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Investigation on the relationship between land use and subsidence pattern in Bandung, Indonesia with both Sentinel-1/2 and ALOS-2 satellite images

Zheyuan Du (1), Linlin Ge (1), Alex Hay-Man Ng (2,1)

(1) University of New South Wales, Faculty of Engineering, School of Civil and Environmental Engineering, Australia (duzheyuan198918@gmail.com), (2) Department of Surveying Engineering, Guangdong University of Technology, Guangzhou, China

Continuous Interferometric Synthetic Aperture Radar (InSAR) research has been conducted in Bandung City, West Java province, Indonesia over the past two decades. Previous studies carried out in regional-scale basis might be useful to estimate the correlation between land subsidence and groundwater extraction, but inadequate for local safety management as subsidence may vary over different areas with detailed characters. Due to the significant environmental and social impacts of this subsidence phenomenon, a systematic and continuous study of the spatial and temporal variations of Bandung's subsidence is urgently needed for managing groundwater extraction regulations, and developing recharging policies at various scales. It also assists designing urban development plans, which is crucial to the welfare of the city. To exclude the influence due to various surface geologies in this work, we selected the study region only categorised as surficial deposits (alluvial and lake deposits). Furthermore, following Chaussard et al. (2013), the scale of land subsidence can be categorised into four groups: regional-scale (> 100 km2), local-scale (10 ∼ 100 km2), patchy-scale (0.25 ∼ 10 km2) and village-scale (∼ 0.25 km2).

In this study, we analysed the general spatial subsidence patterns and temporal evolution in the above scales with time series InSAR techniques. 48 Sentinel-1 and 12 ALOS-2 dataset acquired from September 2014 to July 2017 were exploited in this work. To the best of our knowledge, there is a lack of knowledge in West Java for the analysis of the most recent land subsidence in such scale basis. To fill this gap, we aimed to 1) analyse the spatial pattern of horizontal movement with both descending and ascending pairs; 2) quantify the rate and magnitude of land subsidence over subsiding zones during the 1.5 year period, and 3) investigate spatially explicit variations in selected hot-spot regions. Our findings show that industrial usage of groundwater is not always the dominant factor that causes the land subsidence, and it does not always create large land subsidence also as we observed an extensive area over industrial zones that only experienced moderate subsidence (∼ 6 cm year-1). Regions experiencing subsidence is more as a combined result of a number of factors, e.g., residential, industrial or agricultural activities. However, as the lack of statistical data, e.g., groundwater consumption rates for different land types, we cannot draw the conclusion which is the dominant factor within each zone. Future studies are still needed to examine and quantify the significant factor contributed by residential and industrial area, and to establish the relationship between the density of population and land subsidence. Such potential outcomes are very useful for assisting the hazard mitigation plans as well as to reach an efficient use of the satellite-based monitoring networks.