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Machine Learning Classification of Fused Sentinel-1 and Sentinel-2 Image Data Towards Mapping Fruit Plantations in Highly Heterogenous Landscapes

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Abstract : Mapping smallholder fruit plantations using optical data is challenging due to morphological landscape heterogeneity and crop types having overlapped spectral signatures. Furthermore, cloud covers limit the use of optical sensing, especially in subtropical climates where they are persistent. This research assessed the effectiveness of Sentinel-1 (S1) and Sentinel-2 (S2) data for mapping fruit trees and co-existing land-use types by using support vector machine (SVM) and random forest (RF) classifiers independently. These classifiers were also applied to fused data from the two sensors. Feature ranks were extracted using the RF mean decrease accuracy (MDA) and forward variable selection (FVS) to identify optimal spectral windows to classify fruit trees. Based on RF MDA and FVS, the SVM classifier resulted in relatively high classification accuracy with overall accuracy (OA) = 0.91.6% and kappa coefficient = 0.91% when applied to the fused satellite data. Application of SVM to S1, S2, S2 selected variables and S1S2 fusion independently produced OA = 27.64, Kappa coefficient = 0.13%; OA= 87%, Kappa coefficient = 86.89%; OA = 69.33, Kappa coefficient = 69. %; OA = 87.01%, Kappa coefficient = 87%, respectively. Results also indicated that the optimal spectral bands for fruit tree mapping are green (B3) and SWIR_2 (B10) for S2, whereas for S1, the vertical-horizontal (VH) polarization band. Including the textural metrics from the VV channel improved crop discrimination and co-existing land use cover types. The fusion approach proved robust and well-suited for accurate smallholder fruit plantation mapping.

Keywords : smallholder agriculture, fruit trees, data fusion, precision agriculture
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