The Referees' comments are given in regular font style, and the authors' responses are in blue and italics.

Response to the interactive comment of Prof. Conrad Jackisch (Referee)

General comments

Ginevra Fabiani and co-workers present a very interesting study on ecohydrological adaptation options of beech trees. They have conducted intense data collection along topographic sequences at two different sites (Luxembourg Ardennes and Italian Apennines) for about three vegetation seasons. Most noteworthy is the combination of local differences in water pools (stream, groundwater, rain, soil water and xylem water) approached quantitatively with monitoring sensors and samples analysed for stable water isotopes, and along such a topographic transect. The data are truly impressive and I can only congratulate the authors for the nice study.

Without diminishing my high regard for this work, I still think that the manuscript deserves substantial revisions to really work out its strengths and novelties. This is especially so since the presented data and analysis comes with substantial overlap to their previous study looking at the Luxembourg site only (Fabiani et al. 2021). Although properly cited, it took me a while to become clear about this.

Dear Prof. Conrad Jackisch,

thank you for appreciating our work and acknowledging the effort of combining multiple approaches that have demanded extensive fieldwork in two countries for three consecutive growing seasons. We are grateful for the points you made to improve the quality of our work, which we have addressed more specifically in the following responses and in the revised version of this manuscript.
We acknowledge that this study relies on some of the same data as a previous study and one question overlaps (Fabiani et al., 2022). However, the current study goes also clearly beyond the mentioned work with the primary objective being the investigation of how the physiological response of the beech trees can vary in response to contrasting climates and topography. We hypothesized that the Mediterranean site (Lecciona catchment), characterized by an uneven precipitation regime and high summer evaporative demand, would constrain the physiological activity of beech trees more compared to the stand growing in the Luxembourgish site, which was the focus Fabiani et al. (2022). Additionally, we have extended the monitoring window to include an additional growing season in the Weierbach catchment. The extension also allowed us to test whether drier environmental conditions affect the physiological response of beech trees to hillslope topography. Therefore, the present work leverages a larger spatial scope (two different study sites) and a longer temporal scale (monitoring three growing seasons) to offer insights into the influence of hillslope topography on beech water use.

Major Comment 1:

Since the manuscript tries to reach quite far (water use strategies, physiological responses as a function of water availability, topographic and climate effects…) I am not quite convinced that the scope of the presented analyses is really suitable to make this case. Although I think to be quite within the ecohydrological bubble dealing with beeches and water uptake, I found it difficult to understand your argumentation lines to work out the research questions or how these questions really relate to this extraordinary dataset about state dynamics, fluxes and isotopic compositions. One central issue to me stands with your term of "water limitation", which would always define in terms of potentials not pools (see also Novick et al. 2022).

The overarching aim of this study is to examine the physiological responses of beech trees growing along two hillslopes by conducting a comparative analysis. Existing ecohydrological studies are often limited by snapshot sampling protocols that are restricted to a single study site, few individuals, and by ignoring temporal patterns or trends. This has hampered the understanding of ecohydrological processes and how they affect a tree's physiological response. Additionally, within-species observations in different climates have received little attention compared to variations between species (Li et al., 2022) due to the restricted species distribution ranges.
To the best of our knowledge, the present study is the first one taking up the challenge to examine how the physiological response of the same species (beech) can vary in response to contrasting climates and topography. Our study addresses these limitations and moves beyond spotted observations to learn how beech trees, can adapt spatially to contrasting environmental conditions. While we agree that one can always do more, it is evident from

the literature that the research questions of this study have not been previously addressed at various hillslopes. We thus improved how the water-use strategy and physiological response of beech trees may vary due to the interaction of climatic and topographic factors.

We understand that the "water limitation" wording, might be misleading, and we revised the manuscript with different terminology:

- *LL 25: "Multiple studies that investigated the effect of reduced water availability on forest vulnerability have neglected plot-scale landscape heterogeneity, even though soil properties and topography are important abiotic factors for forest health (Schwantes et al.,2018)."*
- *LL 79-81: "We test these hypotheses by posing the following research questions: (i) does topography drive different water uptake strategies along two contrasting hillslopes? and (ii) does hillslope topography increase tree sensitivity to a seasonal decrease in soil water supply?"*
- *LL 383-385: "The drier and more evaporative-demanding conditions given by the higher solar radiation at the midslope and hilltop areas compared to the footslope (Méndez-Toribio et al., 2017), could cause trees in higher topographic positions to experience shorter growing season to withstand decreasing water supply (Fig. 5)."*

Li, K. and Knighton, J.: Characterizing the heterogeneity of eastern hemlock xylem water isotopic compositions: Implications for the design of plant water uptake studies, Ecohydrology, pp. 1–12, https://doi.org/10.1002/eco.2571, 2023.

Major Comment 2:

Moreover, the study setup has made some of the analyses rather difficult to substantiate: While the non-overlapping temporal coverage might be of minor importance with the climate in Tuscany not strongly coupled to the climate in western Luxembourg, 2019 and 2020 have been strongly characterised by a multi-year drought across Europe (e.g. Rakovec et al. 2022) to which especially older forest stands could not easily adapt at many places. This setting is also visible in the data table 2, where even Tuscany received more rain in 2021 than Luxembourg in 2020. To what degree could this affect your conclusions?

We cannot follow the reviewer's argument regarding the lack of temporal overlap that would impede the comparison. With the selected setup, one can clearly study how sap flow and the composition of water uptake behave at the individual study sites. Our study specifically focuses on sites with different climatic regimes rather than examining specific conditions, such as the impact of a heatwave in two forested catchments.
The lower amount of precipitation received by the Weierbach catchment in the 2020 growing season compared to the Lecciona (Table 2) aligns well with long-term precipitation records. Lecciona has higher mean annual precipitation (2001-2021: 1265 mm) than the Weierbach (2007-2020: approximately 801 mm), as presented in the Materials and Methods section. This is also evident in Fig. R1 and R2, for the Luxembourgish and Italian study sites, respectively. We made sure to make this clearer in the revised version of the manuscript as follows (LL 123-126): "Based on long-term records, the Lecciona catchment consistently receives more precipitation than the Weierbach catchment, both annually and throughout the growing season. While precipitation is evenly distributed across seasons in the Weierbach catchment it falls mostly during the dormant season in the in the Lecciona catchment, typical of a Mediterranean climate (data not shown)."
Regarding the multi-year drought (i.e. 2015, 2018, 2020) experienced by European forests, we believe it may have only a limited effect on our findings. Our experimental approach and process interpretation are limited to the monitoring window covered and therefore may not fully account for potential morphological adjustments (such as root development, stomatal density, basal area), as these changes occur gradually over longer time scales, especially in older forests. What we observed is that for both growing seasons, there was a consistent negligible role of groundwater for transpiration, despite its shallow depth in the Weierbach catchment. These results align well with other studies that pointed out that beech is a species that relies on shallow soil water (Gessler, 2021; Kreuzwieser and Rennenberg, 2014), and that topography does not necessarily lead to more suited growing conditions. We acknowledge the potential relevance of physiological and morphological adjustments that might have occurred over the years, such as sapwood area relative to leaf area, wood density, or water storage. However, delving into these aspects goes beyond the scope of this work.

Considering this, the multi-year drought affecting Europe has only a limited impact on our conclusion regarding the lack of statistical differences in physiological responses between hillslope locations in the Weierbach catchment. However, we agree that carrying out experiments that evaluate how older forest stands will react and adapt to changing conditions in the years to come is urgently needed. However, including forest age as a degree of freedom in the experiment would go beyond what is feasible in such a project.

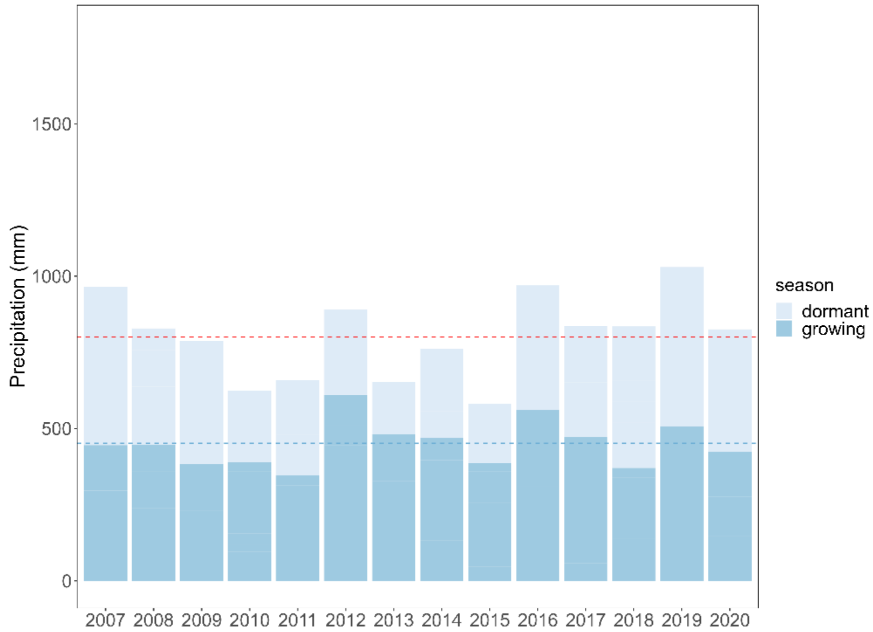


Fig. R1: Long-term precipitation data measured at Roodt climate station (Weierbach catchment, Luxembourg). The red-dotted line is the mean annual precipitation over the observation period, while blue-dotted line is the mean growing season precipitation.

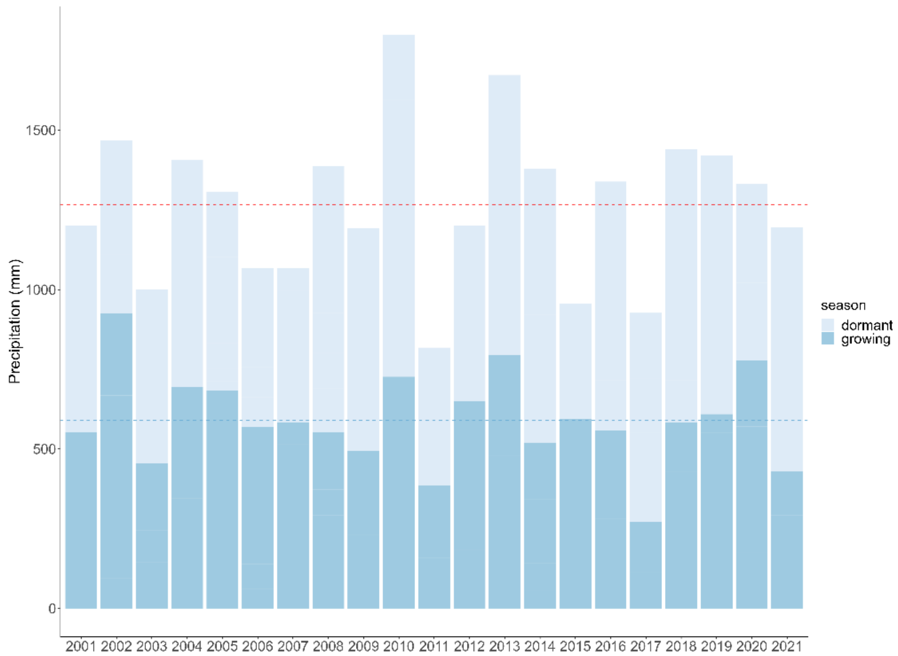


Fig. R2: Long-term precipitation data measured at Consuma climate station (ca. 10 km from the Lecciona catchment, Italy, at the same elevation). The red-dotted line is the mean annual precipitation over the observation period, while blue-dotted line is the mean growing season precipitation.

