

Google Earth Engine-Based Land Use/Land Cover Mapping in Granada, Spain Using Sentinel-2 and Machine Learning Techniques

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Abstract

This study aims to demonstrate the potential of combining seasonal satellite observations with machine learning techniques to improve the accuracy and scalability of land use classification at regional levels, providing valuable insights for sustainable land management and environmental monitoring. This study evaluates the performance of three supervised machine learning algorithms—Decision Tree (CART), Random Forest (RF), and Support Vector Machine (SVM)—for land use classification in the Granada region of Spain. Using Sentinel-2 time series data and 2018 LUCAS Copernicus polygon-based ground truth samples (171 training, 55 testing), 36 spectral variables were derived from seasonal composites representing spring, summer, and autumn of 2024. These composites were created in Google Earth Engine to capture seasonal variability in land surface reflectance. The RF model achieved the highest accuracy (96.36% validation), followed by CART (100% but with signs of overfitting) and SVM (58.18%). Feature importance analysis highlighted specific Sentinel-2 bands (e.g., B7, B11_2, and B7_1) as key predictors. The results demonstrate the effectiveness of integrating seasonal remote sensing data and ensemble learning methods for regional-scale land use mapping. In conclusion, future research could focus on advanced regularization methods, additional data sources, and broader regional applications to enhance model accuracy and generalizability.

Keywords: Land Use/Land Cover Classification, Sentinel-2, LUCAS 2018, Random Forest, Google Earth Engine, Seasonal Composites, Granada

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