



TerraSAR-X time-series interferometry detects human-induced subsidence in the Historical Centre of Hanoi, Vietnam

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Hanoi was the capital of 12 Vietnamese dynasties, where the most historical relics, archaeological ruins and ancient monuments are located over Vietnam. However, those heritage assets are threatened by the land subsidence process occurred in recent decades, which mainly triggered by massive groundwater exploitation and construction activities. In this work, we use a set of high resolution TerraSAR-X images to map small-scale land subsidence patterns in the Historical Centre of Hanoi from April 2012 to November 2013. Images oversampling is integrated into the Small Baseline InSAR processing chain in order to enlarge the monitoring coverage by increasing the point-wise measurements, maintaining the monitoring scale of single building and monument. We analyzed over 2.4 million radar targets on 13.9 km² area of interest based on 2 main sites: The Citadel, the Old Quarter and French Quarter. The highest subsidence rate recorded is -14.2 mm/year. Most of the heritage assets are considered as stable except the Roman Catholic Archdiocese and the Ceramic Mosaic Mural with the subsidence rates are -14.2 and -13.7 mm/year, respectively. Eventually, optical image and soil properties map are used to determine the causes of subsidence patterns. The result shows the strong relationships between the existing construction sites, the component of sediments and land subsidence processes that occurred in the study site.