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Fagus sylvatica L. sap-flux is affected by soil moisture variability along a steep hillslope in Central Italy

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INTRODUCTION & AIM

Soil moisture plays a key role in regulating evapotranspiration, especially in arid and semiarid conditions. The climate in the mediterranean area is prone to episodic summer drought, however, many drought sensitive tree species occur in this area. One of the most widespread is the European beech *Fagus sylvatica* L., which occurs in mountain areas, usually at altitudes above 1000 m a.s.l.. Thus, this environment provides a natural experimental setup for studying the physiological responses of the species to drought, which is especially important under the ongoing climate change.

In this study we exploited the natural variability of soil moisture along a steep hillslope to unravel the responses of beech trees in terms of transpiration to the environmental drivers (radiation, vapour pressure deficit, soil moisture, wind speed), and to analyse the influence of the different variables in time.

METHOD

The study area was set in the Lecciona hillslope (11.63 E; 43.89 N, ~950 m a.s.l.). Sap flux was monitored at three locations (Bottom, Mid and Top of the slope, 4 trees per location) during the 2021 growing season (May-September), along with soil moisture, while the meteorological conditions were monitored using a weather station.

Correlation analysis was performed on the whole period, and over 30 days time windows, employing the Pearson's correlation coefficient.

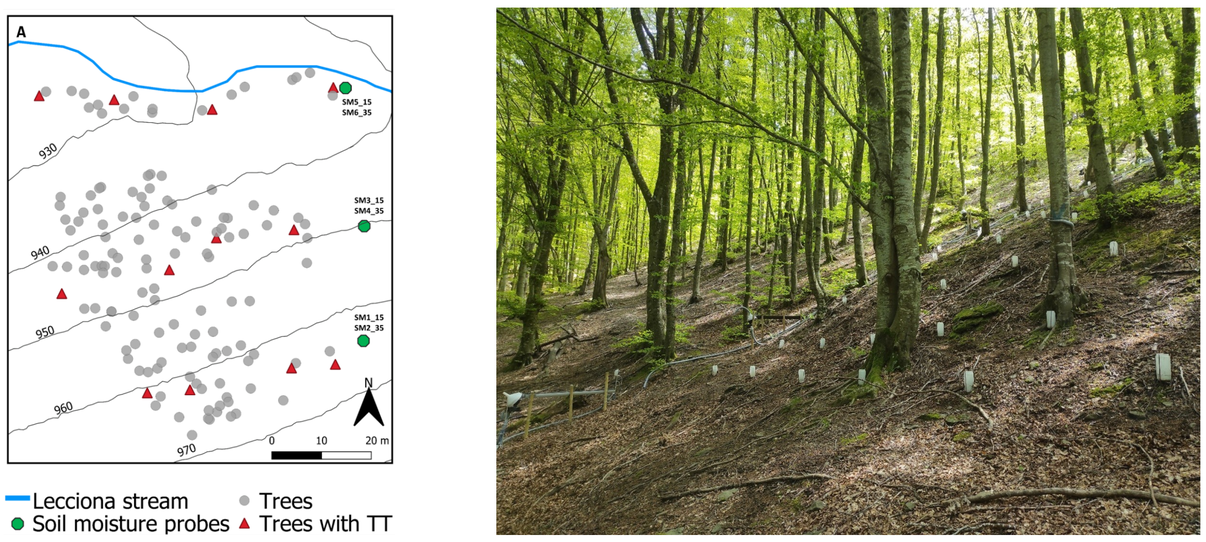

Figure 1: Map of the study area, and a picture of the studied forest on 05.05.2021.

