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Define the water-use strategy: A network study on hydraulic mechanisms regulating water use of European tree species during drought.

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Continuous and long-term monitoring of water use are required to reduce uncertainties in modelling forest transpiration. Since drought threatens the vitality and survival of forests worldwide, understanding and modelling responses to drought are of particular interest. Tree species undergo strong selective pressure to develop specialized mechanisms for regulating water-use dynamics during unfavourable climatic conditions. To cope with drought a tree can adjust its “water-use strategy”, by 1) altering the regulation of water release through the leaves to the atmosphere, 2) adjusting the water storage capacitances, or 3) changing the hydraulic conductivity of the xylem, impacting the water flux. There is thus a pressing need to understand the variability of such hydraulic mechanisms, between and within tree species, and quantify how they impact forest transpiration.

We strive to elucidate hydraulic mechanisms in European tree species by combining, for the first time, three hydraulic components (stomatal conductance regulation, storage water capacity and wood anatomical traits) to identify water-use strategies and mechanistically model their effect on water use under increasing drought and warming. We constructed a European monitoring network, integrating ongoing meteorological measurements (e.g., temperature, relative humidity, global radiation and soil moisture) with sap flow (*SF*) and dendrometer (*DM*) measurements, as well as wood anatomical properties collected from the same tree individuals. Currently, the network includes 22 sites stretching from Spain till Finland (latitudinal range: 40° - 62° N), with a total of 281 individuals (14 tree species) and hourly-resolution monitoring of *SF* and *DM* from ~2011-2018. This large temporal coverage ensures a broad range of dry and wet conditions at each site, while the extensive climatological range of sites promotes the detection of intra-specific variability in hydraulic mechanisms.

Focussing on four common European tree species (*Fagus sylvatica*, *Quercus petraea*, *Pinus* *sylvestris* and *Picea abies*), we present initial results from a Swiss temperate forest, where combining *SF*, *DM* and wood anatomy allowed us to disentangle species-specific differences in water-use strategies. Building upon these empirical observations, we were able to quantify the impact of these inter-specific differences on water use. Moreover, a mechanistic water transport model was used to assess stem water content, stem water potential (i.e., an indicator for hydraulic vulnerability), and subsequently turgidity within the cambium (i.e., crucial for wood formation) during the summer drought of 2015. Our efforts will advance process-based understanding of drought impacts on water use and could constrain predictions of forest transpiration under changing climatic conditions.