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Contrasting tree water use strategies along hillslopes in forested catchments in Luxembourg and Italy

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Topography plays a major role in mediating subsurface water redistribution and ultimately water availability for tree transpiration. Trees located in valley bottoms commonly benefit from greater accessibility to groundwater and wetter soil from lateral redistribution of water compared to trees growing upslopes. However, water availability and movement in the subsurface may differ according to subsurface properties (permeability, soil texture, geology) and climatic regimes. The spatially and seasonally variable water accessibility along a hillslope affects species composition, stand structure, and biomass productivity resulting in areas which will be more likely impacted by potential water shortages. So far, the understanding of how hydrological processes occurring at the hillslope scale affect tree water use is still limited, rising the need of measurements at hillslope-level to allow deeper comprehension of forest dynamic and survival.

Here, we set up a comparative study on a gentle and very steep forested hillslope located in the Weierbach catchment (Luxembourg) and the Re della Pietra catchment (Italy), respectively. We aimed at testing if different climatic and hydrological conditions, i.e., meteorological forcing, groundwater depth, soil moisture, and water redistribution affect water use patterns of beech trees (*Fagus sylvatica* L.) along hillslopes.

We monitored soil moisture, groundwater level, sap velocity, and hydro-meteorological variables and determined the isotopic composition of precipitation, soil water, groundwater, and xylem water to estimate tree water sources. The combination of these measurements allows us to link the transpiration response of trees to water availability along the two different hillslopes. We carried out biweekly field campaigns during the growing season 2019 and 2020 in Weierbach catchment and throughout 2021 in Re della Pietra catchment to sample xylem water, soil water at different depths, groundwater, stream water, and precipitation.

Trees in the Weierbach catchment rely on water stored in the unsaturated zone regardless of the hillslope position and the hydrologic conditions of the season. On the contrary, preliminary results from Re della Pietra suggest position-specific water use strategy. Trees located at the footslope experienced longer vegetative period compared to plants located at the midslope and hilltop locations due to larger soil moisture content recorded at the footslope. Additionally, xylem water

of footslope trees displayed lighter isotopic composition compared to other trees, suggesting the use of a less fractionated water sources.

We argue that contrary to the Weierbach catchment where subsurface hillslope structure promotes vertical water flux over lateral redistribution in the vadose zone, the steep hillslope on the Re della Pietra catchment experiences shallow lateral downslope water redistribution which results in substantial differences in vadose zone water supply between hillslope positions.