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Exploiting SAR Data for Classifying Agricultural Crop and Estimating Vegetation Biomass in Central Italy

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Much research was carried out to classify agricultural surfaces by using optical and microwave satellite sensors. A correct land use classification is in fact useful for different applications, in particular for the early mapping from which the potential final yield can be derived. The combined effects of an accurate crop classification and the estimate of crop biomass would give a significant contribution to agricultural applications and water management issues.

Although optical sensors are undoubtedly the best instruments for surface classification, their signals are often hampered by night satellite passes and the presence of clouds. In this case, microwave sensors, especially SAR systems, although suffering from more difficult data interpretation, can be used to integrate, or in some cases even substitute, optical imagery.

In this paper, a classifier composed by five Convolutional Neural Networks (CNNs) operating in the time-sensor domain was implemented using COSMO-SkyMed (CSK) X-band SAR data collected in StripMap PingPong dual pol. (HH/VV) mode, over an agricultural area in central Italy. Ground data collected on a test site in central Italy were used for validating the CNN algorithm-based classification. The accuracy of the classifier revealed to be satisfactory, with an overall accuracy higher than 80%, depending on the different selected architectures.

The estimate of crop biomass is another key-topic, which can help farmers in decision-making and water management issues; however, the influence of crop type on the radar backscattering coefficient (σ^0) is remarkable. This leads to the consideration that a preliminary accurate land classification can help in selecting the correct retrieval algorithm for biomass estimation.

A sensitivity analysis between σ^0 at X- and C-bands and the agricultural biomass (expressed as Plant Water content, PWC, in kg/m^2) of both narrow-leaf crops (mainly wheat) and broad-leaf crops (sunflower and corn) was therefore carried out. In addition to the CSK StripMap PingPong data, some StripMap HIMAGE single pol. (HH) and Sentinel-1 dual-pol. (VV/VH) C-band data were used for the analysis. The relationships obtained from different sensor configurations and polarizations showed good correlations with rather high determination coefficients (R^2>0.5) and a marked sensitivity to crop type, as already noted in previous research.

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