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Detection of Double-Cropping Systems Using Machine Learning and Sentinel 2 Imagery - A Case Study of Bačka and Srem Regions, Serbia

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Increasing agricultural production is inevitable in the future since population growth and climate change have led to significant pressure on global food security. One of the ways is to intensify the existing cropland by multi-cropping practice, allowing multiple uses of a single field during one year. This research aims to identify and map double-cropping land using multi-temporal Sentinel 2 imagery from 2021 and advanced machine learning models. The case study focus is on Bačka and Srem, regions located in the Autonomous Province of Vojvodina, Republic of Serbia. These regions are characterized by fertile land and widespread agriculture production. However, there is a low presence of double-cropping practice due to usually dry summers, but with a tendency to change as the number of irrigation systems increase.

Considering the small amount of double-cropping fields, there is a need for direct ground truth data collection. For that reason, the first step was to reduce the area of interest to get insight into the locations of potential double-cropping land. This result was obtained by using the threshold method based on the phenology of crops during the year. The NDVI (Normalized Difference Vegetation Index) time series was utilized to define appropriate thresholds for feature two peak values to discriminate double-cropping within each pixel. The identification of the results was used on-site for collecting ground truth data. Based on the collected data and the analyzed NDVI time series, besides double-crop, three more classes of arable land were distincted and included in the classification: single winter crops, single summer crops and clover. The collected data contained 46 parcels of double crops, 43 single winter crops, 55 single summer crops and 27 parcels of clover. We used time-series images to create a dataset for training the pixel-based Random Forest classification. The results showed a very high overall accuracy of 99% and an F-score higher than 0.9 for each of the classes.

This methodology is a suitable approach for detecting double-cropping systems, with further potential to identify exact crop types and the main practice of combining crops. The findings of this study showed that only about 2% of the study area was under this production. Except for positive economic outcomes, utilizing these systems brings significant environmental benefits and rational use of the soil without expanding physical cropland but with the same advantages. Therefore, the resulting geospatial datasets of double cropping croplands could help solve

important questions relevant to food security, irrigation and climate change.