ME1 Monitoring microtopographic changes in boreal peatland of Sarobetsu Wetland, Hokkaido, Japan using InSAR technique

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Abstract: Sarobetsu Wetland is one of the representative peat bogs in Japan[1]. A series of human-induced activities in Sarobetsu Wetland have led to a significant drop in the water table, which has triggered a drying out process that has had a considerable impact on the surface vegetation, which in turn has affected the wetland's vegetative ecosystem. In this study, I used a time series InSAR analysis to extract surface displacement of the wetland, using data derived by Sentinel-1 satellite from 2019 to 2021. The Hyp3 platform provided by ESA [2]and the Mintpy tool were used to analyze the four influencing factors of with displacement rate. The results show that plant invasion in sasa, peat extraction and changes in the water table all have a significant impact on peatland subsidence.
Keywords: SBAS, Sentinel-1, Surface displacement, Groundwater table, Invasive plant

1. Background and objectives

Sarobetsu Wetland in Hokkaido, Japan (Fig. 1) stood as the focal point of this comprehensive study aimed at addressing ecological challenges through the application of advanced Interferometric Synthetic Aperture Radar (InSAR) technology. As the largest upland moor in Japan's lowlands, this wetland is not only a crucial habitat for migratory birds but also plays a pivotal role in the global ecological network, recognized under the Ramsar Convention for its international importance. In several decades, human-induced activities have precipitated significant ecological alterations, including desiccation and vegetation changes, particularly noticeable in areas previously subjected to peat mining. This study leverages InSAR technology to meticulously extract and analyze subsidence data, aiming to illuminate the underlying processes contributing to monitor these ecological changes and guide restoration efforts.

Fig.1 Study area

2. Research Methods

2.1 Data collection

In this study, I used a total of 100 Sentinel-1A images from January 2019 through December 2021 as the primary SAR data source, yielding a total of 218 pairs of images in the area shown by rectangle in Fig. 1. I also collected topography- landuse, and invasive-vegetation maps as well as the on-site observation data of ground surface and groundwater table.

2.2 Data processing and analysis

The collected SAR images were processed using the HyP3 online platform to generate interferometric SAR (InSAR) images, and then the time-series deformation of each pixel was calculated by small baseline subset (SBAS) analysis using the Mintpy software[3]. The predicted surface displacement was compared with observed ground surface data, and the factors impacting mean displacement rate were analyzed.

3. Result and Discussion

Time-series analysis of the surface displacement (GS) groundwater level changes (GL) showed a periodic variations of the two show some similarity , they have a complex interactions between the fluctuation patterns (Fig. 2), indicating underlying geophysical processes and possible anthropogenic influences. Although the data points fluctuate, there is a clear general downward trend, particularly evident in the latter part of the sequence, which suggests an acceleration of land subsidence during the period of observation.

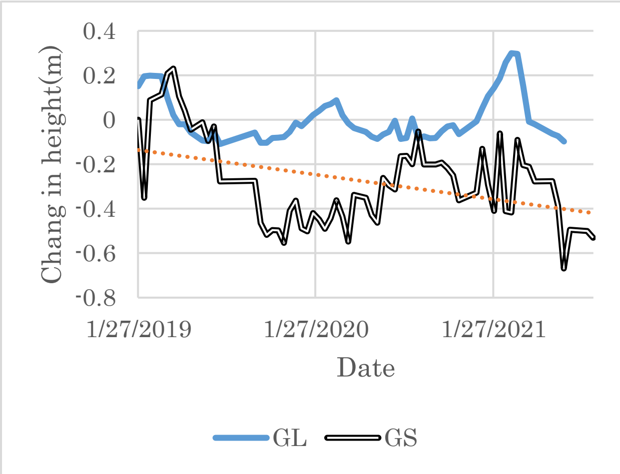

Fig.2 Mean surface displacement change.

Fig. 3 shows the comparison of mean surface displacement rate between the possible factors including sasa invasion, peat extraction, and groundwater table. They were found that; (a) sasa's invasion had an effect on the land subsidence of the wetland; (b) settlement inside the peat extraction relic was smaller than that outside within 50 meters from them; (c) the change of groundwater level (GL) had a positive impact on surface displacement (GS).

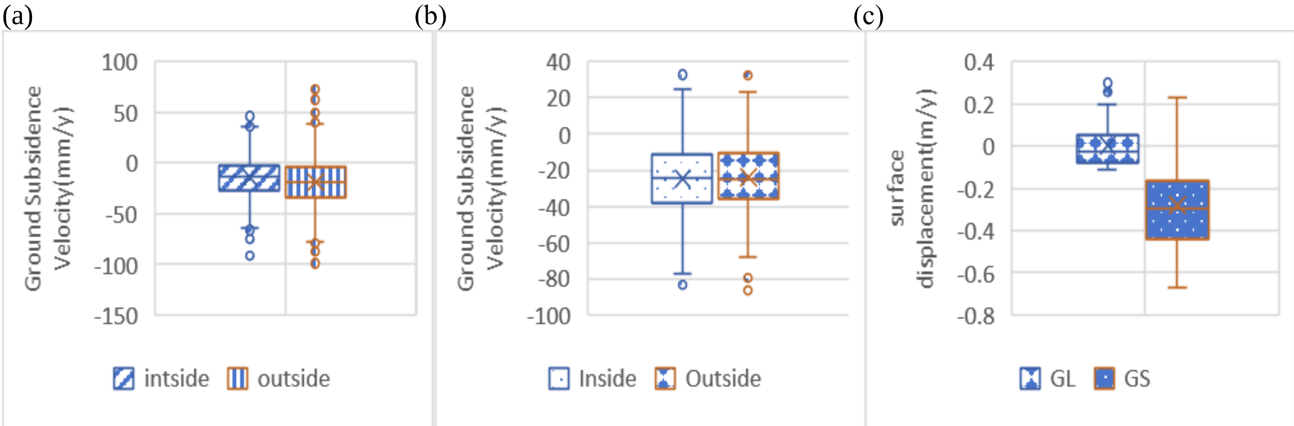

Fig. 3. Mean surface displacement rate change by factors; (a) inside/outside sasa invaded area, (b) inside/outside peat extraction area, and (c) ground surface and groundwater level.

4. Future Tasks

The following perspectives are still remained for future tasks; Verification of accuracy is required in conjunction with other monitoring tools; Use of the more coherent L-band ALOS PALSAR satellite; Carrying out studies over a longer time period.

5. Reference

1) 「上サロベツ自然再生全体構想」, 上サロベツ自然再生協議会, 2006 年

2) Hogenson, K., Kristenson, H., Kennedy, J., Johnston, A., Rine, J., Logan, T., Zhu, J., Williams, F., Herrmann, J., Smale, J., & Meyer, F. (2020). Hybrid Pluggable Processing Pipeline (HyP3): A cloud-native infrastructure for generic processing of SAR data [Computer software].

3) Yunjun, Z., Fattahi, H., and Amelung, F. (2019), Small baseline InSAR time series analysis: Unwrapping error correction and noise reduction, Computers & Geosciences, 133, 104331.