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Monitoring Volcanic Activity of Baekdu Mountain based on Ice Area Changes During the Winters of 2015-2020

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Baekdu Mountain is a 2,744 m high stratovolcano, located on the border of China and North Korea. The mountain has a caldera lake, Lake Cheonji, as a result of past volcanic activity. The ice area changes during winter in Lake Cheonji could act as a proxy for volcanic activity monitoring in Baekdu. As Baekdu laid on a political border, remote sensing allows us to quantify attributes of otherwise inaccessible or dangerous places. We assessed changes in winter (October–April) ice area in a high-altitude groundwater-fed caldera lake using Sentinel-1 synthetic aperture radar (SAR) data acquired from 2015 to 2020. To calculate the ice-covered area, 10 gray level co-occurrence matrix (GLCM) texture features were computed from SAR images obtained with VH (vertical transmission and horizontal reception) and VV (vertical transmission and vertical reception) polarizations. A support vector machine (SVM) algorithm was used to classify ice and water pixels from the GLCM layers, and the results from VH and VV imagery were combined to calculate the total area covered by ice. We examined the relationship between ice area and air temperature from the closest weather station, Samjiyeon using fixed period regression. The ice area was inversely proportional to 30-day averaged air temperature and these variables were highly correlated (-0.86). Our results show that there were no significant ice changes during the period, which indicates that there was no significant volcanic activity in Baekdu Mountain during the winters of 2015–2020. This study is expected to be useful for a better understanding of whether and how ice area changes in volcano lakes aid in eruption forecasting.