Does available soil moisture determine the daily water use of European beech trees?

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Background Climate change is leading to rising temperatures and erratic rainfall patterns. Higher temperatures in combination with changes in frequency and intensity of precipitation have a strong effect on physiological processes in trees. For central European forests higher frequency of droughts is predicted, which could lead to increased forest decline and tree mortality rates particularly for drought-sensitive species such as European beech (*Fagus sylvatica* L.). Furthermore, studies of sapflow and tree water use focus on the influence of meteorological variables. Soil moisture availability is a key determinant of tree water use, influencing sap flow, transpiration rates, and drought sensitivity.

BENEATH The project seeks to increase the understanding of the interactions between available soil water, decaying deadwood, living trees and their root systems, and soil carbon. These interactions are still poorly understood under the rapidly changing environmental conditions with increasing frequency of droughts and heavy rainfall events.

Research question To what extent do variability in soil moisture explain the differences in sapflow and transpiration along a soil moisture gradient from wet to dry conditions?

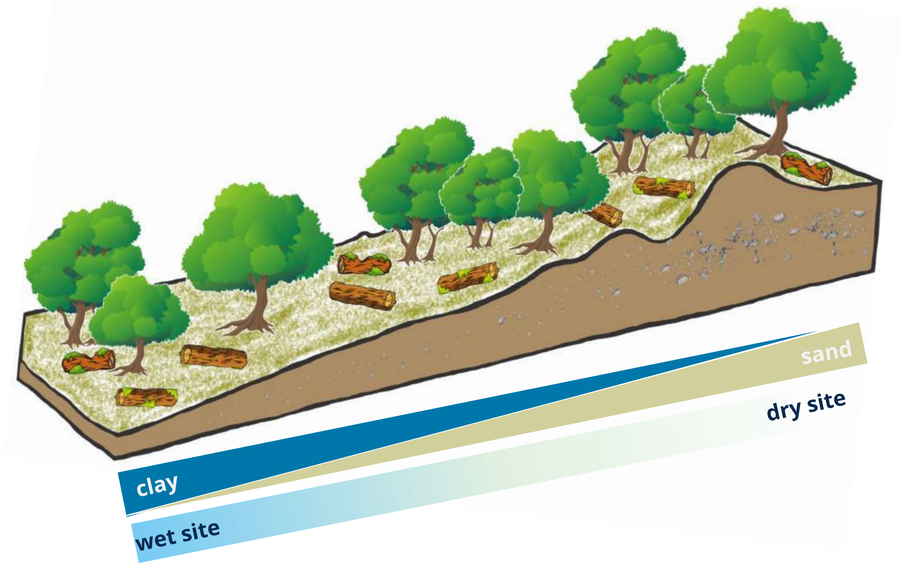


Fig. 1 Soil moisture gradient for the installation of the intensive monitoring plots

Results – Sensitivity of transpiration to meteorological conditions and soil moisture variability

Key messages

- The dry site presents significantly lower daily water use (DWU) than the wet and intermediate sites.
- There are not significant differences in DWU between the wet and the intermediate sites.
- The sites do not differ in their vapor pressure deficit (VPD) sensitivity of sapflow.
- VPD rather than soil matric potential explains the daily variation in sapflow -> anisohydric nature of European beech.
- Soil matric potential limits the total/maximal sapflow.

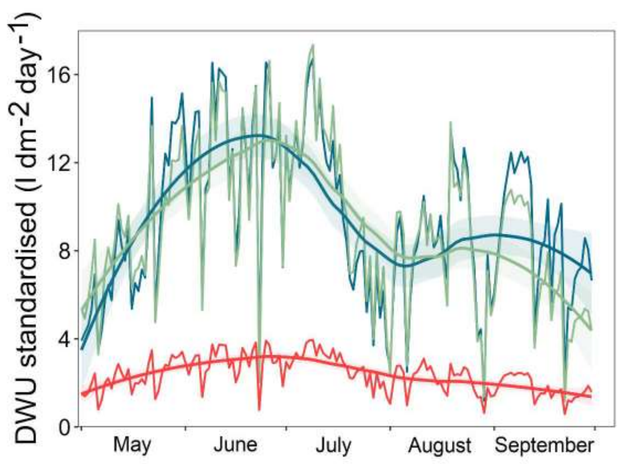


Fig. 2 Daily water use (DWU) standardised by tree basal area, averaged per site.

