Quantification of intra-plot variability of vine water status using Sentinel-2: case study of two Belgian vineyards

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1 Vine water status monitoring constitutes a basic parameter for vineyard management

Traditional field methods exist to quantify the water status of the vine:

- Midday stem water potential (Ψ_{stem})
- Predawn leaf water potential (Ψ_{pd})
- Carbon isotopic discrimination ($\delta^{13}C$)

The **spatial and temporal resolutions** of these methods are generally **low** and **extrapolation of measurements** over a wider area is **difficult** given the spatial variability of vineyards, particularly in terms of soil properties.[a]

The aim of this study is to characterise and understand the **spatial and temporal variability of the water status of the vine** at the plot level.

2 Soil properties and weather conditions are well known in two Belgian vineyards

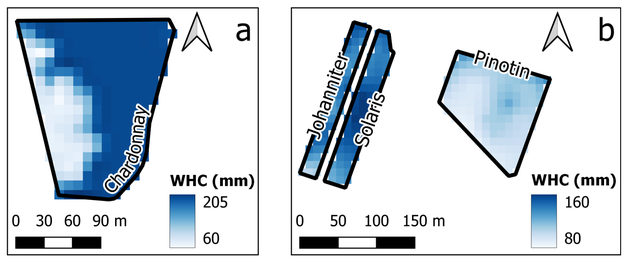

Figure 1 – Water holding capacity (WHC) of the parcels of **(a)** the Bousval vineyard (Genappe, Brabant Walloon) and **(b)** the Chenoy estate (La Bruyère, Namur).

Weather conditions are defined by an **annual cumulative drought index (DI_{cum})** which is the cumulative annual difference between precipitation (P) and potential evapotranspiration (ETP):

$$DI_{cum} = \sum_{01/01}^{31/12} P - ETP \qquad (mm)$$

3 Sentinel-2 as a tool to monitor vine water status over time at the plot level

Sentinel-2 provides a good opportunity to monitor vineyards at a large scale.[b]

Six spectral indices (NDWI, $NDWI_1$, $NDWI_2$ and their ratio to EVI) were tested **to quantify the water status** of the vine.

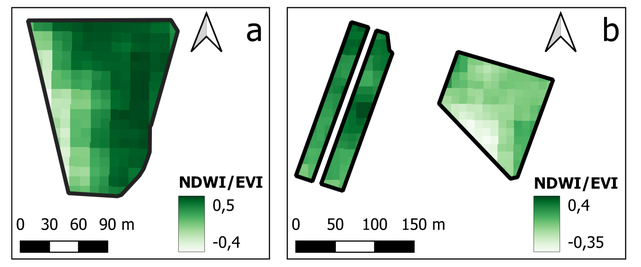

Figure 2 – NDWI/EVI measured from Sentinel-2 data in **(a)** the Bousval vineyard (16/08/18) and **(b)** the Chenoy estate (08/08/20).

NDWI/EVI is the spectral index measured from Sentinel-2 data that **best quantifies the water status of the vine.**

NDWI/EVI and water holding capacity are better correlated when the water conditions are the most constraining for the vine.

