve the ground displacements over time. Great attention was paid to the choice of reference pixels on the existing buildings and structures, in order to maximise their density in the study area, and to the definition of the considered time span ranging from 6 to 365 days, allowing to analyse both quicker and slower ground movements. Compared to previous surveys, the displacement map obtained by Sentinel has a much higher spatial and temporal resolution, thus leading to a detailed interpretation of the ongoing subsidence. Results show that the displacement field well agrees with the 3D geological model of the area and that the temporal evolution of the subsidence rate nicely matches the piezometric level and groundwater pumping temporal series.