48. Multi-source Explained Data Fusion for Predawn Leaf Water Potential Estimation in Rain-fed Mediterranean Vineyards under Spatial Cross-validation

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Water stress monitoring is a key driver of irrigation and canopy management decisions in viticulture. The reference indicator, predawn leaf water potential (Ψpd), is usually measured manually with an invasive, time-consuming protocol and instruments (e.g. Scholander Pressure Chamber) that do not scale to operational vineyard management. Remote-sensing proxies based on Sentinel-2 (publicly available data) are an attractive alternative due to its frequent revisit and wide spectral coverage. In this work we adopted a multi-source data fusion approach to estimate Ψpd from Sentinel-2 imagery, evaluated on the open dataset by Zhang et al., which provided Ψpd measurements collected across two vineyards and 12 acquisition dates between June and August 2022. Complementary sources of information were combined for each plot: the 10 raw Sentinel-2 L2A bands, a panel of 13 vegetation indices, and daily weather variables (relative humidity, maximum temperature, etc.). We trained four machine learning (ML) models and evaluated them under a leave-one-plot-out cross-validation scheme. This protocol prevented the vines of the same plot from appearing in both training and test sets, a leakage source often underestimated when random validation splits are used. The fusion of these sources outperformed the use of spectral bands alone, suggesting that these features were complementary and could capture additional information relevant for water-status estimation. We further analysed the models through interpretability techniques. Future research would try to fuse other sources of information, leverage other AI/ML sensor fusion schemes and eventually extend the validation to unseen acquisition dates, additional cultivars and climates.