

Detection of Land Subsidence and its Relationship with Land Cover Types using ESA Sentinel Satellites data: A case study of Quetta valley, Pakistan

Waqas Ahmad¹, Dongkyun Kim^{1,*}

¹Department of Civil Engineering, Hongik University, Mapo-gu, Seoul, 04066 Korea

*Correspondence to: Prof. Dongkyun Kim (kim.dongkyun@hongik.ac.kr)

Abstract. Land subsidence caused by excessive groundwater pumping is a serious hydro-geological hazard. The spatial variability in land use, unbalanced groundwater extraction and aquifer characteristics are the key factors which make the problem more difficult to monitor using conventional methods. This study uses the European Space Agency (ESA) Sentinel satellites to investigate and monitor land subsidence varying with different land covers and groundwater use in the arid Quetta valley, Pakistan. The Persistent Scattering Differential Interferometry of Synthetic Aperture Radar (PS-DInSAR) method was used to develop 28 subsidence interferograms of the study area for the period between 16 Oct 2014 and 06 Oct 2016 using ESA's Sentinel-1 SAR data. The uncertainty of DInSAR result is first minimized by removing the dynamic effect caused by atmospheric factors and then filtered using the radar 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, the comparison of DInSAR subsidence with GPS readings showed an R^2 of 0.94 and mean absolute error of 5.7 ± 4.1 mm. The subsidence maps were also analysed for the effect of aquifer type and 4 land covers which were derived from Sentinel-2 multispectral images. The analysis show that during the two year period, the study area experienced highly non-linear land subsidence ranging from 10 to 280 mm. The subsidence at different land covers was significantly different from each other except between the urban and barren land. The barren land and seasonally cultivated area show minor to moderate subsidence while the orchard and urban area with high groundwater extraction rate showed excessive amount of land subsidence. Moreover, the land subsidence and groundwater drawdown was found to be linearly proportional to each other.

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