Gessler, A., Bachli, L., Rouholahnejad Freund, E., Treydte, K., Schaub, M., Haeni, M.,Weiler, M., Seeger, S., Marshall, J., Hug, C., Zweifel, R., Hagedorn, F., Rigling, A., Saurer, M., and Meusburger, K.: Drought reduces water uptake in beech from the drying topsoil, but no compensatory uptake occurs from deeper soil layers, New Phytologist, 233.

Kreuzwieser, J. and 540 Rennenberg, H.: Molecular and physiological responses of trees to waterlogging stress, Plant, Cell & Environment.

Major Comment 3:

With respect to the two selected sites I see the issues of a) the slopes are facing in opposite direction (entailing not only different exposition but also that the sap-flow sensors have to be placed at opposite sides, see e.g. Renner et al. 2016 in the same Luxembourgish catchment), b) geologically and pedologically contrasting conditions (shallow gravelly, silty soils on slate vs. sandy loams on sandstone), and c) topographically different settings (slope steepness and length differ, leading to questions about how well the delineated sections footslope, midslope and hilltop/plateau can be equally defined at both sites).

Maybe these are all elements you have thought of, but which I could not find sufficiently addressed in the manuscript. Since in the end your analyses boil down to statistical comparisons between the relative differences along each transect and between both sites in the 2+1 years, I am not really convinced that this really corroborates water use strategies (as suggested in the title), nor that the conceptualisation of ecohydrological process (fig. 9) is really the lesson to learn. There are few places with more intense and long-lasting monitoring of ecohydrological compartments than the Weierbach and we have come to much more precise concepts already. Moreover, we studied root water uptake and sap flow under contrasting geology/soil close to the Weierbach and did not see much effect on sap flow despite pronounced differences in soil moisture dynamics (Jackisch et al. 2019, and we unfortunately lacked isotopic analyses).

We understand your concern regarding the differences in slope length, steepness, geologic settings, and aspect between the two study sites. We agree that the prospect of a standardized experimental setup with long-term monitoring across the two study sites would be ideal, but most of the time we must compromise given the intrinsic difficulty of achieving representability in real-life scenarios. Before digging into the potential implications of these differences on our interpretations, it is important to highlight that the selection of a study site involves prioritization and compromises. In our study, a primary consideration was to focus on the same species (Fagus sylvatica L.) to mitigate potential variations in morphological and physiological characteristics.

Regarding the installation of the sap flow sensors, it is standard practice to install them on the north face of the tree trunk to avoid direct radiation, and we followed this convention in the Weierbach catchment. In the Lecciona catchment, the steepness of the hillslope induces the formation of tension wood and consequential asymmetry in tree ring formation (Telewski, 2016) on the north and south aspects. Therefore, we installed the sensors on the east side of the trunk. Considering the proven robustness of the heat ratio method to temperature fluctuations (Burges et al., 2014), this installation design does not have any impact on the sensor functioning.
The aspect of sap flow installation does not affect the absolute values of sap velocity, and therefore, our analyses of the seasonal dynamics and the investigation of the transpiration response between locations at the two study sites remain unaffected. The latter is assured by the consistent sap flow installation within each study site. We acknowledge that the installation of sensors at the branch level may lead to different daily patterns of sap velocity due to the timing of illumination of foliage (Burgees and Dawson; 2008). However, this potential issue is prevented in our study by installing the sensors on the trunk.
We clarified this as follows (LL:151-153): "In the Weierbach catchment, we positioned the sap flow sensors on the north-east side of the trunk at 1.3 m height. In the Lecciona catchment, we opted to install them on the west side to avoid placement in tension wood, which is characterized by lower lignification and eccentric growth in hardwood species on steep slopes."

In consideration of the distinct soil properties and geologic settings between the study sites, we agree with the reviewer that those differences hold direct implications on water availability for transpiration and preferential flow patterns along the landscape. For this reason, we selected not only the Relative Extractable Water proxy to compare the soil water content but we also conducted drilling campaigns to monitor the groundwater table.

This is highlighted in the following lines (LL 128-129): "In order to account for inter-site differences in soil properties and facilitate the inter-site comparison we estimated the daily relative extractable water (REW, unitless) (Granier et al., 1999) over all monitored depth classes at each site."

Concerning the topographic locations, we selected slopes in both catchments that spanned from the stream to the highest point of each catchment as we wanted to address the extreme locations and the progressive edaphic and environmental changes. In the Weierbach catchment, the gentle slope was subdivided into plateau, midslope, and footslope locations based on the Topographic Wetness Index (Fabiani et al., 2022). In the Lecciona catchment, we defined as hilltop the highest point in the slope (close to the catchment ridgeline), the footslope location in the proximity of the stream, and the midslope location as situated between the two.
As this was not clear in the previous version of the manuscript, we specified for the Weierbach catchment as follows (LL 87-88): "The site description and characterization of plateau, midslope and footslope location has been provided in detail by Fabiani et al., 2022. Here we report only the key details of the study site (Table 1).
For the Lecciona catchment we specified as follows (LL 102-105): "The selected hillslope spanned from the stream to the highest point of each catchment to address the extreme locations and the progressive edaphic and environmental changes. We defined as hilltop the highest point in the slope (close to the catchment ridgeline), the footslope location in the proximity of the stream, and the midslope location as situated between the two."

One last factor we had to consider when selecting the hillslopes was the accessibility to the site to allow the fieldwork activities and drilling campaigns to reach the groundwater. As an example, in the Lecciona catchment the biweekly battery change for the sapflow sensors amounted to a total of ca. 40 kg for transportation in and out of the forest, and therefore the need for an unpaved road in the vicinity of the hillslope.

To conclude, while we acknowledge that stronger analogies between the two sites would enhance statistical robustness, we believe that our experimental approach can already shed light on the functioning of these systems. The present work goes beyond the previous understanding highlighting that surface topography and hillslope structure may result in varying sap velocity responses to environmental controls, but not consistently across landscapes. This has been possible by exploring the influence of topography on tree water use within the same species growing in diverse climatic settings. This represents an initial step towards a more generalized understanding. For clarity, we edited the manuscript to refrain from generalized interpretations.

Burgess, S. S. O., & Dawson, T. E. (2008). Using branch and basal trunk sap flow measurements to estimate whole-plant water capacitance: a caution. Plant and Soil, 305(1–2), 5–13. https://doi.org/10.1007/s11104-007-9378-2

Burgess, S., Downey, A. (2014). SFM1 Sap Flow Meter Manual Armidale.

Fabiani, G., Schoppach, R., Penna, D., & Klaus, J. (2022). Transpiration patterns and water use strategies of beech and oak trees along a hillslope. Ecohydrology, 15(2), 1–18. https://doi.org/10.1002/eco.2382

Telewski F. W. (2016) Flexure Wood: Mechanical stress induced secondary xylem formation, in Secondary Xylem Biology https://doi.org/10.1016/C2014-0-01292-0.

Major Comment 4:

With respect to the analyses, I find it difficult to follow your conclusions, too. E.g. the average temperature appears to compare the timeseries March 2019-Oct 2020 (Lux) with the timeseries Jan 2021-Oct 2021 (It). Hence the population of the variables are neither aligned to hydrological years nor to the same period. Does this cause the differences you work out in the averages and maybe even in your distributions/statistical tests? Are the slightly higher midlope sap velocities in the Weierbach catchment consistent in both years and across the active flow field (not just a matter of the sampled fraction)? What are effects of the data subset and what are really things we can attribute to the physical/physiological reality?

We understand that with this comment you are referring to Figure 2. This figure is intended to provide an overview of the environmental variables recorded in the Weierbach and the Lecciona catchment. As you have pointed out, they correspond to not-overlapping time windows. It's important to note, however, that the analyses in the study (such as Table 2, Fig. 3, Fig. 6, Fig. 7, Fig. A2) are focused on the growing season: 1 April- 31 October, cf. Material and Methods section. Focusing ecohydrological studies and plant physiological studies on the growing season and *not on the hydrological year is common practice (e.g.,Tsuruta et al., 2023, Gaines et al., 2015). For this reason, we can exclude the effect of data length on our analyses and interpretations.*

Gaines, K. P., Stanley, J. W., Meinzer, F. C., McCulloh, K. A., Woodruff, D. R., Chen, W., et al. (2016). Reliance on shallow soil water in a mixed-hardwood forest in central Pennsylvania. Tree Physiology, 36(4), 444–458. https://doi.org/10.1093/treephys/tpv113

Tsuruta, K., Kwon, H., Law, B. E., & Kume, T. (2023). Relationship between stem diameter and whole-tree transpiration across young, mature and old-growth ponderosa pine forests under wet and dry soil conditions. Ecohydrology, (February). https://doi.org/10.1002/eco.2572

Major Comment 5:

I suggest to revise the manuscript to really work out its biggest strengths: The combined data for the different ecohydrological state dynamics and isotope rations. I suspect that a slightly more detailed analysis can hold so much more interesting results which avoid most of the issues pointed out above. This should also help to clearly differentiate this manuscript from its 2021 predecessor. Further, I suggest to revise the title, since water use strategies would in my view require even more detailed physiology-related data and analyses.

Even if you disagree with my suggestion, I think that the manuscript can substantially gain from a much more intense and well-structured argumentation about the relationships between REW (relative extractable water), VPD (vapour pressure deficit), sap velocity and isotopic characteristics. All these aspects are largely lacking in your introduction. When they appear in the methods section, they are described without much context and interrelation. In the end, the paper appears to be quite lengthy for few simple mixed effects models with different time series and with the rather broad conceptual sketch in the end. I doubt that this was your intended takeaway.

I will attach my handwritten comments to your paper as pdf (simply due to time-constraints, please accept my apologies). I did not note much to the discussion and conclusions since I suppose that they will be largely reworked anyways. I sincerely hope that you will receive my suggestions as constructive remarks helping to advance your manuscript. I can only repeat my sincere regards for your work and I really think that it deserves to be presented in a more rigorously worked out and condensed manner.

