

We are sincerely grateful to the reviewer for your positive assessment and the constructive suggestions provided. In accordance with their guidance, we have carefully revised the manuscript point-by-point and addressed other related issues identified during our review. The specific modifications made in response to each comment are detailed as follows.

1. The statements of the two scientific hypotheses in the abstract and introduction are slightly different. It is recommended to ensure that the statements of the two scientific hypotheses are completely consistent throughout the entire text (abstract, introduction, and discussion).

Reply: We sincerely appreciate your careful review and valuable suggestions. Upon careful examination, we have identified inconsistencies in the statement of the research questions between the Abstract and the Introduction. To enhance the logical coherence and academic rigor of the manuscript, we have revised the relevant statements in accordance with the exploratory nature of this study.

This research is inherently exploratory, aiming to reveal how rock fissure water regulates root-zone water replenishment in plants with different rooting depths in the epikarst of karst regions, and how this subsequently influences the seasonal variation in plant transpiration water age. It does not seek to test a priori statistical hypotheses. Accordingly, we have replaced the term "scientific hypothesis" with "research objectives," which more accurately reflects the study's orientation and avoids potential misinterpretation regarding hypothesis testing.

The revised research objectives are as follows:

(i) How does rock fissure water regulate the dynamics of root-zone water replenishment in plants with different rooting depths within the epikarst? (ii) How does the seasonal variation in root-zone water replenishment further influence plant transpiration water age?

Accordingly, we have revised the Introduction and Discussion sections to ensure consistency with these research objectives. Furthermore, we recognize that the previously proposed "interaction between rock fissures and plant roots" was overly broad and lacked sufficient empirical support. This recognition further motivated our decision to reframe the "scientific hypotheses" as more focused "research objectives."

2. L47: The core indicator "transpiration water age" was directly used, but it was not defined and its ecological hydrological significance was not explained in the introduction. Before introducing the research question, define "transpiration water age" in 1-2 sentences and point out: "Understanding transpiration water age is crucial for revealing whether plants utilize current precipitation or stored 'old water' to cope with environmental changes, and it is the key to analyzing the temporal dimension of plant water use."

Reply: Thank you for your suggestion. We have incorporated the revision into the Introduction as follows: "The transport and retention of root-zone water not only determine whether plants can utilize current precipitation or rely on stored 'old water' in response to environmental changes, but also serve as a key to understanding the temporal dimension of plant water use. Therefore, an in-depth understanding of the dynamics of root-zone water replenishment and transpiration water age—defined as the residence time of water within the vegetation root zone—is of great significance for revealing how vegetation responds to hydroclimatic disturbances."

3. L99-101: The statement of Hypothesis (i) is slightly long and the expression "exploring water sources" is ambiguous. It is recommended to refine and strengthen it: make the hypothesis more direct and testable.

Reply: Thank you for your valuable suggestion. Based on the feedback from all reviewers, we concluded that the original scientific hypotheses were not well-founded.

The revised research objectives are as follows:

(i) How does rock fissure water regulate the dynamics of root-zone water replenishment in plants with different rooting depths within the epikars?

(ii) How does the seasonal variation in root-zone water replenishment further influence plant transpiration water age?

4. L232: Why is "root zone water storage" equated to "rock fissure water" to calculate the recharge rate β ? This deviates from the traditional application of the PIB method in soil-dominated systems. Suggestion: Add a theoretical argument at the beginning of Section 2.4 or in the methods section.

Reply: We sincerely appreciate your raising this critical question, which provides us with an opportunity to further clarify the theoretical rationale for the methodological

adaptation in this study. We fully agree that clearly defining the connotation of "root-zone water storage" and providing a theoretical justification for its difference from traditional PIB applications are essential to ensuring the reliability of our research conclusions.

First, the traditional Piecewise Isotope Balance (PIB) method was indeed developed in soil-dominated ecohydrological studies (Luo et al., 2019, 2022), with the implicit assumption that soil water constitutes the primary component of plant root-zone water storage and that precipitation replenishes root-zone moisture through soil infiltration. However, the hydrogeological structure of our study area—located in the karst plateau gorge of Southwest China—exhibits significant specificity: the combination of shallow soils (with an average thickness of only 26 cm in the study area) and a well-developed epikarst forms a typical "rock–soil" dual structure. In this habitat, the effective root zone of plants extends far beyond the physical confines of the soil layer, penetrating deep into the rock fissure network. Therefore, equating "root-zone water storage" solely with soil water would severely underestimate the actual water sources available to plants and fail to accurately characterize the unique root-zone hydrological processes in karst regions.

Second, geological drilling and endoscopic observations reveal that plant roots are densely distributed within rock fissures at depths of 1.8–3.2 m below the surface, where they are in direct contact with fissure water, indicating that the fissure network is an active zone for root activity. Using stable isotope tracing, we found that rock fissure water is an important water source for plants (Liu et al., 2025), a quantitative result that confirms fissure water as the main source sustaining plant transpiration. Furthermore, Electrical Resistivity Tomography (ERT) inversions show significant low-resistivity anomalies beneath the plants, indicating deep water storage bodies with high moisture content. These "reservoirs" are located below the soil layer and correspond to the spatial position of the rock fissure network, providing a structural basis for deep plant water uptake.

