Monitoring tropical peatland subsidence using time-series InSAR technique in Bengkalis Island, Indonesia

(インドネシアのベンカリス島における時系列InSAR技術を使用した熱帯泥炭地の沈下のモニタリング)

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Peatlands in Indonesia are subject to subsidence in recent years, resulting in an immense soil organic carbon loss. Their degradation is responsible for a number of serious environmental concerns, however understanding the causes of peatland subsidence are of prime concern for implementing mitigation measures. Here, we employed time-series Small Baseline Subset (SBAS) Interferometric Synthetic Aperture Radar (InSAR) technique using ALOS Phased Array type L-band Synthetic Aperture Radar (PALSAR)-2 images to assess the relationship between subsidence rates and various environmental factors including land use/land cover (LULC) change, and drainage periods derived from decadal Landsat data (1972-2019). Overall, the study area subsided with a mean rate of -2.646±1.839 cm/year as observed in 2018-2019. The rates of subsidence slowed over time, with significant subsidence decreases were noticed in the peatlands after being drained for more than nine years. We found that the long-time persistence of vegetated areas leads to subsidence deceleration. The relatively lower subsidence rates are in areas that changed to rubber/mixed plantations as compared to forests, mainly due to the dry condition of peat soil in the remaining forests. Further, the potential of subsidence prediction was assessed using Random Forest regression based on LULC change, distance from peat edge, and elevation. With a coefficient of determination (R^2) of 0.532 (RMSE (root mean square error) = 0.594 cm/year), the potential of enlarging the spatial coverage of InSAR based result was demonstrated to cover decorrelated areas in vegetated tropical peatlands resulting from the higher frequency SAR data. According to feature importance, the contribution of LULC change (including drainage period) to the subsidence model is comparable with distance from peat edge and elevation. Other uncertainties may come from some unexplained factors, comprising drainage and peat condition, which need to be accounted as well. In conclusion, this work shows the significance of decadal LULC change analysis to supplement InSAR measurement in tropical peatland subsidence monitoring.