All the best.

Conrad

Fabiani, G., Schoppach, R., Penna, D., and Klaus, J.: Transpiration patterns and water use strategies of beech and oak trees along a hillslope, Ecohydrology, 15, https://doi.org/10.1002/eco.2382, 2022.

Jackisch, C., Knoblauch, S., Blume, T., Zehe, E., and Hassler, S. K.: Estimates of tree root water uptake from soil moisture profile dynamics, Biogeosciences Discuss, 2019, 1–25, https://doi.org/10.5194/bg-2019-466, 2019.

Novick, K. A., Ficklin, D. L., Baldocchi, D., Davis, K. J., Ghezzehei, T. A., Konings, A. G., MacBean, N., Raoult, N., Scott, R. L., Shi, Y., Sulman, B. N., and Wood, J. D.: Confronting the water potential information gap, Nat Geosci, 15, 158–164, https://doi.org/10.1038/s41561-022-00909-2, 2022.

Rakovec, O., Samaniego, L., Hari, V., Markonis, Y., Moravec, V., Thober, S., Hanel, M., and Kumar, R.: The 2018–2020 Multi-Year Drought Sets a New Benchmark in Europe, Earth's Future, 10, https://doi.org/10.1029/2021ef002394, 2022.

Renner, M., Hassler, S. K., Blume, T., Weiler, M., Hildebrandt, A., Guderle, M., Schymanski, S. J., and Kleidon, A.: Dominant controls of transpiration along a hillslope transect inferred from ecohydrological measurements and thermodynamic limits, Hydrol. Earth Syst. Sci., 20, 2063–2083, https://doi.org/10.5194/hess-20-2063-2016, 2016.

We thank you for your constructive feedback. We reworked the manuscript to address the weak points of the discussion, provided a more detailed explanation of our methodology in the introduction, and we proposed an adjusted title. We also divided the Discussion into two sections to enhance the readability. Regarding the conceptualization of the study sites (Fig. 9), for the Weierbach catchment this aligns with extensive literature from the site, the Lecciona catchment represents a novel perspective, being the first study conducted in that location.

The new proposed title is: "The influence of hillslope topography on beech water use: a comparative study in two different climates"

Minor comments:

Abstract

L1: Replace "interaction" with "interrelation"
We agree, we replaced "interaction" with "interrelation" (LL 1 Abstract, and 27 Introduction).

L17: "tree performances" improper wording
We replaced "performance" with "responses" (LL 17 Abstract, LL 441 Conclusions).

Introduction

L23: tree species performance
We replaced "performance" with "responses" (LL 17 Abstract, LL 441 Conclusions).

L24: "The severity of water limitation is variable in space, time, and among domains of the hydrological cycle (Klaus et al., 2022; Tijdeman et al., 2022), and is expected to affect tree species performance not only at the limits but also at the centre of their distribution range (Parmesan, 2006)". How does this relate to the citation? Why "performance"? What Is the measure?
Performance may encompass various aspects, such as photosynthetic performance, tree-water interaction performance, growth and reproductive performance. We agree that the wording "performance" is too generic. We modified the sentence as follows (LL 22-25):
"Water availability is variable in space, time, and among domains of the hydrological cycle (i.e. atmosphere, belowground, surface water) (Klaus et al., 2022; Tijdeman et al., 2022), and changes in water availability are expected to affect the distribution of tree species based on their ecophysiological adaptations to varying water conditions (Hahm et al., 2018)."

Hahm, W. J., W. E. Dietrich, and T. E. Dawson. 2018. Controls on the distribution and resilience of Quercus garryana: ecophysiological evidence of oak's water-limitation tolerance. Ecosphere 9(5):e02218. 0.1002/ecs2.2218

L25: "fine spatial resolution". What is fine?
We modified as follows (LL 25-27): "Multiple studies that investigated the effect of reduced water availability on forest vulnerability have neglected plot-scale landscape heterogeneity, even though soil properties and topography are important abiotic factors for forest health (Schwantes et al.,2018)."

L28: "Belowground properties determine the water flow patterns along a hillslope (Dunne et al., 1975; Jencso et al., 2009; Xiao et al., 2021.." What makes these studies good citations for the argument?
We modified the references list with more suited references (Klaus and Jackson 2018; Xiao et al., 2021). These studies link the hillslope structure (topography, shape, permeability variation) to hydrological connectivity within the landscape.

The sentence is modified as follows (LL 28-30): "Belowground properties determine the water flow patterns along a hillslope (Klaus and Jackson, 2018; Xiao et al., 2021) resulting in different water availabilities in the subsurface, one of the main drivers of tree productivity (Hogg et al., 2008)."

L51: "Inter-annual meteorological variability represents … decadal timescales (Grossiord et al., 2017a; McDowell et al., 2008)." Move after line 49.

We followed this suggestion and moved this section below (LL 50-54).

L69: "We combined sap velocity and isotope measures" Why isotopes?
We clarified the significance of combining the two methods to test our hypotheses and to answer our research questions. We added as follows (LL 75-76): "While sap velocity measurements allow a continuous assessment of the tree's physiologic response to environmental drivers, stable isotopes of xylem water offer insights into the origin of the water utilized."

L73: "in the Mediterranean site, the physiological activity of beech trees is more constrained compared to the stand growing in the Luxembourgish site" because?
We clarified this sentence as follows (LL 76-79): We hypothesize that (i) the physiological response of beech trees varies as a function of topography-driven changes in water availability, (ii) at the Mediterranean site, characterized by an uneven precipitation regime and high summer evaporative demand, the physiological activity of beech trees is more constrained compared to the stand growing at the Luxembourgish site.

Materials and methods

L88: "Volumetric soil moisture was measured at the plateau". The Weierbach plateau is not that pronounced, and it flaws your argument → drop → uphill transect

We disagree with this statement. The characterization of a plateau in the Weierbach catchment was initially introduced by Martínez-Carreras et al. (2016) through a geomorphological and subsurface structures analysis using the description of six drillings within the catchment. The authors defined the plateau as the area with slopes <5°. Other studies carried out in the catchment refer to the plateau area (Hissler et al., 2021; Pfister et al., 2010; Rodriguez and Klaus, 2019, Fabiani et al., 2022). In Fabiani et al. (2022) and in this manuscript, we relied on a slightly adapted version, using the mean slope or the mean of the topographic position index. It is evident from the conceptual figure (Fig. 9), where the terrain profile of the Weierbach catchment has been extracted from the digital terrain model, the presence of a break in the steepness in the upper location.

We would like to highlight that the study conducted by Renner et al. (2016) took place in a different location within the Weierbach catchment compared to our study, where a plateau is largely absent.

Hissler, C., Martinez-Carreras, N., Barnich, F., Gourdol, L., Iffly, J. F., Juilleret, J., Klaus, J., and Pfister, L.: The Weierbach experimental catchment in Luxembourg: A decade of critical zone monitoring in a temperate forest - from hydrological investigations to ecohydrological perspectives, Hydrological Processes, 35, 1–7, https://doi.org/10.1002/hyp.14140, 2021.

Martínez-Carreras, N., Hissler, C., Gourdol, L., Klaus, J., Juilleret, J., Iffly, J. F., & Pfister, L. (2016). Storage controls on the generation of double peak hydrographs in a forested headwater catchment. Journal of Hydrology, 543, 255–269.

Pfister, L., McDonnell, J.J., Hissler, C. and Hoffmann, L. (2010). Ground-based thermal imagery as a simple, practical tool for mapping saturated area connectivity and dynamics. Hydrological. Processes 24, 3123–3132 (2010).

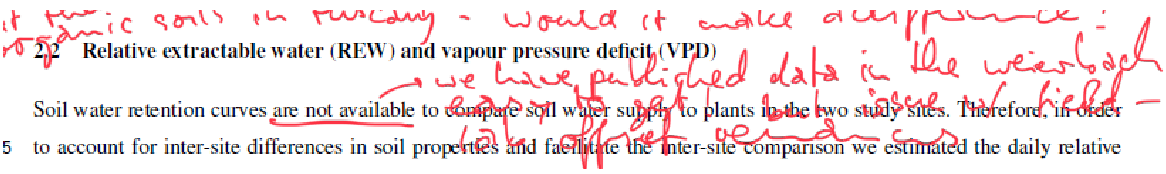
Rodriguez, N. B. and Klaus, J. (2019). Catchment travel times from composite StorAge Selection functions representing the superposition of streamflow generation processes. Water Resources Research, 55, 9292–9314.

L94: "We selected a north-facing hillslope transect ranging from 940 to 970 m a.s.l." Why did so many properties not aligned?
Please refer to the response to Major Comment 3.

L106: "TEROS 10, Meter Group"
This is the name of the sensor we deployed (https://www.metergroup.com/en/meter-environment/products/teros-10-soil-moisture-sensor).

L107: "The standard calibration for organic soils recommended by the manufacturer was applied". Why organic soil? I doubt that there are organic soils in Tuscany. Would it make a difference?
Thank you for pointing this out, this was indeed a mistake as a standard calibration was applied. "We applied a standard calibration for soils suggested by the manufacturer (reported precision: 0.03 m^3/m^3)."

L114: "Soil water retention curves are not available to compare soil water supply". We have published data in the Weierbach. Easy to get! But issue with offset. Soil offset


2.2 Relative extractable water (REW) and vapour pressure deficit (VPD)

Soil water retention curves are not available to compare soil water supply to plants in the two study sites. Therefore, in order to account for inter-site differences in soil properties and facilitate the inter-site comparison we estimated the daily relative

We are uncertain about understanding the handwriting. In our study, we relied on the Relative Extractable Water (REW) index to facilitate the cross-site comparison. REW has been successfully employed to account for inter-site differences in soil properties and absolute soil moisture levels (Salomon et al., 2022, Granier et al., 2007). We removed that sentence and added the cited studies in the revised version of the manuscript as follows (LL 136): "REW has been quantified in previous studies to characterize soil drought intensity (Bréda et al., 2006; Grossiord et al., 2017b) and to carry out inter-site comparison (Salomón et al., 2022b; Granier et al., 2007)."

Granier, A., Reichstein, M., Bréda, N., Janssens, I. A., Falge, E., Ciais, P., et al. (2007). Evidence for soil water control on carbon and water dynamics in European forests during the extremely dry year: 2003. Agricultural and Forest Meteorology, 143(1–2), 123–145. https://doi.org/10.1016/j.agrformet.2006.12.004

Salomón, R. L., Peters, R. L., Zweifel, R., Sass-Klaassen, U. G. W., Stegehuis, A. I., Smiljanic, M., et al. (2022). The 2018 European heatwave led to stem dehydration but not to consistent growth reductions in forests. Nature Communications, 13(1), 28. https://doi.org/10.1038/s41467-021-27579-9

Equation 1: super sensitive to sensors.
The sensors deployed (cs650, https://www.campbellsci.com/cs650*) have an accuracy of ±3% and have been in place since 2013, which ensures the reliability of the recording and a proper soil contact for accurate readings.*

L119: "REW varies between 0 (i.e., permanent wilting point)" Is it really?
We agree with your comment, we rephrased as follows (LL 133): "REW varies between 0 and 1 and represents the ratio between available soil water and maximum extractable water."

