Land subsidence prediction in Beijing plain using machine learning methods

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Land subsidence is usually difficult to be predicted due to its complex regulating processes, especially in the metropolitan environment, such as Beijing, where both natural and anthropogenic factors exist. This study aims to investigate the potential and limitations of machine learning methods in predicting land subsidence of a metropolitan area with a case study in Beijing, where significant land subsidence has been reported since early 1950s. The SAR image data of Radarsat-2 was collected, and the SBAS-InSAR (Small Baseline InSAR) interferometry was used to monitor the spatial distribution of land subsidence in the Beijing Plain from 2012 to 2015, while five machine learning methods (random forest algorithm, decision tree algorithm, extra tree algorithm, Boosting algorithm, neural network algorithm) were used to establish the models for prediction, with a focus on the driving factors of precipitation, groundwater level changes (unconfined water level and confined water level), distance from the fault, elevation, compressible layer thickness, and land use. The results shown that: (1) the extra tree method had the best performance (94.03%), followed by the boosting algorithm (93.91%) and decision tree (90.50%), in contrast to a degraded performance by the neural network (79.8%) and boosting algorithm (67.4%). (2) based on data mining methods of machine learning algorithms, the factor contribution rate of diving factors to land subsidence in Beijing plain was obtained, which showed that precipitation has the highest influence, followed by compressible layer thickness, confined water level change, unconfined water level change, distance from fault zone, altitude, and land use; (3) future development of land subsidence was simulated with varying groundwater level rise scenarios. The results demonstrated a good potential of machine learning methods in predicting and understanding the land subsidence in the metropolitan area towards a sustainable groundwater resources management.

Keywords: land subsidence, Machine learning, InSAR technology, Beijing