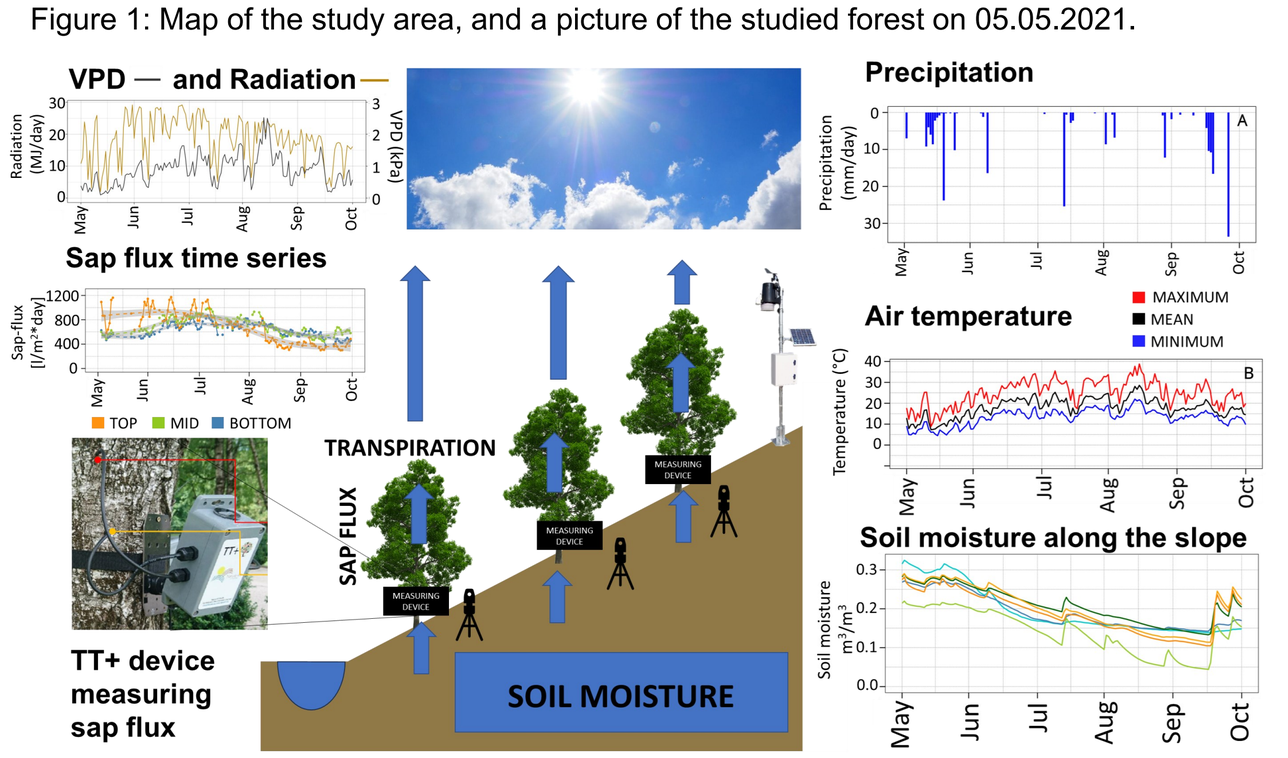

Figure 2. Schematic representation of the experimental design in the Lecciona hillslope.

RESULTS & DISCUSSION

In the Bottom location, the highest correlation between sap-flux and radiation, and sap flux and VPD were recorded. Going up the slope the correlation between sap flux and soil moisture increased becoming statistically significant ($p<0.05$), while the one between sap-flux and radiation and VPD decreased. This suggests that in the drier locations upslope (Top and Mid), soil moisture is more influential in determining the transpiration rate, while in the Bottom, riparian site, with high water availability, radiation and evaporative demand are the limiting factors.

With respect to the evolution of the correlation in time, during late summer, a significant positive correlation between sap-flux and soil moisture arose, with a different timing in the three locations, following the soil moisture decrease. This highlights that the effects of meteorological variables on transpiration change in time, in mediterranean ecosystems, following the change in meteorological conditions.