L124: "REW is generally quantified to characterize soil drought intensity (Breda et al., 2006; Grossiord et al., 2017b)." Check last citation: which citation for the topic/in general study, but not really an argument for the method.
We are unsure if we understood the comment correctly; we modified the sentence as follows (LL 136): "REW has been quantified in previous studies to characterize soil drought intensity (Breda et al., 2006; Grossiord et al., 2017)."

L125: VPD formula: Missing citation and units! Magnus Eq for e* in Kpa. As metereologic version of the Clausius-Clapeyron eq.
Thank you for pointing this out, we added the unit of measurement (VPD, KPa).

L136. "In the Weierbach catchment, we positioned the sap flow sensors at the north-east side of the trunk at 1.3 m height. In the Lecciona catchment, the sensors were installed on the west side to avoid installing in tension wood, which is grown by hardwood species on steep slopes." Important points, but why not selected both south facing? Makes it so difficult to compare.
Please refer to response to Major Comment #3.

Fig.1 Still not plateau in the Lecciona?
The Lecciona catchment is characterized by a marked V-shape morphology (you can view a video of the site https://www.youtube.com/watch?v=afwcXENZA0g). *The hilltop location is in the proximity of the catchment ridgeline (Fig. R1) and thus no plateau. The hillslope topography can also be seen in Fig. 9.*

L144: "We filled the data gaps due to power malfunctioning via linear interpolation with sensors at the same location (Table A1, Fig.A1)." Needed? What for?

We filled the data gaps with linear interpolation to prevent potential biases that might arise from sample size and ensure a robust dataset for our statistical tests. Specifics regarding time-window data gaps are outlined in Table A1, presenting R2 and p-values for each interpolation. Given the robust correlation coefficients observed, we could fill the data gaps with a reasonable approximation of the missing values.

L188: "We applied linear mixed effects models (LMEM) with lme4 package" So no time series related analysis? Is this clever? Might be dominated by overall range and flashiness

In our study, we conducted a time series-related analysis by implementing a linear mixed effects model for each month monitored during the growing season. We believe that this analysis suits our study case as allows us to evaluate the combined effect of environmental variables (VPD, REW, and radiation W) and topographic positions on sap velocity over the course of the growing season.

L196. The Pairwise Wilcox" and "non-parametrics Mann-Whitney" What is the difference?

Thank you for pointing this out. We will replace Kruskal Wallis test with pairwise Wilcox test because the Pairwise Wilcox test function was used to test the significant difference between group levels after having used Kruskal.test function.

L219: "The Lecciona catchment in 2021 was characterized by a higher average temperature compared to the Weierbach catchment (Table 2) but a similar precipitation amount." Fig.2 data does not really look like this. Is this an effect of the short time series? 2 months in winter are missing!

Thank you for pointing out, with that sentence we were referring to the growing season only (as presented in Table 2), therefore the missing data for the winter month do not affect this observation. We made this clear in the revised version of this manuscript as follows (LL 236-238):

"In the Lecciona catchment, the 2021 growing season was characterized by a higher average temperature compared to the Weierbach catchment (Table 2) but with a similar precipitation amount."

Fig.4 Title "Weierbach" and "Lecciona" are missing.

Thank you for pointing this out, we added the site name to the figure (Fig. R3).

Fig. 5 Legend is missing

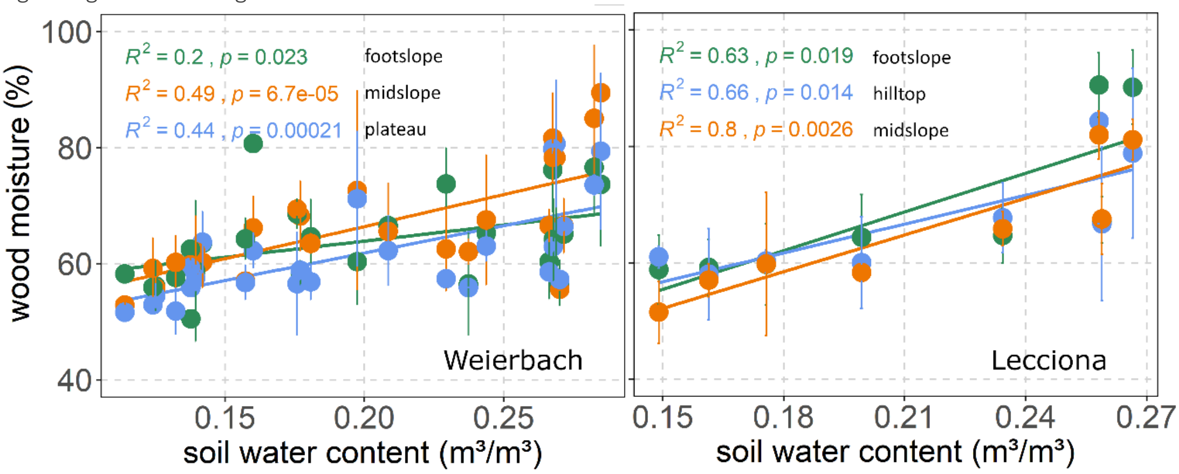


Fig. R3: Fig.4. Relationship between wood moisture content (%) and volumetric soil moisture content of the xylem sampling date in the Weierbach catchment (left side) and the Lecciona catchment (right side).

Fig.5 Legend is missing.

We believe the legend is unnecessary for this figure, as the boxplot color code informs about the location where sap velocity is recorded.

Fig.8 No overlap between soil and xylem water.

We have also addressed this topic in the Response to reviewer #2. As mentioned in the Discussion, the mismatch between xylem water and its potential water source is a common occurrence rather than an exception regardless of the extraction method or analyzer deployed (Barbeta et al., 2019; Poca et al., 2019; de la Casa et al., 2022; Schreel et al., 2023). Many tentative and non-exclusive explanations have been proposed in the literature, such as fractionation during root water uptake, xylem isotopic heterogeneities, and cryogenic water extraction biases (Li et al., 2024). However, no ubiquitous explanations have been confirmed.

Barbeta, A., Jones, S. P., Clave, L., Wingate, L., Gimeno, T. E., Frejaville, B., Wohl, S., and Ogee, J.: Unexplained hydrogen isotope offsets complicate the identification and quantification of tree water sources in a riparian forest, Hydrology and Earth System Sciences, 23, 2129–2146, https://doi.org/10.5194/hess-23-2129-2019, 2019.

de la Casa, J., Barbeta, A., Rodriguez-Una, A., Wingate, L., Ogee, J., and Gimeno, T. E.: Isotopic offsets between bulk plant water and its sources are larger in cool and wet environments, Hydrology and Earth System Sciences, 26, 4125–4146, https://doi.org/10.5194/hess-26-4125-2022, 2022.

Li, Y., Song, X., Wang, L., Sprenger, M., Ma, Y.: Quantitative contribution of cryogenic vacuum extraction and radial water transport to xylem-source water deuterium offsets, Agricultural and Forest Meteorology, 345, 2024, 109837, https://doi.org/10.1016/j.agrformet.2023.109837.

Poca, M., Coomans, O., Urcelay, C., Zeballos, S. R., Bode, S., and Boeckx, P.: Isotope fractionation during root water uptake by Acacia caven is enhanced by arbuscular mycorrhizas, Plant and Soil, 441, 485–497, https://doi.org/10.1007/s11104-019-04139-1, 2019.

Schreel, J. D. M., Steppe, K., Roddy, A. B., and Poca, M.: Does back-flow of leaf water introduce a discrepancy in plant water source tracing through stable isotopes ?, Hydrology and Earth System Sciences, pp. 1–20, https://doi.org/doi.org/10.5194/hess-2023-13, 2023.

The Referees' comments are given in regular font style, and the authors' responses are in blue and italics.

Response to the interactive comment of Anonymous Referee #2

General comments

This manuscript presents an interesting comparative study for water use strategies of beech trees along two climatically and topographically differing hillslope transects. It is accompanied by two extensive data sets encompassing sap velocities and stable water isotopic signatures of precipitation, soil- and xylem water.

Overall, the paper is well written its storyline is coherent. However, before I can recommend the paper for final acceptance, there are some points that should be addressed.

Dear Referee #2,

thank you for appreciating the manuscript. We are grateful for the points you made to improve the quality of our work, which we addressed more specifically in the following responses and in the revised version of this manuscript.

Minor comments:

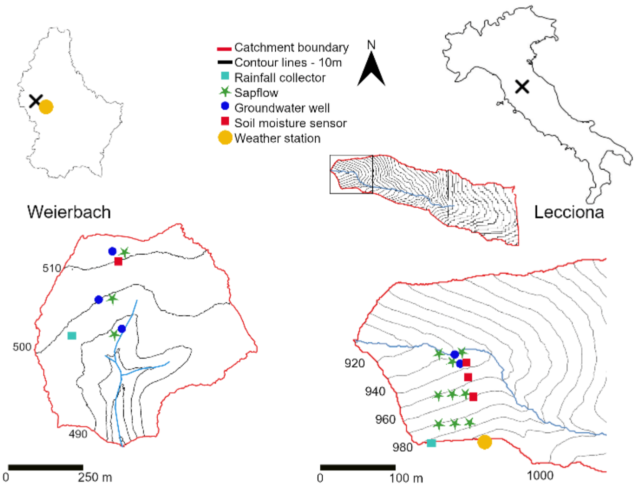
line 95: Are you talking of a species "space oak"? Then please provide a scientific name, because I'm unable to find anything by that name. Or is "space" used as an adjective? Then please rephrase before other people also start looking for "space oak".
Thank you for pointing out the typo. We replaced "space" with "sparse".

line 97: Could you provide a scientific name for those "Scotch broom bushes"?
We added the scientific name (L: 107): "Cytisus scoparius L.*"*

line 137: Could you also add the information at which xylem depths the two measurement points of your SFM1 sensors ended up after the installation?
We added this information as follows (LL: 147-149): "The selected trees were equipped with heat pulse sap flow sensors (SFM1, ICT International Pty Ltd., Australia), which record sap velocity at distances of 12.5 and 27.5 mm from the bark."

