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Assessing the vegetation water status by using multispectral and SAR data combination

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Timely monitoring vegetation water status is becoming increasingly necessary in view of growing damages caused by climate change. The persistency and worsening of drought situations in many areas of the world is causing significant losses in agricultural production with consequent threatening of many human lives. Moreover, recently these risk situations are spreading also in temperate regions and Mediterranean areas. An appropriate management of soil and water resources will therefore be fundamental to obtain sustainable food production.

In this paper the potential of integrating optical and microwave data to monitor vegetation features has been exploited by using experimental data and models. The general idea was to cope the high sensitivity of radar data to water content of vegetation with the high sensitivity of optical data to pigments, thus producing dense time series and obtaining a more in-depth information on vegetation status.

Experimental activities were conducted in central Italy on a sorghum field in summer 2022 and 2023, by collecting ground data of the main soil and vegetation parameters and by using satellite images from Sentinel-1 and Sentinel-2. Leaf reflectance at two wavelengths (531 nm and 570 nm) was measured with PlantPen PRI210®, Photon Systems Instruments and the photochemical reflectance index (PRI), which is sensitive to changes in carotenoid pigments and can be considered a reliable water-stress index, was computed [1]. Backscattering coefficients (σ°) at C-band and some optical indices have been related to soil and vegetation water content (*mv*) and plant water status.

A simple forward e.m. model as the Water Cloud model (WCM) was used to simulate the S-1 σ° from vegetated surfaces by accounting for the volume contribution of the vegetation layer above the soil and for the surface scattering of the soil attenuated by the above vegetation [2, 3]. The retrieval of *mv* from S-1 σ° data has been achieved by inverting the WCM. A relationship between the *mv*, derived from microwave data and multispectral vegetation indexes (in particular, the normalized difference red edge index, NDRE, from Sentinel-2) with respect to in-situ measurements, was observed. Then, an integration between microwave and multispectral information has been attempted to classify the vegetation water status.

The obtained results confirmed the validity of the followed approach, at least in a preliminary way. The relationship between *mv* and NDRE, derived respectively from S-1 and S-2 data, shows, in fact, three statuses of vegetation: health, risk, and suffering. This semi-empirical approach was not so far validated with respect to an independent dataset. Thus, more processing and experimental data will be necessary in the prosecution of this research. So far, data collected in 2022 only were taken into account.

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