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Classification of paddy rice through multi-temporal multi-sensor data fusion

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Rice is one of important food resources in the world and its consumption continues to increase with increasing world population. Accurate paddy rice mapping and monitoring are crucial for food security and agricultural mitigation because they enable us to forecast rice production. There have been studies for paddy rice classification using optical sensor data. However, optical sensor data has a limitation for data acquisition due to cloud contamination. Active Synthetic Aperture Radar (SAR) data have been used to complement the cloud problems of optical sensor images. Integration of the multispectral and SAR data can produce the more reliable crop classification results than from a single sensor data. In addition, as paddy rice has distinct phenology, many studies used phenology features from multi-temporal data for detecting paddy rice. Thus, this study aims at mapping paddy rice by expanding the spectral and temporal dimensions of data. In this study, we conducted paddy rice classification through fusion of multi-temporal optical sensor (Landsat) and SAR (RADARSAT-1 and ALSO PALSAR) data using two machine learning approaches—random forest (RF) and support vector machines (SVM) over two study sites (Dangjin-si in South Korea and Sutter County, California in the United States). This study examined six scenarios to identify the effect of the expansion of data dimension. Each scenario has a different combination of data sources and seasonal characteristics. We examined variable importance to identify which sensor data collected at which season are important to classify paddy rice. In addition, this study proposed a new index called Paddy rice Mapping Index (PMI) for effective paddy rice classification considering the spectral and temporal characteristics of paddy rice. Scenario 6 that uses optical sensor and SAR multi temporal data showed the highest overall accuracy (site 1: 98.67%; site 2: 93.87%) for paddy rice classification among six scenarios. Both machine learning approaches performed well, producing high accuracy, and infrared-related variables such as Normalized Difference Water Index (NDWI) and Normalized Difference Vegetation Index (NDVI) showed higher importance than the other variables.