Fig. 1: It would be nice to see both countries within the same overview map, which should also include a scale bar.
In case one overview map for both countries does not seem feasible to you, you should at least add scale bars to both countries' outlines.
Thank you for this suggestion. We revised the figure adding an overview map of Europe and scale bars to the countries (Fig. R1).

old figure



new figure

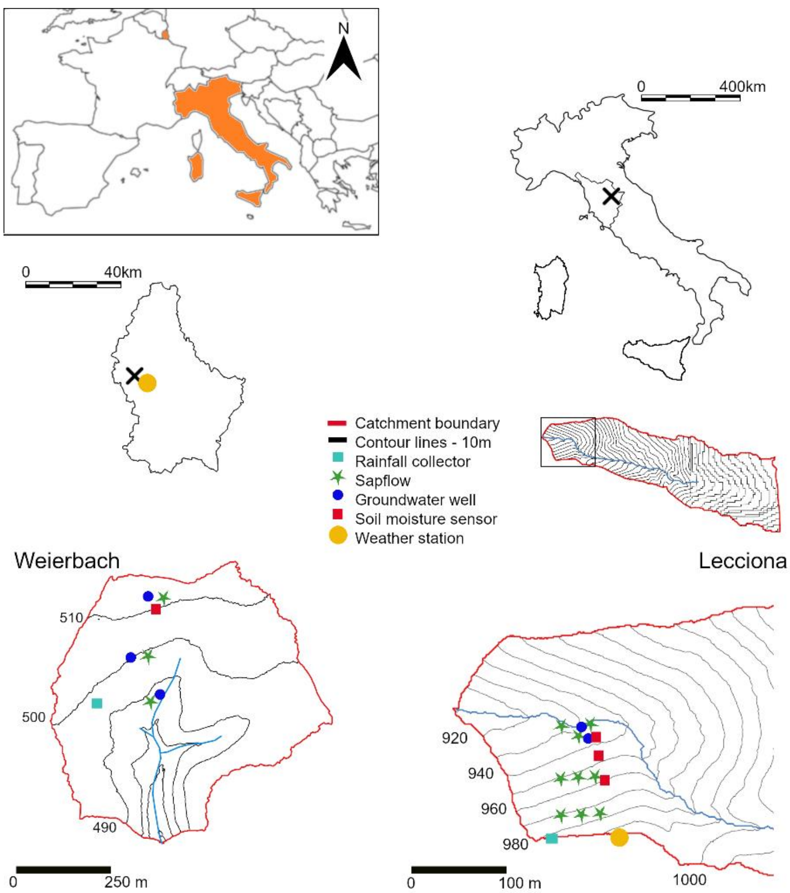


Fig R1: Fig. 1. Sites overview with sensors in place: on the left the Weierbach catchment, Luxembourg, and on the right the Lecciona catchment.

line 143: As far as I know, the wounding correction causes a linear scaling of the original measurements.

This is correct, given our utilization of a fixed correction factor of 0.13 cm (Green et al., 2003). It is important to account for it as the mechanical damage disrupts the water flow in the xylem. While a more accurate direct measurement of wound size from each instrument installation would improve the accuracy, it necessitates a destructive sampling from the tree after the experiment.

Green, S., Clothier, B., and Jardine, B.: Theory and Practical Application of Heat Pulse to Measure Sap Flow, Agronomy Journal, 95, 1371–1379, https://doi.org/10.2134/agronj2003.1371, 2003

In Section 2.6 you normalize all sap velocities. So this step here seems superfluous...
We are unsure to have understood this comment. We normalized sap velocities to compare their response to environmental controls (i.e., VPD and REW) across locations and the two study sites. However, statistical analyses were conducted using the non-normalized data.

line 149: How exactly did you determine the sapwood-hardwood boundary? For beech that should not be so obvious. Or ist it?
In Fabiani2022a you wrote that "Beech tends to develop HW only after decades [...];thus, we sampled cores for beech with an average length of 7 cm which was split into two, representative for outer and inner SW."
Assuming we are talking about the same sampling campaign, does that mean, that you simply treated the outer 3.5 cm as the relevant outer sapwood and ignored the rest of your cores?
Indeed, in certain species like beech, distinguishing between sapwood and hardwood on a macroscopic level can be difficult unless a species-specific dye, such as Methyl Orange, is applied. To overcome this obstacle, we specifically sampled the outer ca. 3.5 cm of xylem in both sites. This approach ensures the sampling of the external sapwood, where the majority of the water flow occurs.

We specified it as follows (LL 167-169): "Tree cores encompassing only the sapwood (ca. the outer 3.5 cm of xylem) were collected around the stem circumference with a Pressler borer. We avoided sampling above or below previous cores to minimize possible disturbances in sampled trees due to prior wounding."

line 179: Previously you said, that the bags already have been heat sealed. How did you inflate the previously heat sealed bags?
We clarified this as follows (LL 198-199): "We inflated the bags with dry air by piercing the hardened silicon blots, and we let them equilibrate for 48h at a constant temperature for isothermal equilibration."

line 194: How did you determine the daily mean velocity of one tree if your sensors are giving you values for outer and inner xylem? According to Fabiani2022b you averaged the two values - I think you should also mention that somewhere in this paper.
Thank you for pointing this out. We specified this as follows (LL: 158-160): "We averaged sap velocities measured at an hourly basis by the inner and outer thermistor, and then we calculated a daily mean sap velocity, which is used as a proxy of tree transpiration (Smith and Allen, 1996)."

line 204: I suppose you are talking about precipitation, but I would suggest to actually state that here.
Thanks, we rephrased it as follows (LL: 328-330): "According to our results, a lower availability of soil water in the Weierbach catchment in the 2020 growing season compared to the 2019 growing season - which also marked the lowest recorded in the past eight years - did not lead to a stronger sensitivity (i.e. stronger stomatal control and therefore reduced sap velocity) of tree water use to topography (Fig. A2)."

line 214: Your method section does not mention how you determined wood moisture content - where do those values come from?
Thank you for pointing this out. We specified this as follows (LL: 182-190): "We assessed the gravimetric water content for xylem samples by weighing them before and after cryogenic water extraction. We quantified the wood moisture content (%) as the ratio of the weight of extracted water (liquid mass) to the weight of dry wood after cryogenic water extraction (Peck, 1953; Steppe et al., 2010; Fabiani et al., 2022)."

Peck, E. C. (1953). The sap of moisture in wood. U.S Dept. Agr. For. Serv. For. Prod. Lab. Rpt. No. U.S. Dept. Agric. For. Service, For. Orid., Kab.).

Steppe, K., De Pauw, D. J. W., Doody, T. M., & Teskey, R. O. (2010). A comparison of sap flux density using thermal dissipation, heat pulse velocity and heat field deformation methods. Agricultural and Forest Meteorology, 150(7–8), 1046–1056. https://doi.org/10.1016/j.agrformet.2010.04.004

Fabiani, G., Penna, D., Barbeta, A., & Klaus, J. (2022). Sapwood and heartwood are not isolated compartments: Consequences for isotope ecohydrology. Ecohydrology, 0–2. https://doi.org/10.1002/eco.2478

Fig. 2: Please add the respective years to your x-axes.

As suggested, we added the years to the x-axis (see below Fig. R2)

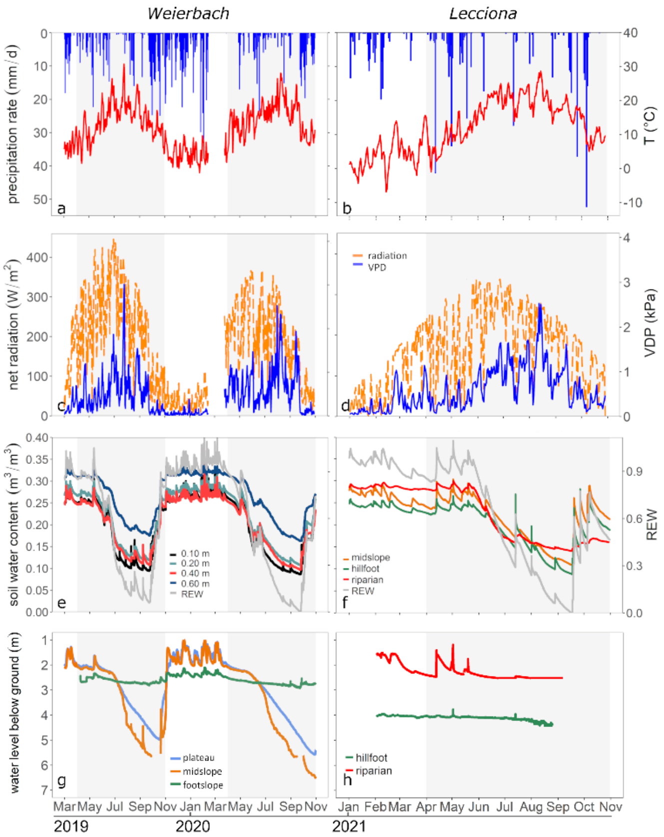
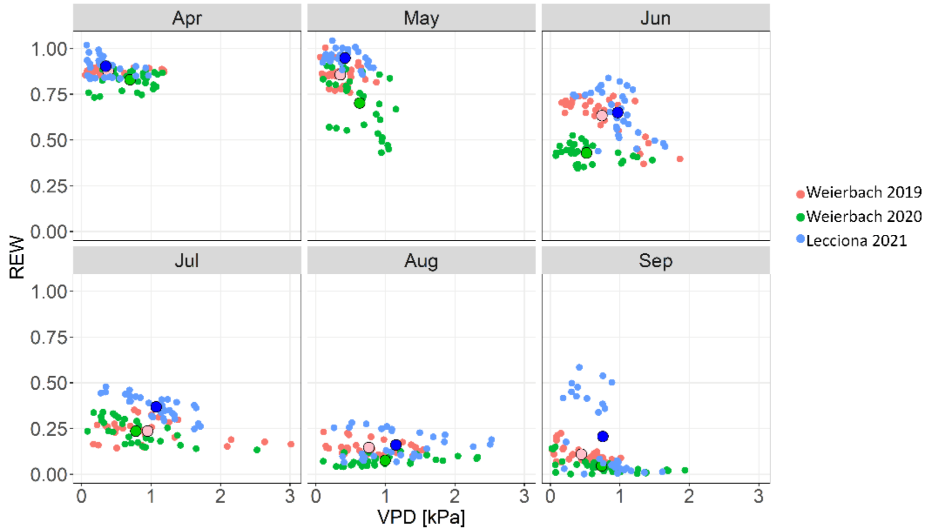


Fig. R2: Fig. 2. Daily total precipitation amount (mm/d) and daily mean air temperature (°C), and daily mean radiation (W/m2) and daily mean vapour pressure deficit (VPD) (kPa) observed at the Roodt (left plots, a, and c) weather station and the Lecciona catchment (right plots, b and d). Volumetric soil water content (m3/m3) and REW (relative extractable water) in the Weierbach (e) and the Lecciona catchment (f). Soil moisture in the Weierbach catchment was measured at four depths in the plateau location. In the Lecciona catchment, soil moisture was recorded in three topographic positions at two depths, which are averaged in the plot. Groundwater level below ground surface (m) in the Weierbach (g) and the Lecciona catchment (h). The shaded area represents the growing season.