Finally, this method has been successfully applied and validated in karst regions, fully demonstrating its scientific validity and applicability under such complex hydrogeological conditions. Such as Luo, Z., Nie, Y., Ding, Y., Chen, H.: Replenishment and mean residence time of root-zone water for woody plants growing on rocky outcrops in a subtropical karst critical zone, *J. Hydrol*, 603, 127136, 2021. Luo, Z., Nie, Y., Zhang, J., Wang, F., Liu, W., Zhuang, D., Chen, H.: Subsurface

structure-induced water use strategies mediate shrub-herb coexistence in soil-limited hillslopes, *Plant Soil*, 1-19, 2025.

Reference: Liu, X., Chen, X., Zhang, Z., Liu, W., Gao, F., Cheng, Q., Peng, T.: The role of rock fractures as a water source for trees growing in karst, *Water Resour. Res.*, 61(11), e2024WR039588, 2025.

5. Some paragraphs read like "data recitation" and fail to highlight the main contradictions. In Section 3.2 of the original text: "The $\delta^2\text{H}$ of deep-rooted and shallow-rooted tree xylem water ranged from -65.9‰ to -57.6‰ and $\delta^{18}\text{O}$ from -8.5‰ to -6.8‰ in the rainy season; in the dry season, they were -59.7‰ to -52.9‰ and -7.3‰ to -5.7‰ respectively."

Reply: We are very grateful to the reviewers for their valuable comments. We have carefully considered the wording of Section 3.2 in the original manuscript and acknowledge that it did indeed present a problem of 'listing data' without 'clarifying its significance'. We have therefore made the necessary revisions.

Namely: During the study period, the hydrogen and oxygen isotopic compositions of various water pools and their seasonal variation characteristics were analyzed. As shown in Figure 5, all water pools exhibited the pattern of isotopic depletion in the rainy season and isotopic enrichment in the dry season. The precipitation-weighted isotopic values of rainwater were $\delta^2\text{H}$: -68.5‰ and $\delta^{18}\text{O}$: -8.6‰ in the rainy season, and were significantly enriched in the dry season ($\delta^2\text{H}$: 15.0‰ , $\delta^{18}\text{O}$: -3.8‰). In the rainy season, the $\delta^2\text{H}$ of xylem water in deep-rooted trees ranged from -86.2‰ to -48.7‰ , and $\delta^{18}\text{O}$ ranged from -10.8‰ to -5.1‰ ; for shallow-rooted trees, $\delta^2\text{H}$ ranged from -92.3‰ to -43.4‰ , and $\delta^{18}\text{O}$ ranged from -12.0‰ to -4.7‰ . In the dry season, these values were $\delta^2\text{H}$: -59.7‰ to -52.9‰ and $\delta^{18}\text{O}$: -7.3‰ to -5.7‰ , respectively. Soil water exhibited the largest isotopic fluctuation ($\text{SD} = 19$), with $\delta^2\text{H}$ ranging from -96.5‰ to -35.7‰ and $\delta^{18}\text{O}$ ranging from -11.7‰ to -4.2‰ . Fissure-filled soil water had $\delta^2\text{H}$ ranging from -82.4‰ to -47.4‰ and $\delta^{18}\text{O}$ ranging from -10.7‰ to -6.7‰ . Rock fissure water showed $\delta^2\text{H}$ ranging from -75.5‰ to -56.4‰ and $\delta^{18}\text{O}$ ranging from -9.6‰ to -5.7‰ . Spring water exhibited $\delta^2\text{H}$ ranging from -80‰ to -49.1‰ and $\delta^{18}\text{O}$ ranging from -11.2‰ to -6.9‰ .

6. The results section contains too much explanatory content. For example, in Section 3.3, "Overall, the hydrological connectivity of deep-rooted trees in the rainy season was lower than that of shallow-rooted trees, while the opposite was true in the dry season, which may be related to the depth of the plant roots and the water utilization strategies." It is recommended to strictly distinguish between "results" and "discussion". The results section should objectively state the discovered data and phenomena, while moving all explanations, comparisons, and mechanism analyses to the discussion section. This will make the manuscript structure clearer and the argument more powerful.

Reply: Thank you very much for this important comment. We fully agree that in academic writing, the "Results" and "Discussion" sections should be strictly separated. The original manuscript indeed had the problem of mixing explanatory content into the Results section, which affected the clarity of the article structure and the rigor of the argumentation. To address this, we have systematically reviewed and revised the entire Results section.

7. Lack of clear statistical information. It is recommended to specify the statistical test methods: indicate in the methods section or figure captions what statistical tests were used (e.g., one-way ANOVA with Tukey's HSD post hoc test).

Reply: Thank you for pointing that out; we have now included it in the methodology section.

Namely: To test the differences in root-zone water replenishment and transpiration water age among plants with different rooting depths and across seasons, a one-way analysis of variance (ANOVA) was used for significance testing. This analysis was performed using IBM SPSS Statistics 26 (IBM Inc., Armonk, NY, USA) at a significance level of $p > 0.05$. In the text, "SD" stands for Standard Deviation, which is used to measure the dispersion of data relative to the mean. All charts and visualizations were generated using Origin 2021 (Origin Software Inc., Fairview, TX, USA).

