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Mapping Land Subsidence in Pekalongan, Indonesia using Time Series Interferometry and Optimized Hot Spot Analysis with Sentinel-1 SAR Data

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Floods in Pekalongan, Indonesia often occur due to the overflowing of river water during heavy monsoon rain. While the northern coast area of Pekalongan which located adjacent to the Java sea was affected by coastal floods due to sea-level rise. The flood conditions in every area were exacerbated by land subsidence and lead to coastal inundation. Monitoring land subsidence in Pekalongan becomes important to predict the further possible land subsidence occurrence area and mitigate the possible hazard caused by land subsidence. The analysis of land subsidence is much easier since the existence of radar satellites. This study used Synthetic Aperture Radar (SAR) datasets from the Sentinel-1 radar satellite between 2017 and 2020 in descending tracks. The data was processed through a time-series Interferometry SAR (InSAR) method based on the Stanford Methods for Persistent Scatterer (StaMPS) algorithm to provide accurate measurements over large areas by improving the selection of coherent pixels and reducing atmosphere noises. The result of persistent scatterer points then spatially clustered using Optimized Hot Spot Analysis (OHSA) to estimate significant points statistically and define them as the hot spot points. The results of time-series vertical deformation in Pekalongan were compared with the GPS station measurements. The comparison showed a good correlation in deformation patterns between time-series InSAR and GPS measurements. Our study revealed that the land subsidence in Pekalongan occurred mostly in settlement areas under the young alluvium soil which did not support the maximum compression from many buildings. Another cause of land subsidence in Pekalongan was the excessive groundwater extraction in the settlement areas could reduce the effective stress of pore pressure and lead to compaction in the aquifer areas. The time-series method that using the StaMPS algorithm and Optimized Hot Spot Analysis in this study can be applied for monitoring land subsidence in another area and from all-terrain.