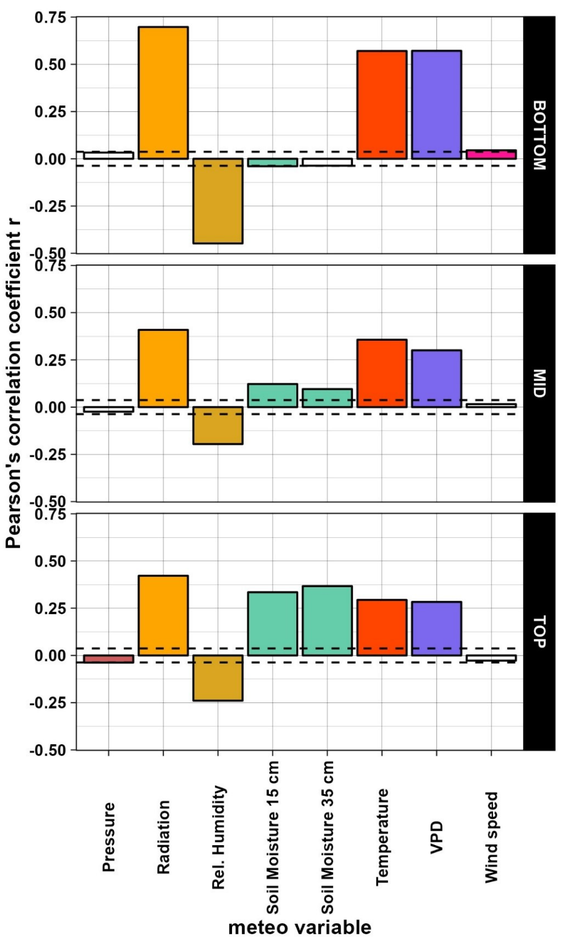

Figure 3: Pearson's correlation between the sap-flux time series and the environmental forcings. Coloured bars indicate significant correlations, dashed lines correspond to the significance threshold.

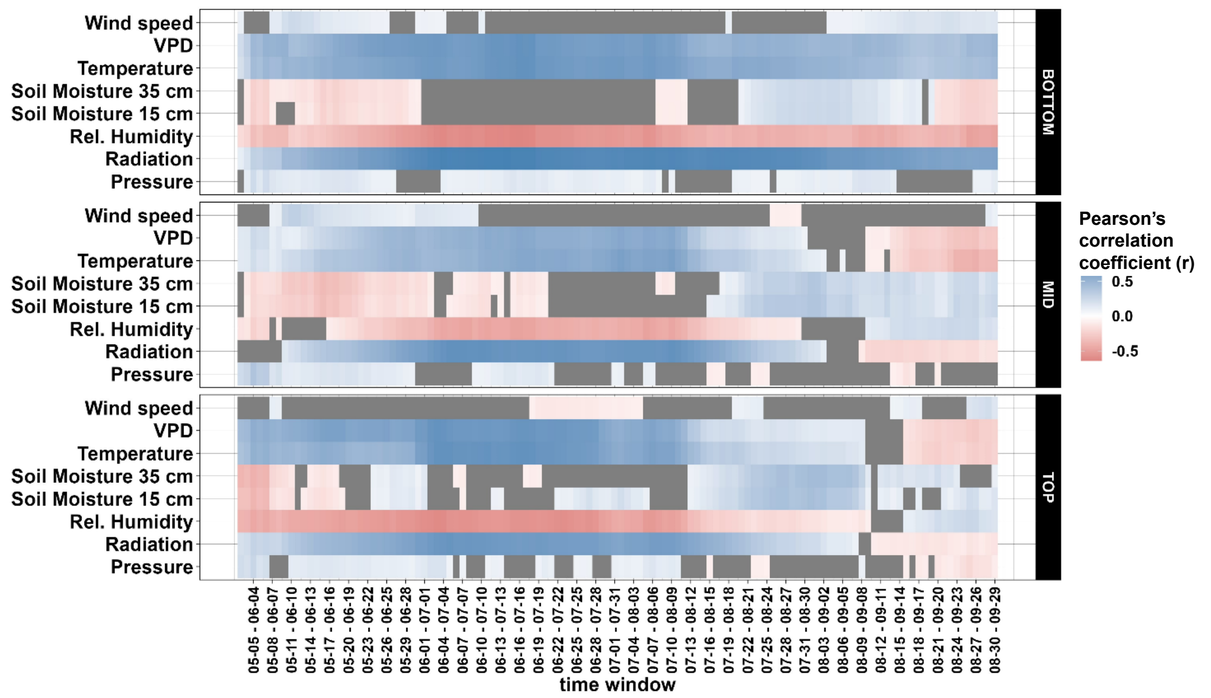

Figure 4: Evolution of the correlations in time during the growing season.

CONCLUSION

This study showed that mediterranean beech forests can shift from radiation control over transpiration, to moisture control, depending on soil moisture availability. Moreover, there is a spatial variability in the relationship between transpiration and its drivers. These findings will enhance our ability of modelling transpiration and provide valuable information for implementing appropriate management practices in response to drought and climate change.