Fig. 3: Instead of using three colors that are very similar to your location color codes, I would suggest to introduce a new color coding for Weierbach2019, Weierbach2020 and Lecciona2021 (e.g. light purple, dark purple and yellow).

We updated the color code for Weierbach 2019, Weierbach 2020 and Lecciona 2021 in red, blue, and yellow, respectively (Fig.R3). We opted for this palette because is color-blind friendly.

old figure



new figure

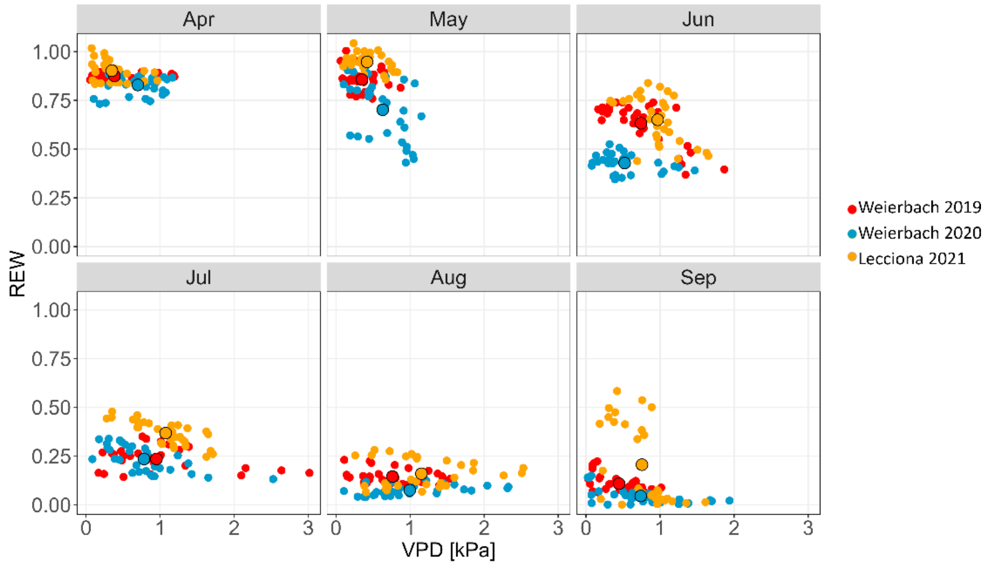


Fig. R3: Fig3. Old (upper plot) and updated figure (lower plot). Relationship between VPD (kPa) and REW over the growing season (2019-2020) in the Weierbach catchment and (2021) in the Lecciona catchment. Full dots with black outlines represent monthly means.

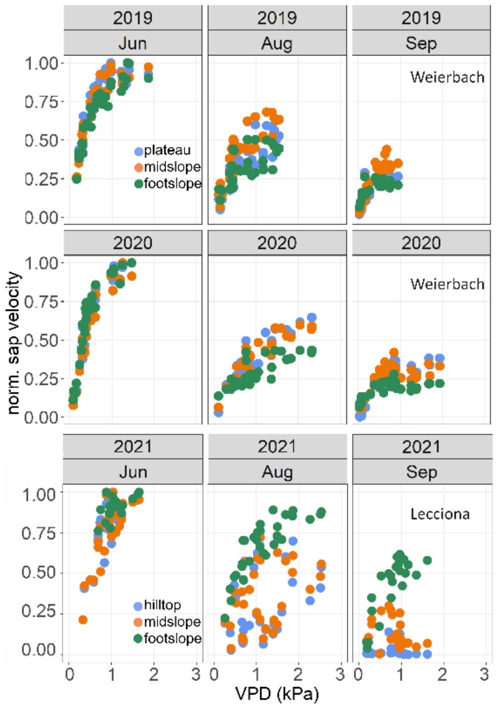
Fig. 5: In line 131 you said that there was only one tree per location at the Weierbach catchment. So where does your "average deviation between trees at the same location" in this figure come from?

We agree that this was not clear. We clarified this in the caption (Fig. 5) as follows: “Daily mean sap velocity (cm h^{-1}) of Weierbach (a) and Lecciona (b) trees. In this figure, the Weierbach catchment data were averaged between the 2019 and 2020 growing seasons) while data from the Lecciona catchment cover the 2021 growing season. The area inside the colored lines is the mean average deviation among trees at the same location for the Lecciona catchment and between monitored years for the Weierbach catchment.”

Fig. 6: The current combination of subfigure headers is a bit awkward. I would suggest to have the three months as column headers once at the very top row of your figure. Then each subfigure could have a color coded header (see my suggestion for Fig.3) to indicate Weierbach2019, Weierbach2021 and Lecciona2021.

We agree that the previous headers were confusing. Following your suggestions, we have modified the figure by using months’ names as column headers and years’ names as row headers (Fig. R4, see below). We have chosen not to change the color of the headers to avoid too many colors.

old figure *new figure*



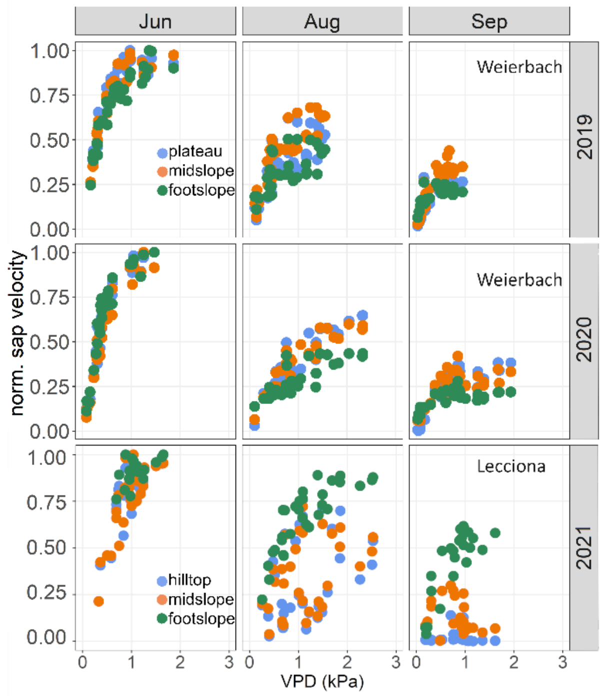


Fig. R4: Fig.6. (left side: old figure, right side: new figure): Figure 6: Relationship between normalised mean sap velocity and daily vapour pressure deficit (VPD) (kPa) at different hillslope positions in June, August, and September 2019 and 2020 in the Weierbach catchment and 2021 in the Lecciona catchment.

Fig. 7: In this Figure, the 2019 above all figure columns is just wrong, since the second row surely refers to 2020 and the third to 2021. I would suggets to follow my hints to Fig. 6. Generally, I think that Fig.6 and Fig.7 take more space in the main part of the paper than they should. Please consider moving one of them to the appendix. *Following your suggestions, we have modified the figure by using months' names as column headers and years' names as row headers (Fig. R5, see below).*

old figure *new figure*

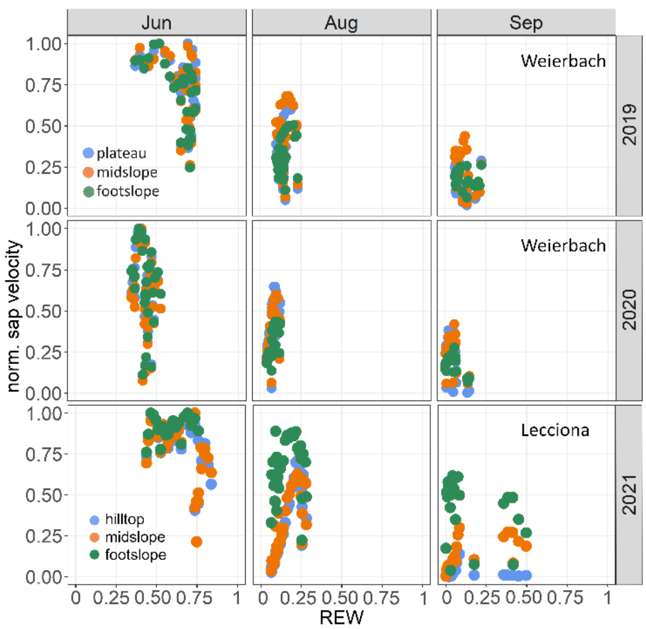


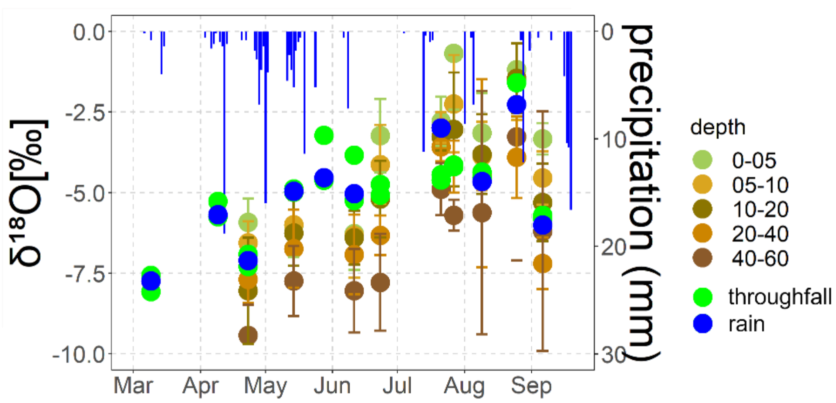
Fig. R5: Fig. 7. (left side: old figure, right side: new figure): Fig. 7: Relationship between normalised mean sap velocity and relative extractable water (REW) at different hillslope positions in June, August, and September of 2019 and 2020 in the Weierbach catchment and 2021 in the Lecciona catchment.

line 292: Since all soil water signatures in Fig.8 are displayed in the same color it is impossible to see that there.
We agree, we changed the sentence as follows (LL 308): "Soil water in Lecciona showed a marked depth gradient (data not shown)".

line 293: I would expect to find heavier summer precipitation somewhere along the "upper right" part of the LMWL but not above it. Can you rule out any issues with the soil water isotope measurements? Or could there be an issue with the data basis of your LMWL? Where (coordinates, elevation), when (time period, sampling intervals) and how (type of sampler, measures against evaporation) were the isotopic signatures of precipitation measured? All that might be crucial information for future users of your impressive data sets.
We thoroughly investigated potential reasons for this pattern. In the Lecciona catchment, the site specific LMWL is "relatively" recent with precipitation water samples collected only since April 2018 on at least a monthly basis using an evaporation minimized-collector. The location of the collector is depicted in Fig.1, and we have now referenced this to make this clearer in the manuscript: "We sampled groundwater at the sampling areas in the Weierbach catchment and rainfall bi-weekly with an evaporation-protected rainfall collector (Palmex Ltd.) placed in a clearing at both sites (Fig 1).". Considering the high reliability of the Palmex collector in preventing evaporation, we can confidently rule out potential issue related to the rainfall sampling procedure.
As shown in Fig. R6, the soil isotopic composition closely tracked the isotopic composition of precipitation, with shallower classes reflecting the isotopic composition of the antecedent precipitation event. However, toward the middle of the growing season when little precipitation occurred, the precipitation isotopic composition started to be closer to the deeper soil layers. We speculated that the low water content in the soil sampled might have impacted the direct vapour equilibration analyses; however the water vapour concentrations during the analyses were above 28000 ppm, which ensures reliable performance of the analysis.
We also considered the potential impact of microbial activity, which might have developed during the shipping from Italy to Luxembourg. However, the CH_4 values detected during the Picarro analyses - which typically indicate contamination or microbial activity - were comparable to those of the standard samples.

