Response Letter:

Reviewer(s)' Comments to Author:
Reviewer: 1
Comments to the Author

MS#: hess-2023-91

Title: Root water uptake patterns are controlled by tree species interactions and soil water variability

It has been a pleasure reading through this contribution. This research underlines the lack of research on how throughfall patterns influence root water uptake patterns. The authors propose to close this knowledge gap by examining the role of throughfall patterns, soil water variability, soil properties, and biotic factors on root water uptake patterns using a statistical model.

We would like to thank the reviewer for finding our contribution valuable and for enjoying reading our manuscript.

I will organize my comments following the structure, per section, of the manuscript.

INTRODUCTION

The introduction provides a detailed background on below-canopy precipitation, specifically focusing on throughfall. It covers previous research about throughfall, its spatial distribution, and its impact on soil moisture patterns.

1. Line 62: Consider rephrasing the phrase "Previously proposed explanations" to "Previous studies have suggested". This would be more direct.

Thanks, the sentence will be rephrased.

2. Line 86: The term "water scarcity" is introduced without any context or explanation. A brief explanation or definition would enhance understanding. In fact, this is the only part of the manuscript where "water scarcity" is mentioned.

We agree that "water scarcity" was used vaguely. Here, we meant that the term refers to lack of soil water during drought, which is what the cited studies refer to as well. We will revise the sentence.

MATERIALS AND METHODS

The Materials and Methods section is well-written. Some areas that could be improved to make it clearer and easier to understand follow:

1. Line 174: Provide units for variables, such as λ (latent heat of vaporization).

Thanks for the reminder, the units and the constant variables will be provided.

2. Line 196-197: Elaborate why only 56 sensor locations provided high-quality data, and why only 34 of these provided data for root water uptake estimation. What qualifies as 'high-quality data'?

We agree that this section needs further explanation and will revise the sentences accordingly. Here, the high-quality data refers to the data that have passed the quality control (Section 2.3.1), which means that the soil water content data (6 min time intervals) are flagged and cleaned of artificial jumps and drops, or duplicate time stamps of different values, long discontinuities in the measurements, and lack of temporal variation in the time series despite rain events. During the throughfall sampling period among all sensors, only 56 sensors provided data that could be used after identification and removal of the errors within the data. The number of sensors decreased to 34 because only these sensors provided data within the dry periods when the root water uptake method can be applied to both soil layers at the same time interval.

3. Linear Mixed Effects Model: Explain the terminology used (like 'random effects', 'fixed effects') for readers unfamiliar with these statistical methods.

We will add new informative sentences to the section for explaining the terminology.

4. Linear Mixed Effects Model: Add a few sentences as justification or rationale for including each of the factor (fixed and random) and their interactions (for fixed) in the model. The reader may be able to identify the rationale by referring to the texts in Introduction. But it pays to be redundant in the Methods so that it is clear to the reader which factors were included, and more importantly 'why'.

Agreed, we will elaborate on the rationale for including interaction terms by describing that in a linear mixed effects model, the relationship between the dependent variable and one predictor, as it depends on the level of another predictor, can be represented by the interaction term. Thus, the fixed effects interaction terms represent the combined effect of the interacting predictors on the dependent variable.

DISCUSSION

This discussion section is generally well-written, but there are some areas for improvement to enhance clarity and readability:

1. Structure and Organization: The text is divided into several subtopics, which makes it easier to follow. However, it could benefit from a clearer outline or roadmap at the start of the discussion section that provides an overview of what will be discussed.

We will adopt the suggestion and add a general summary of the findings - a roadmap for discussion - at the beginning of the section.

2. Data Presentation: Some results are mentioned without an explicit description of how they were obtained. For example, in lines 477 to 479, the authors state they found that bulk density of the monitored soil layer did not affect local water uptake, but there is no explanation of how this conclusion was reached. Providing a more detailed explanation would enhance the credibility of the findings.

Thank you for pointing this out, and we agree that a more detailed explanation would be necessary to remind the reader of the finding before discussing it and providing final arguments. We will revise the discussion subsections that lack explicit description accordingly.

3. Clearer takeaways: The section could benefit from more direct conclusions or 'takeaway' after discussing each main point. For instance, after discussing the influence of tree species richness on root water uptake patterns (lines 504 to 533), a one-sentence conclusion summarizing the main takeaway could be beneficial.

Thank you for the suggestion. we agree and we will include a conclusion/takeaway statement in the sub-section. Moreover, we will adopt the same strategy in the other sub-sections if the take home message of the section is not clearly stated.

Hypotheses and Expectations: It might be useful to explicitly state the original hypotheses or expectations before explaining how the results confirm or contradict them. This can provide the reader with a clearer understanding of the study's purpose and significance. Perhaps, these hypotheses can be explicitly stated towards the end of Introduction. The authors can then 'revisit' these hypotheses in Discussion following their presentation of results.

We see the benefit of stating hypotheses to guide the reader; however, we believe that stating research questions and hypotheses at the same time may lead to repetition and would be a slightly different writing style compared to the current version of the manuscript. In the current version, we have structured the results and discussion sections of the manuscript according to the explicitly stated research questions. We have discussed our results in light of the expectations based on the previous studies (e.g., L416, L467, L477). In addition, the reviewer's previous comments will help to revise the manuscript to clarify the communication of the purpose and significance of the study. Yet as the reviewer sees a need to state hypotheses, we may add hypotheses at the end of the Introduction and revisit them in the general section of the Discussion.

5. Broader context of the literature. This study appeared broadly consistent with the finding of Knighton, Singh, Evaristo (2019, DOI: 10.1029/2019GL085937), which showed that monoculture catchments dense with trees reliant on shallow soil water exhibited reduced transpiration losses compared to deep-rooted and mixed-species forests. It is an important confirmation to make considering that this study is based purely on a statistical framework whilst that of Knighton et al. (2019) was based on the Budyko framework.

Thank you for drawing our attention to this catchment scale study. The authors studied 139 catchments. It enriches and highlights our findings, which emphasize the complex interplay between tree species diversity, complementary mechanisms, and water uptake patterns, and is consistent not only with the plot-scale studies listed above, but also with the larger-scale studies.

6. Broader context of the literature. Demir et al. may find use in placing their finding within the larger context of the topic (root water uptake studies) that used other techniques, particularly stable H and O isotopes in water. That is, the hours-long timescales used in this study for estimating transpiration losses are orders of magnitude shorter than what stable isotopes would show. See, for example, the study by Evaristo et al. (2019, DOI: 10.1029/2018WR023265), which showed that transpiration water was between 17 and 62 days. How do the timescales of Demir et al. (and their findings) compare and contrast to the timescales (and findings) of studies using tracers? A few sentences that place Demir et al. within the larger context of the topic would be useful for future researchers to recognize.

Thank you for the suggestion, which will definitely help to put our findings in a broader context, we will take it into account when revising the manuscript. With our study, we cannot estimate the exact travel time (or time scale) for water transport to the deeper layer to the ground water and water transpiration through trees: However, our findings are in line with Evaristo et al.(2019) and ecohydrological separation phenomenon such that our finding support that throughfall inputs are rapidly transported into deep layers with preferential flow paths while transpiration is mainly driven by water remained in the soil which in result pose to longer residency time. In other words, our study suggests that the main source for transpiration is the water remaining in the soil with a longer residence time which concurs with the previous studies suggest that water is taken up by trees from soil matrix storage while ground water recharge is fed by active water storage – preferential flow or due to local soil structure (e.g, Evaristo et al., 2019; Sprenger et al., 2019). We will clearly incorporate this statement in the subsection 4.2