Monitoring and Analysis of Ground Subsidence of Dhaka City and its Surrounding Areas, Bangladesh Based on Multi-Temporal InSAR Methodology

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SUMMARY

Extensive groundwater extraction is a widespread practice in Dhaka city and is widely recognized to cause land subsidence. Over the past few decades, numerous high-rise buildings and industries have been developed in and around Dhaka city. This has significantly increased the demand for groundwater for both industrial and domestic use, resulting in a rapid depletion of groundwater levels. Sediment load and soil compaction due the long-term groundwater overexploitation leads to land subsidence especially in areas with significant building loads. The analysis presented in this study focuses on land deformation obtained over the metropolitan area of Dhaka city and its environs by using multi-temporal Interferometric SAR (InSAR) methodology. The study utilizes the use of Differential Interferometric SAR (DInSAR) and Persistent Scatterer Interferometric SAR (PS-InSAR) methodology those are useful for the effective monitoring of ground deformation. This research leverages PS-InSAR time series by utilizing multiple SAR images (Sentinel-1) acquired over the same area during the period spanning from 2020 to 2023 in and around Dhaka city. The analysis of land subsidence and time series of deformation was conducted by reviewing 121 Sentinel-1 SAR images whereas SRTM (30m resolution) digital elevation model data served as the reference for adjusting the residual phase. It has been noted that there is a connection between the decline in groundwater levels and compaction of aquifer systems with land surface subsidence. The rate of observed land deformations has been found to be associated with the recorded groundwater levels at water observation wells in the vicinity. Distinct variations of the land subsidence are observed throughout the study regions. The highest rate of subsidence is experienced in reclaimed land, which is composed of loose sand, silt, and clay materials. Some parts (eastern part) of the study lacks sufficient PS density due to temporal decorrelation. Many of such low-lying areas are reclaimed for industrial development and urbanization. Five major PS clusters have been identified as subsiding areas with deformation rates varying from -1 cm/yr to ≤ -2.5 cm/year along the radar line of sight (LOS). In some places, the subsidence rate reached up to 50 mm/yr. The maximum subsidence rate (≤ -40 mm/year) was observed in and around Mirpur, Banani and Mouchak areas. The results have unveiled a significant control on land subsidence by the geomorphology of the study area. Geomorphic landforms such as natural levees, point bars and back swamps were found to be more susceptible to land surface subsidence compared to the river terrace. The results provide useful insights into understanding the relationship of groundwater overexploitation regime with land surface deformation. The alarming rate of subsidence in some areas raises concerns about potential future damage to infrastructures. Due to the dependable reliability of the DInSAR and advanced InSAR (PS-InSAR) methodology, these results could offer crucial assistance in decision-making regarding geological disaster mitigation in Dhaka city and its vicinity for climate resilient urban planning.