We did not identify any alternative interpretation. As a precautionary measure, we will explicitly mention in the manuscript that these samples should be looked at critically.

LL310-316: "Although we followed standard protocol for this analysis and soil isotopic composition tracked the isotopic composition of precipitation, potential artefacts in the direct vapour equilibration method may have influenced these results. During the analyses, water vapour concentrations were above 28000 ppm and no methane was detected as an indication of potential microbial activity, both factors should ensure a reliable performance of the analysis (Gralher et al., 2021). However, we cannot exclude that shipping and storing procedures may have influenced the isotopic composition of soil samples."



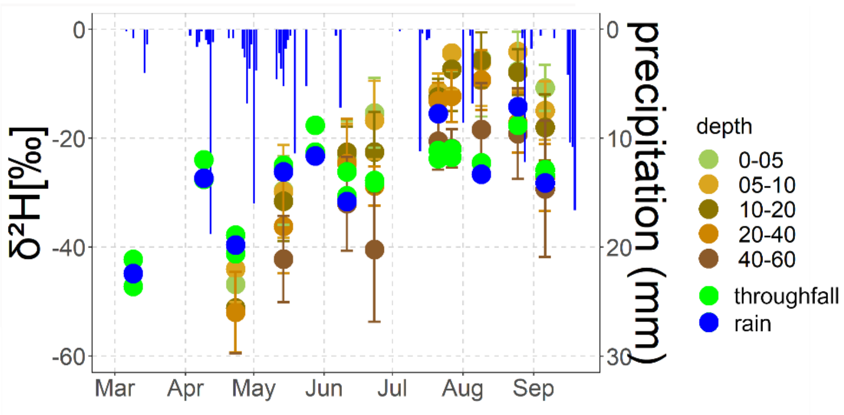
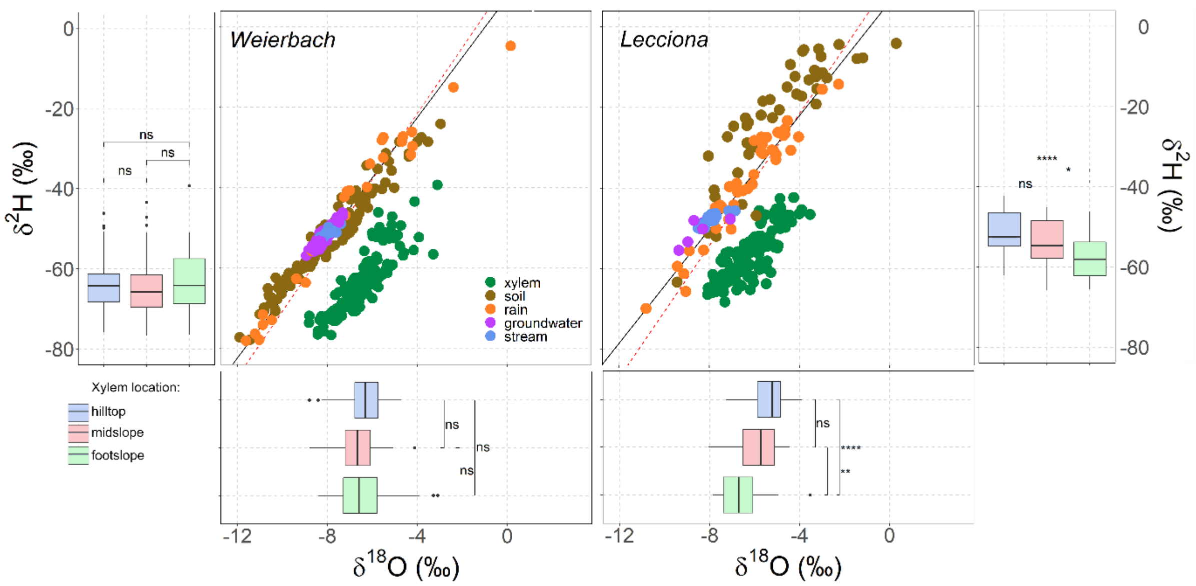


Fig. R6: Isotopic composition of soil water, rain, and throughfall for each sampling campaign across the growing season. Data of soil depth were averaged. Solid dots represent the mean; the whiskers indicate the confidence interval (95%).

Fig. 8: In this figure, you are using different colors for your three topographic locations than in the previous figures. Instead, rain and xylem are occupying your midslope and footslope colors. Please consider to harmonize your use of colors across all figures. This will facilitate a more intuitive understanding of your visualizations.

We agree with this comment. We harmonized the color code of this figure (Fig. R7) with that of previous figures (Fig. 4, 5, 6, 7).

Old figure



New figure

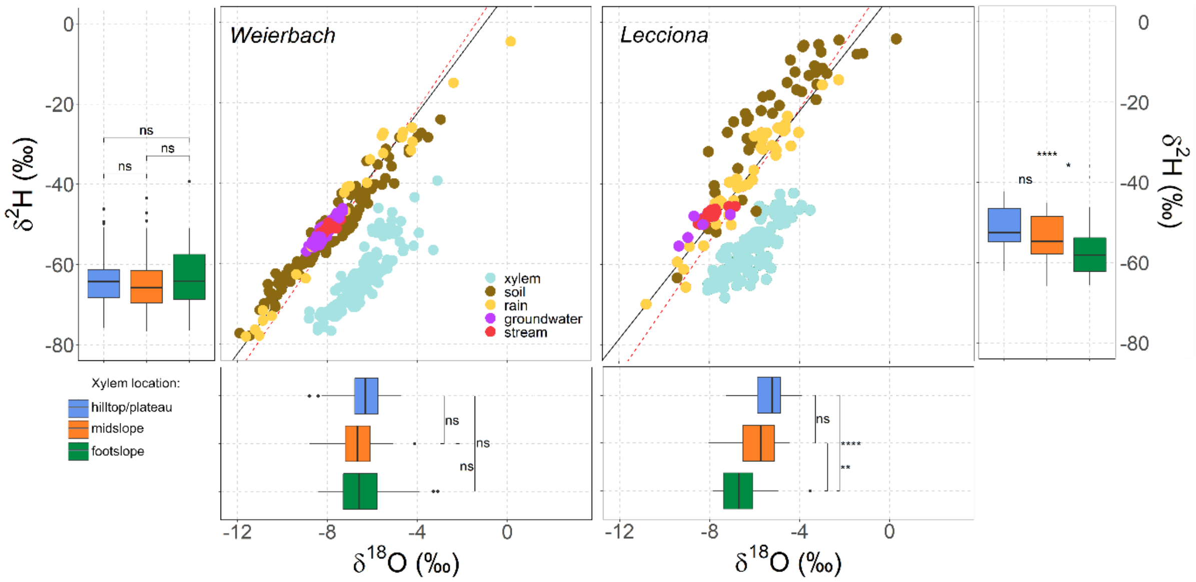


Fig. R7: Old (upper plot) and updated figure (lower plot). Dual isotope plots showing soil water, rain, groundwater, stream, and xylem water isotopic composition sampled in the Weierbach catchment (left panel) and the Lecciona catchment (right panel).

line 317: Now that you brought the topic up: Are there any observations available of what happend in 2021 in the Weierbach catchment?

In 2021, the field activities were focused on the Lecciona catchment (Italy); unfortunately, this means we were not on site in the Weierbach and do not have specific on-site observations of phenological evolution in the Weierbach catchment (Luxembourg).

line 319: I guess you meant to talk about "lateral subsurface flow" (flow is missing)
Thank you for spotting this, we have modified accordingly as follows (LL 341-344): "Consistent with previous observations at the study site for 2019 (Fabiani et al., 2022b), the high vertical hydraulic conductivity in the Weierbach catchment (Glaser et al., 2016; Gourdol et al., 2021) does not promote shallow lateral subsurface flow from the plateau to the footslope (Fig. 9)."

line 357: Did you account for different levels of solar radiation, when you diagnosed an incomplete recovery of sap velocities after rainfall in September?
Following our analysis, solar radiation was positively associated with an increase in sap velocity at all locations (Fig. A2). However, trees at the hilltop displayed lower sap velocities compared to other locations. We calculated the total insolation (direct and diffuse) using SAGA GIS analysis for the time span from September 1, 2021, to September 31, 2021, where negligible differences in total insolation were detected across the investigated hillslope (fig. R7). SAGA GIS incoming solar radiation analysis is based on the solar constant and geographic location.

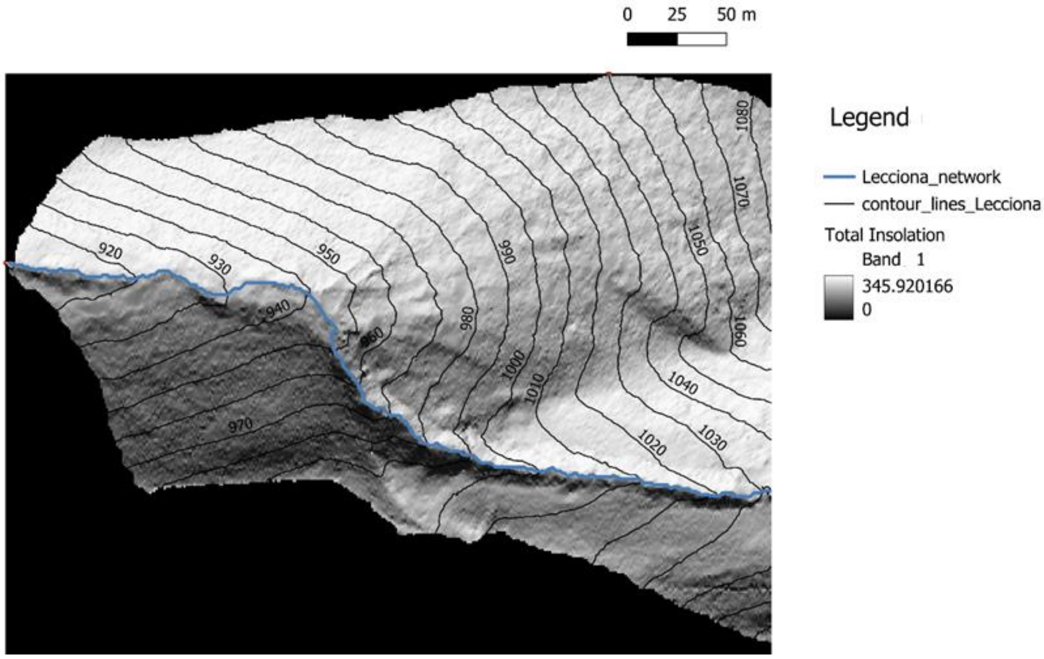


Fig R8: Total insolation (direct and diffuse radiation KWh/m^2) along the hillslope from 01 September 2021 to 31 September 2021.

line 367-396: The trees might be adapted to capitalize water sources from different soil depths (or other potential sources) and in case these sources have distinct isotopic signatures, the isotopic signatures of xylem water may be evidence for that adaption. But a specific adaption "to capitalize water sources with different isotopic composition" seems quite unlikely to me...

