

Interferometric radar satellite and in-situ well time-series reveal groundwater extraction rate changes in urban and rural Afghanistan

Population growth, climate change, and a lack of infrastructure have contributed to an increase in water demand and groundwater exploitation in urban and rural Afghanistan, resulting in significant ground subsidence. Based on a 7-year-long Sentinel-1 radar-interferometric time-series (2015–2022), we assess country-wide subsidence rates. Of particular focus are urban Kabul and the growing agricultural sector of rural Ghazni. In Kabul, we compare spatiotemporal subsidence patterns to water table heights and precipitation amounts. In Ghazni, we monitored the transition from ancient to modern irrigation techniques by mapping solar-panel arrays as a proxy for electrical water pumping and evaluating the vegetation index as a proxy for agricultural activity. Several cultural centers (Kabul, Ghazni, Helmand, Farah, Baghlan, and Kunduz) exhibit significant subsidence of more than ~5 cm/yr.

In Kabul, ground subsidence is largest near the city center with a 6-year total of 31.2 cm, but the peripheral wells of the Kabul basin exhibit the highest water-table drops. In Ghazni, with a 7-year total of 77.8 cm, subsidence rates are dramatically accelerating since 2018. The barren land was transformed into farmland and traditional irrigation was replaced by electrical water pumps to tap groundwater. As a result, m-wide and km-long desiccation cracks appeared in the area with the highest irrigation volume and subsidence.

Primary author: KAKAR, Najibullah (Helmholtz Centre for Geosciences)

Co-authors: Prof. BOOKHAGEN, Bodo (University of Potsdam (UP), Potsdam-Golm, Germany); Prof. AMELUNG, Falk (Department of Marine Geosciences, Rosenstiel School of Marine, Atmospheric, and Earth Science, University of Miami, Coral Gables, FL, USA); Dr WAIZY, Hamidullah (Faculty of Geology and Mines, Kabul Polytechnic University (KPU), Kabul, Afghanistan); MOTAGH, Mahdi (GFZ Helmholtz Centre for Geosciences); Dr LAZECKY, Milan (COMET, School of Earth and Environment, University of Leeds, Leeds, UK); Mr NASRAT, Nasir Ahmad (Faculty of Geology and Mines, Kabul Polytechnic University (KPU), Kabul, Afghanistan); METZGER, Sabrina (GFZ Potsdam); Dr SCHÖNE, Tilo (Helmholtz Center for Geosciences)

Presenter: KAKAR, Najibullah (Helmholtz Centre for Geosciences)