Identification of secular ground motions in Istanbul by long term time-resolved InSAR analysis (1992-2017)

Gokhan Aslan (1), Ziyadin Cakir (2), Semih Ergintav (3), Cécile Lassarre (4), and François Renard (5)

(1) ISTerre, Université Grenoble-Alpes, Grenoble, France; gokhan.aslan@univ-grenoble-alpes.fr, (2) Department of Geological Engineering; Istanbul Technical University, 34469 Istanbul, Turkey; ziyadin.cakir@itu.edu.tr, (3) Department of Geodesy, Kandilli Observatory and Earthquake Research Institute (KOERI), Bogazici University, 34684, Istanbul, Turkey; semih.ergintav@boun.edu.tr, (4) Laboratoire de Géologie de Lyon : Terre, Planètes, Environnement (LGL-TPE),Université Lyon 1,France; cecile.lasserre@univ-grenoble-alpes.fr, (5) Physics of Geological Processes (PGP) , The NJORD Centre, Dept of Geosciences, UiO, NO-0316, Oslo, Norway

Abstract: Identification and measurement of subsidence susceptibility in urban areas have a vital importance to determine vulnerable part of the cities prone to geohazards, which is crucial for sustainable urban planning and hazard mitigation. Interferometric synthetic aperture radar (InSAR) time series analysis is a very powerful tool for operational mapping of land deformation such as urban subsidence and landslide phenomena. Spanning almost 25 years of satellite radar observations, we compute integrated InSAR time-series data of several satellites (ERS, Envisat, Sentinel-1A and its twin sensor Sentinel-1B) to investigate the rate and extent of land deformation in the mega-city of Istanbul. By combining the various multi-track InSAR datasets (291 images in total) and analyzing persistent scatterers (PS-InSAR), we present mean velocity maps of ground surface displacement in selected areas of Istanbul. We have identified several sites along the terrestrial and coastal regions of Istanbul that undergo ground subsidence at line-of-sight rates varying from 5 mm/yr to 12 mm/yr. The results reveal that the most distinctive subsidence events are associated with relatively weak lithologies and anthropogenic factors. Slow-moving landslide failure has been observed along the Haramidere valley located in the urbanized center of Avcilar Peninsula at a constant rate of ∼10 mm/yr and along the Ayamama river stream at a constant rate of ∼5mm/yr since 1992. We have also identified subsidence at the rate of 5 mm/yr along the coastal region of Istanbul, associated with land reclamation, and very slow subsidence around a skyscraper built in 2010.