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MONITORING LAND SUBSIDENCE FROM SENTINEL-1A DATA USING PERSISTENT SCATTERER INTERFEROMETRY (PSI) – A CASE STUDY OF QUETTA VALLEY, PAKISTAN

Abstract

Balochistan is a semi-arid and the largest province of Pakistan, it's capital city Quetta is sinking at an average rate of 100 mm/year at some points (revealed from GPS observations). This phenomenon is known as land subsidence, which has been damaging houses, schools, hospitals, roads, and other infrastructure reported during the past two decades. The underlying reason for land subsidence in the Quetta Valley is the extraction of excessive groundwater, which is the primary source of water supply in the area to fulfill almost all the agricultural and domestic needs, and meet the requirements of growing population and increasing agricultural activities. Synthetic Aperture Radar (SAR) has the ability to detect subtle changes on the earth surface with an accuracy of millimeters making it a useful tool to monitor land subsidence. This study has exclusively used all the available Sentinel-1A (C-band SAR satellite) data for the Quetta Valley during the descending pass of the satellite (as ascending pass acquisition geometry is inconsistent) to find each year's land subsidence from Oct 2014 to Nov 2020. For the detection of land subsidence, PSI analysis was performed through the open source toolboxes SNAP and StaMPS. The outcomes from the study suggests that the maximum subsidence for each year has a slightly increasing trend with an overall 6mm rise in the maximum subsidence value. Six maps, one for each year, reveals major damage has been observed in the central north valley, and it is referred as high-risk zone. This high-risk zone has grown in size in the past three years indicating that the scope of subsidence in the Quetta Valley is also increased. Cumulative subsidence for the entire period was correlated with groundwater table data recorded for the same observation period. The 35 wells data correlate well with subsidence (R-squared=0.70), suggesting groundwater is the main driving force for subsidence. This study has also categorize land subsidence into four landcover types namely barren, built-up, orchards and seasonal vegetation classes and found built-up land is the most affected landcover with a mean value of 46 mm/year. We recommend less water consumption in agricultural activities and efficient use of groundwater for domestic purposes in order to use the underground water resources for a longer period of time and minimize subsidence. We also suggest government authorities impose strict measures on illegal drills so that groundwater can be used in a controlled environment and water balance would not be disturbed.