In Situ Measurements for the Validation of Sentinel-2 Data

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Abstract. Validation of remotely-sensed data is crucial for the massive adoption of applications fostering remote sensing data. In the framework of the Copernicus program, the Sentinel-2 data are an invaluable source of information for agriculture. In this abstract we perform two types of in situ measurements for the validation of Sentinel-2 data: (i) by using an FieldScout NDVI meter – which is a portable device capable of instantly measuring the Normalized Difference Vegetation Index [1] widely used for assessing the status of vegetation, and (ii) by using hyperspectral images acquired with the SPECIM IQ – which is a portable camera within the VISNIR (visible and near infra-red) domain (400-1000 nm). From the hyperspectral images acquired in situ we computed the entropy for each spectral band corresponding the Sentinel-2 multi-spectral instrument (MSI), as entropy is often use for the evaluation of grassland quality [2]. We show experimental results from two typers of agricultural crops – common spring wheat and grassland. We notice that the in situ NDVI measurements usually exhibit larger values compared to the NDVI values computed based on the Sentinel-2 data, while the entropy values are usually larger for the satellite data.

Experimental results. In Figure 1 we show the validation of NDVI measurements based on the Sentinel-2 data using the in-situ measurements performed with an NDVI portable meter. The validation is performed for a parcel on which common spring wheat was grown in 2023. On September 22, 2023, 15 ground-based NDVI measurements were taken and shown as a box

plot over the NDVI time series computed on Sentinel-2 data. The NDVI values measured in the field ranged from 0.29 to 0.32, with an average of 0.31. The average of the NDVI values computed from Sentinel-2 data between the closest dates (12 and 27 September 2023) is 0.23. One may notice a difference of 0.08 between the average of the values measured in the field and the average of the values calculated using Sentinel-2 images. The entropy values are shown in Table 1.

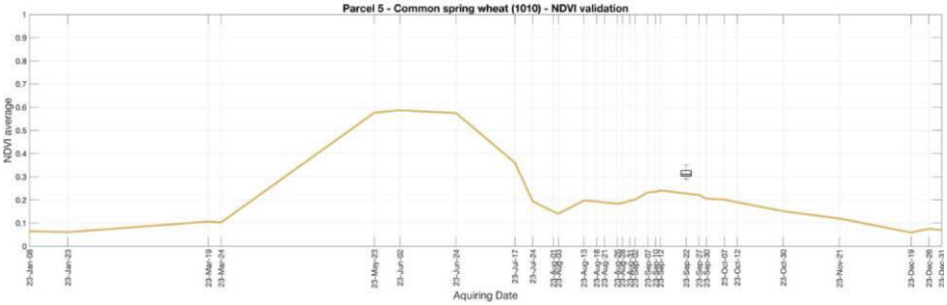

Fig. 1. Graph with validation of NDVI values. The average NDVI values over the year 2023 and a *box plot* of NDVI values measured in situ.

Table 1. Entropy values computed based on the hyper-spectral images acquired in situ (Hin-situ) and based on Sentinel-2 data (HS2) for 10 spectral bands of Sentinel-2 MSI.

band	B1	B2	B3	B4	B5	B6	B7	B8	B8A	B9
$H_{in-situ}$	4.108	4.125	4.093	4.030	4.125	4.132	4.102	4.064	4.093	3.819
H_{S2}	4.187	4.160	4.179	4.142	4.229	4.195	4.191	4.243	4.257	4.184
ΔH	0.081	0.035	0.086	0.112	0.104	0.063	0.089	0.179	0.164	0.364

Conclusions. In our experiments, the Sentinel-2 data lead to more pessimistic NDVI measurements compared against the in-situ validation data. From an application point of view, this may leave to a false positive alarm which is preferably over a false negative alarm. The difference can be explained by various factors, as every involved equipment (i.e. Sentinel-2 MSI, FieldScout NDVI Meter) has its own characteristics and performance. In addition, the

atmosphere and the associated correction for the satellite data can affect the remote sensing measurements. The slight disagreement in the NDVI measurements can be mitigated [3]. For the entropy, the Sentinel-2 data showed larger values, confirming the larger spread of the data and consequently indicating more optimistic values which can be erroneously interpreted as higher quality grassland. On average, there was a difference in entropy of 0.1277.

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