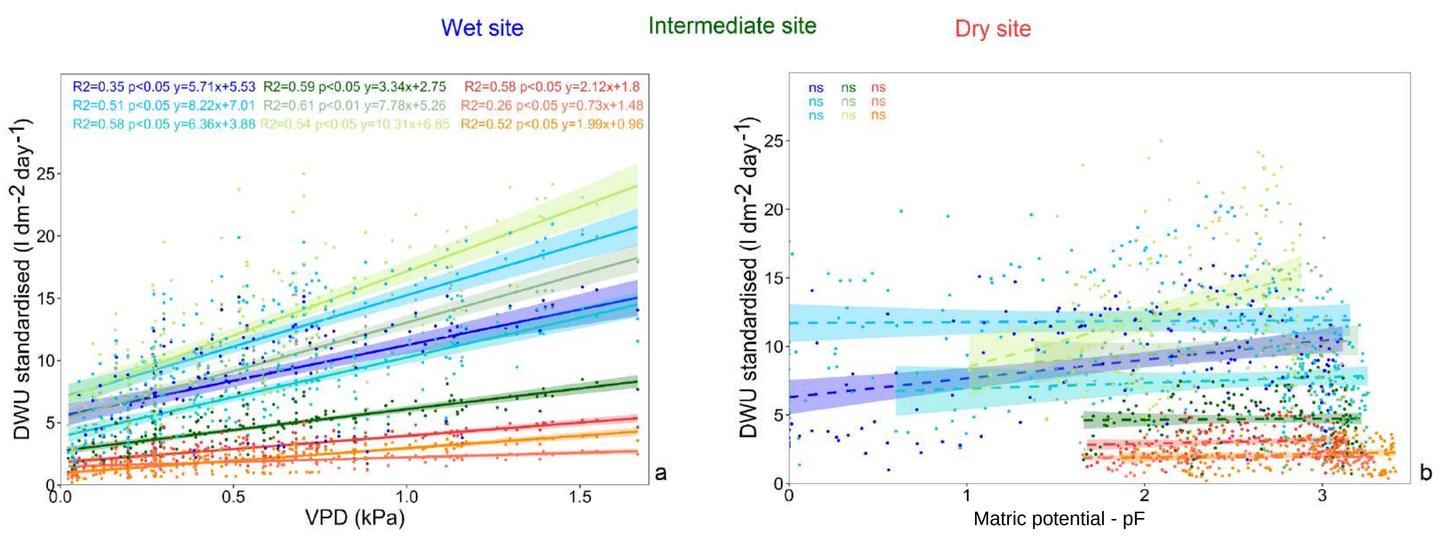


Fig. 3 Relationship between daily water use (DWU), vapor pressure deficit (VPD, a) and soil matric potential (b).

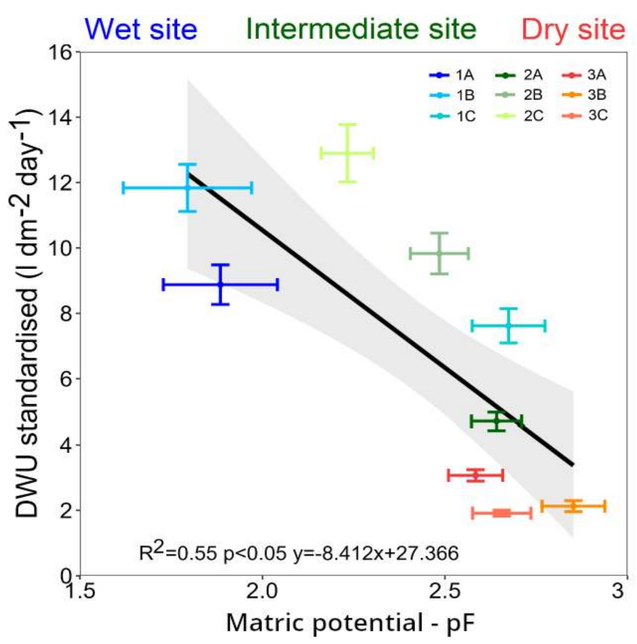
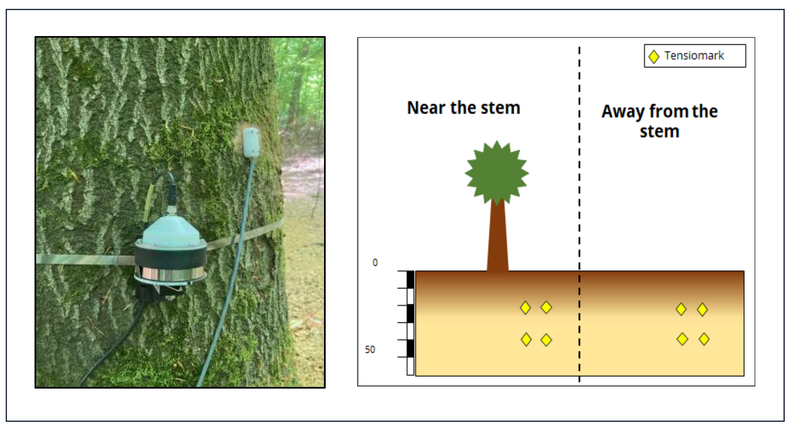


Fig.4 Relationship between annual (May – September) average daily water use (DWU) standardized by basal area and soil matric potential at tree level.

Experimental design

- Three sites along a soil moisture gradient: wet, intermediate and dry sites.
- Monitoring of different elements of the hydrological and C cycles:
  - soil moisture
  - matric potential
  - sapflow
  - stem growth
  - leaf area index (LAI)
  - meteorological variables



Outlook: do soil parameters shape tree growth?

Link soil moisture gradient with:

- Radial growth of beech trees.
- Determination of water use efficiency -> combination of cumulative transpiration vs tree growth.

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