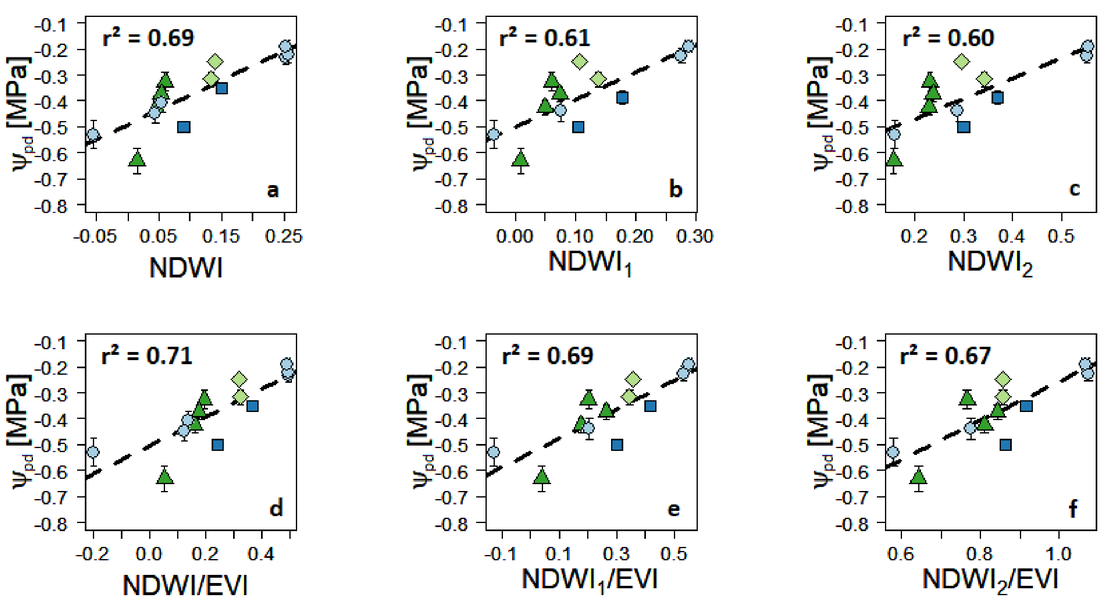

Figure 3 - Linear regressions between the predawn leaf water potential (Ψ_{pd}) and **(a)** NDWI, **(b)** $NDWI_1$, **(c)** $NDWI_2$, **(d)** NDWI/EVI, **(e)** $NDWI_1$/EVI and **(f)** $NDWI_2$/EVI of the same day (dotted black lines). Measurements on Chardonnay (Bousval) are the light blue circles, on Johanniter (Chenoy) are the dark blue squares, on Solaris (Chenoy) are the light green diamonds and on Pinotin (Chenoy) are the dark green triangles. The Ψ_{pd} measurements in Bousval were taken on 23/09/19 at 3AM and those in Chenoy on 24/09/20 at 3AM.

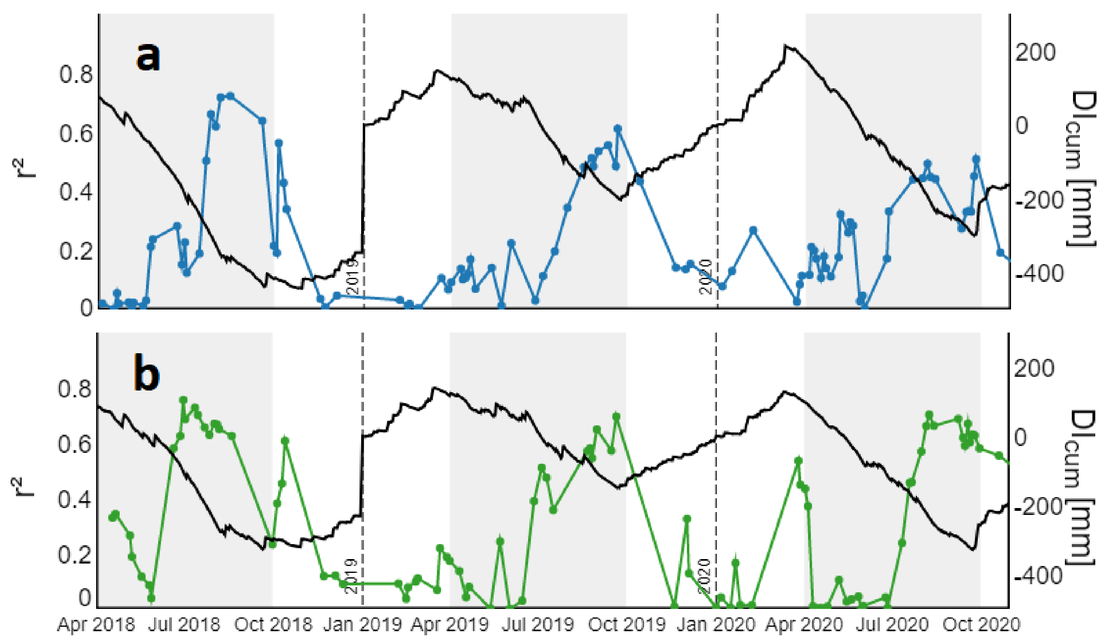

Figure 4 - Time series of the determination coefficient r^2 between the spatial distributions of NDWI/EVI and WHC measured from Sentinel-2 data, and of DI_{cum} in **(a)** the Bousval vineyard and **(b)** the Chenoy estate in 2018, 2019 and 2020. The blue and green lines are the time series of the r^2 in Bousval and Chenoy respectively, and the black lines are the DI_{cum}. The shaded areas correspond to the wine-growing season (between 1st April and 30th September).

References

[a]C. Acevedo-Opazo, B. Tisseyre, H. Ojeda, S. Ortega-Farias, et S. Guillaume, « Is it possible to assess the spatial variability of vine water status? », *OENO One*, vol. 42, n° 4, p. 203, dec. 2008.
[b]N. Devaux, T. Crestey, C. Leroux, et B. Tisseyre, « Potential of Sentinel-2 satellite images to monitor vine fields grown at a territorial scale », *OENO One*, vol. 53, n° 1, mar. 2019.