We agree that this wording was misleading. We rephrased as follows:

"The statistical difference in xylem isotopic composition between locations observed in the Lecciona but not in the Weierbach catchment (Fig. 8) might suggest that trees capitalize on different water sources with contrasting isotopic compositions to adapt to spatial changes in water availability."

line 375: Could contrasting measurement techniques for soil and xylem water isotopic signatures be a reason for that mismatch?

We understand your concern. While we cannot rule out the possibility that the method employed may have influenced the isotopic composition of our samples, we followed well-established procedures from the literature. Please note that the mismatch between xylem water and its potential water source is a common occurrence rather than an exception regardless of the extraction method or analyzer deployed (Barbeta et al., 2019; Poca et al., 2019; de la Casa et al., 2022; Schreel et al., 2023). Many tentative and non-exclusive explanations have been proposed in the literature, such as fractionation during root water uptake, xylem isotopic heterogeneities, cryogenic water extraction biases (Li et al., 2024). However, no ubiquitous explanations have been confirmed.

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de la Casa, J., Barbeta, A., Rodriguez-Una, A., Wingate, L., Ogee, J., and Gimeno, T. E.: Isotopic offsets between bulk plant water and its sources are larger in cool and wet environments, Hydrology and Earth System Sciences, 26, 4125–4146, https://doi.org/10.5194/hess-26-4125-2022, 2022.

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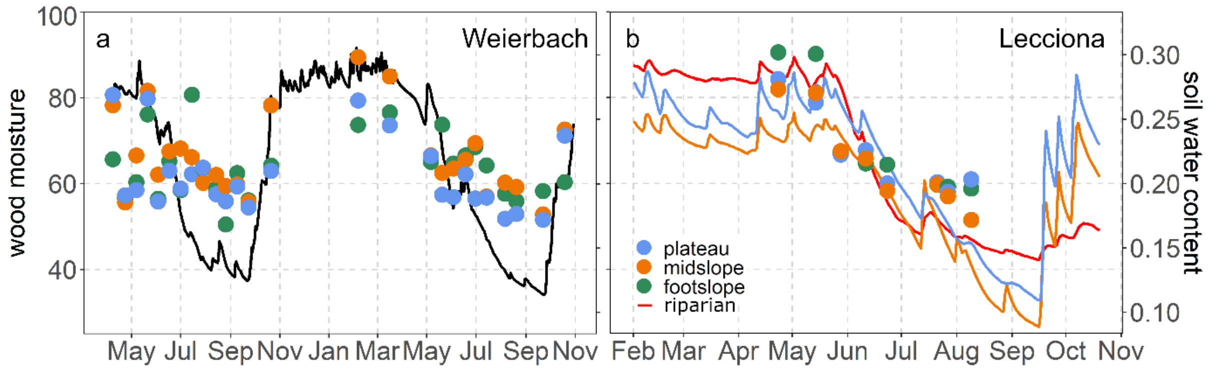
Schreel, J. D. M., Steppe, K., Roddy, A. B., and Poca, M.: Does back-flow of leaf water introduce a discrepancy in plant water source tracing through stable isotopes ?, Hydrology and Earth System Sciences, pp. 1–20, https://doi.org/doi.org/10.5194/hess-2023-13, 2023.

Fig. A2: This doesn't have to be a figure. A table might be more efficient to convey the displayed information.
We tried to present the results in a table, but we found that the Figure was more visually effective.

Fig. A3: Why are you showing one average over all soil moisture measurements for the Weierbach, but location averages for the Lecciona catchment? Once again, where do your wood mositure contents come from? If you derived them from your xylem cores - why don't they have confidence intervals like your xylem water isotopic measurements?. Also: I think the left y-axis label is clipped (i-dot and the top of the d seem to be missing).
We improved the visualization and fixed the Figure below (Fig R9). We added the confidence interval for both plots, and we displayed the average soil moisture content between locations in the Lecciona catchment. In the Weierbach catchment, we had soil moisture recorded in the plateau location only.

old figure



new figure

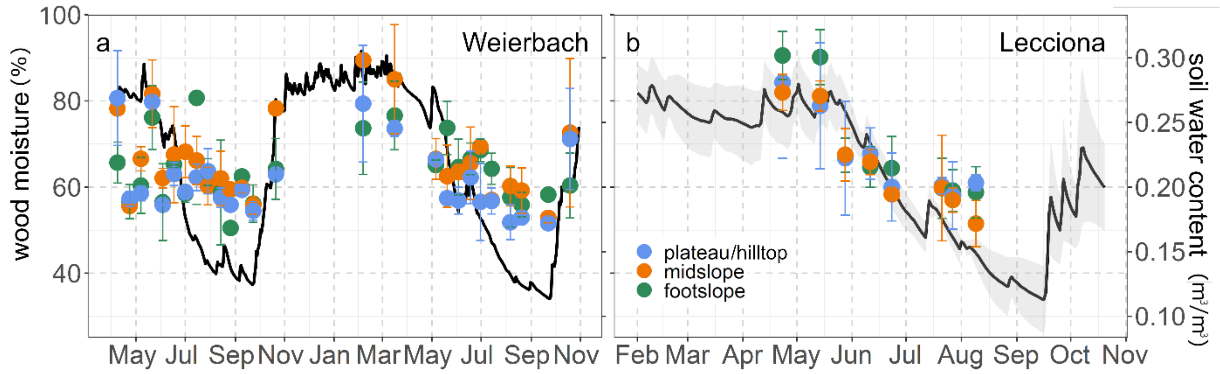


Fig. R9: Fig. A3. Temporal pattern of wood moisture content (%) and volumetric soil moisture content in the Weierbach catchment (a) and in the Lecciona catchment (b). Solid dots represent the mean, the whiskers indicate the confidence interval (95%). In the Weierbach catchment we used the average soil moisture content over the four depths, while in the Lecciona catchment, we used the average soil moisture.

Fig. AA & A5: The symbol sizes between the two Figures vary unexplicably. Have you considerd to merge the two figures with two subfigures each into one with four subfigures? Personally, I find those time series more intersting than Fig.7 or even Fig. 8. in the main section of the paper. Maybe you can swap them with one of them?

We combined the two figures resulting in Fig. A4 with the temporal pattern of oxygen and Fig. A5 with the temporal pattern of hydrogen.

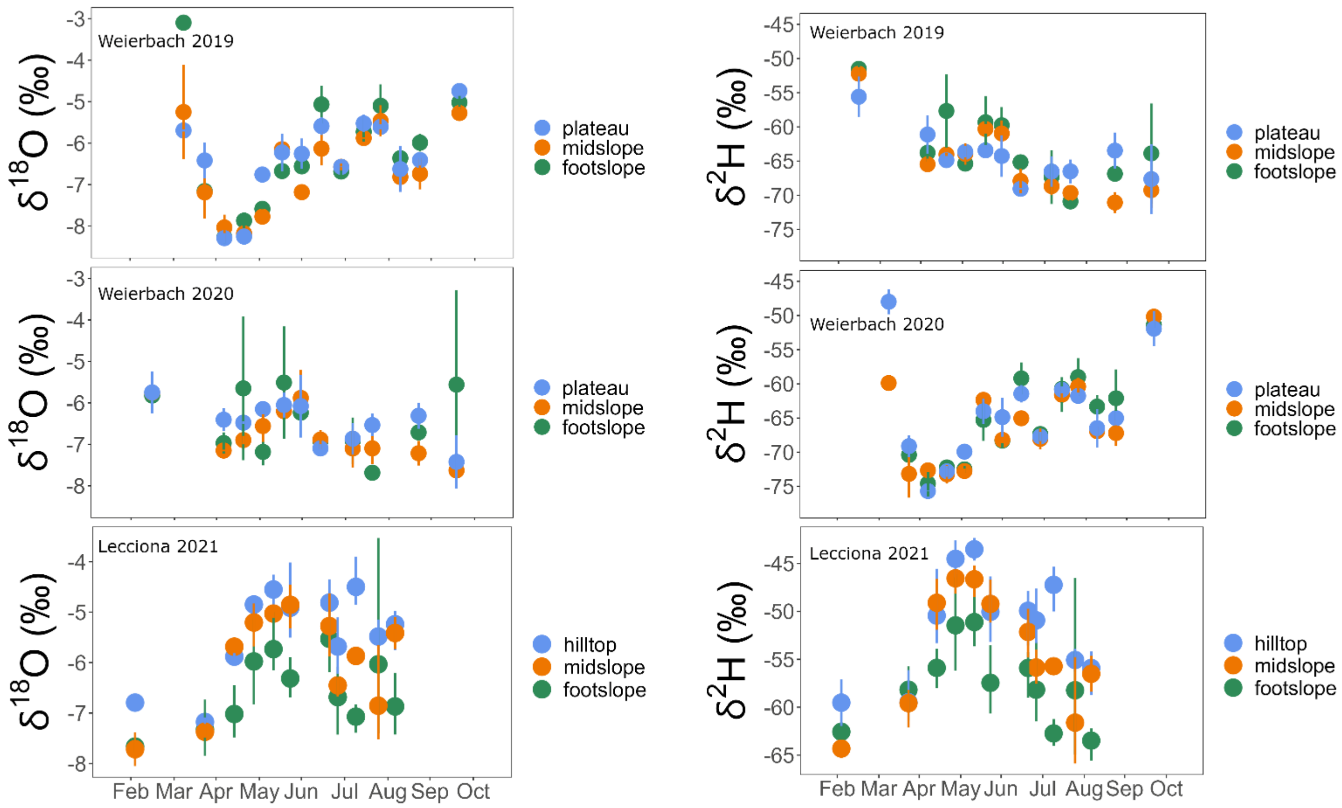


Fig. R10: Figure A4 and A5 display the isotopic composition of xylem water for each sampling campaign across 2019 and 2020 growing season in the Weierbach and 2021 in the Lecciona catchment. Data were averaged by location. Solid dots represent the mean, the whiskers indicate the confidence interval (95%).