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Spatial Downscaling of Land Surface Temperature Using Sentinel-2 and Sentinel-3 Data Fusion for Agricultural Applications

Bouchra Boufous[1], Fatima Ben zhair[1], and Salwa Belaqziz[1,2]
[1]Ibn Zohr University, Faculty of Science, Department of Computer Science, Morocco (bouchraboufous0@gmail.com)
[2]Center for Remote Sensing Applications (CRSA), Mohammed VI Polytechnic University (UM6P), Benguerir 43150, Morocco.

Land surface temperature (LST) is a key variable for assessing crop thermal stress and supporting precision agriculture. However, thermal satellite products often involve a trade-off between spatial and temporal resolution. Sentinel-3 provides frequent LST observations, but its coarse spatial resolution limits its use for field-scale agricultural monitoring.

This study proposes a spatial downscaling approach for LST based on the fusion of Sentinel-3 thermal data with high-resolution multispectral information from Sentinel-2. The method exploits the inverse relationship between surface temperature and vegetation cover through the Normalized Difference Vegetation Index (NDVI). A linear regression model was developed to estimate LST at a spatial resolution of 10 m using Sentinel-2 NDVI as the primary predictor.

The approach was applied over the agricultural site of El Ghaba in the Marrakech–Safi region (Morocco), covering different crop types, including annual cereals (barley, wheat, and kerenza) and perennial olive orchards. Results show a clear negative correlation between NDVI and LST, confirming the regulatory role of vegetation on surface temperature. The downscaled LST maps reveal fine-scale spatial heterogeneity that is not detectable in the original Sentinel-3 product.

Quantitative evaluation indicates low absolute errors for annual crops (generally below 0.5 °C), demonstrating the robustness of the proposed method, while higher discrepancies observed for olive orchards highlight the complexity of perennial crop thermal behavior. This work enhances the spatial usability of satellite thermal data for agricultural monitoring and crop stress assessment.