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Land subsidence and aquifer compaction caused by excessive groundwater extraction and varying land cover types in the arid region of Pakistan using ESA-Sentinel satellites data

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Land subsidence due to excessive groundwater extraction in arid regions is a serious natural hazard. The spatially unbalanced groundwater extraction and varying subsidence due to different types of land use make this problem more difficult to monitor using conventional methods. This study investigates land subsidence varying with different land covers and groundwater use based on the European Space Agency (ESA) Sentinel satellites data in the arid Quetta valley, Pakistan. Differential interferometry of Sentinel-1 SAR data (DInSAR) was used to develop subsidence interferograms of the study area for the period between 16 Oct 2014 and 06 Oct 2016. To minimize the uncertainty of the results, the interferograms were corrected for atmospheric effects and then filtered using the Amplitude Dispersion Index (ADI) to select only the stable pixels. Finally the subsidence maps were generated by spatially interpolating the land subsidence at the stable pixels, which were highly correlated with the observed subsidence of the GPS station. The subsidence maps were also compared with the land cover map of the study area which was derived from Sentienl-2 multispectral images. The results show that, for the period of two years, the entire study area experienced highly uneven land subsidence ranging from a minimum of 10 mm to a maximum of 280 mm. The subsidence at different land covers was found to be significantly different from each other except between the urban and barren land. Moreover, the subsidence was found to be linearly proportional to the drawdown of the groundwater level. The urban and cultivated area with high groundwater extraction rate showed excessive amount of land subsidence while the seasonally cultivated and barren area show moderate to minor land subsidence.

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