8. L385: What does "hydrological disconnection" mean?

Reply: Thank you for your question. "Hydrological disconnection" refers to the lack of effective hydraulic connectivity between precipitation or surface water and the root-

zone water storage available to plants on specific temporal or spatial scales, resulting in the inability of water to be replenished in a timely manner to the layer where plant roots absorb water.

9. L454-472: The author's speculation and description of root depth in this paragraph are too rough and the logic is confusing. It is suggested to further clarify the context and present a clearer expression.

Reply: Thank you very much for this important comment. We will now reorganise and rephrase the relevant content to ensure that it is presented to readers in the clearest and most logical manner possible.

10. L522-529: "However, within the context of climate change—particularly in regions with limited water storage capacity like karst areas—this "old water" sustains transpiration during dry seasons, thereby creating a critical survival window for plants to await subsequent precipitation recharge." The discussion about "old water" and the vulnerability of the ecosystem needs to be balanced.

Reply: Thank you very much for this insightful comment. We have carefully reconsidered the relevant statements in the original manuscript and acknowledge that the discussion was indeed not sufficiently balanced. However, we believe this statement is appropriate. Given the unique habitat and the "dual" hydrological structure of the study area, precipitation can hardly remain on the surface for extended periods. Therefore, in karst regions, "old water" indeed provides the necessary transpirational water for plants to survive drought stress. At the same time, we will maintain a dialectical perspective to avoid overemphasizing the role of "old water."

11. At the end of the discussion, there is no strong review and confirmation of whether the two scientific hypotheses have been verified. It is suggested to add a summary paragraph: In Section 4.3, it is clearly stated: "The results of this study fully support the two scientific hypotheses initially proposed. ... " 。 This jointly proves that the interaction between rock fissures and root depth is a regulatory factor for the water utilization of karst plants...

Reply: Thank you very much for this important comment. We have carefully reflected on the concluding part of the original manuscript and acknowledge that there was indeed an issue. This may prevent readers from clearly understanding what questions the study has answered and what conclusions have been drawn after reading the full text. However, since we have revised the "scientific hypotheses" in the manuscript (changed to "research objectives"), we will add a dedicated summary paragraph at the beginning of Section 4.3 (Research Contributions, Limitations, and Prospects) in the revised manuscript. This paragraph will explicitly revisit the two research objectives proposed in the introduction and systematically elaborate on how this study has addressed them.

12. L557-560: The manuscript mentions that the study area is dominated by rocks (with a soil thickness of approximately 40 cm). I do not recommend that the author stratify such a shallow soil. Instead, the soil sampling description should be adjusted to an integrated single-layer approach, represented as soil or overlying soil. This is because when quantifying plant water sources through the Bayesian mixing model, excessive division of water sources would weaken the importance of rock fissure water emphasized in the manuscript.

Reply: Thank you for your reminder. After comprehensive consideration, we have added a common potential water source in karst regions (fissure-filled soil water), while soil is no longer stratified but treated as a whole. We found that rock fissure water is an important water source for plants, with a total contribution rate of 64.6–71.4% (Liu et al., 2025). Therefore, the importance of rock fissure water to plants can be highlighted. In addition, we collectively refer to fissure-filled soil water and rock fissure water as rock fissure water, and have added the sampling protocol for fissure-filled soil water in the methodology.

Namely: The sampling method for fissure-filled soil is consistent with that for surface soil. In the study area, we selected 18 semi-exposed fissure soil profiles, with an average depth of 183.8 ± 71.8 cm, an average inclination of $83.6 \pm 7.3^\circ$, and an average aperture of 39.7 ± 29.1 cm (see Li et al., 2020 for details). Previous studies have shown that the vertical isotopic variation of the fissure-filled soil water is relatively small (Cai et al., 2023). Therefore, an auger was used to collect fissure-filled

soil from depths of 0.5–1 m, stratified into two layers: 50–70 cm and 70–100 cm. Each layer was sampled in triplicate, and the soil samples from the two layers were mixed again uniformly to obtain a representative sample for stable isotope ($\delta^2\text{H}$, $\delta^{18}\text{O}$) analysis. To inhibit evaporation and minimize the influence of rainwater mixing, plastic film was used to cover the partially exposed fissure soil during non-sampling periods (Li et al., 2020, Fig. 2f).

Reference: Liu, X., Chen, X., Zhang, Z., Liu, W., Gao, F., Cheng, Q., Peng, T.: The role of rock fractures as a water source for trees growing in karst, *Water Resour. Res.*, 61(11), e2024WR039588, 2025.

13. Make sure that the text in the charts (especially the axis labels and legends) is of appropriate size and legible in the PDF version. For instance, can the axes and images in Figure 9 be presented more clearly through other inversion software?

Reply: Thank you for your suggestion. Due to limitations in the software, the image details were unclear. We have therefore switched to a different software programme to re-quantify the data.

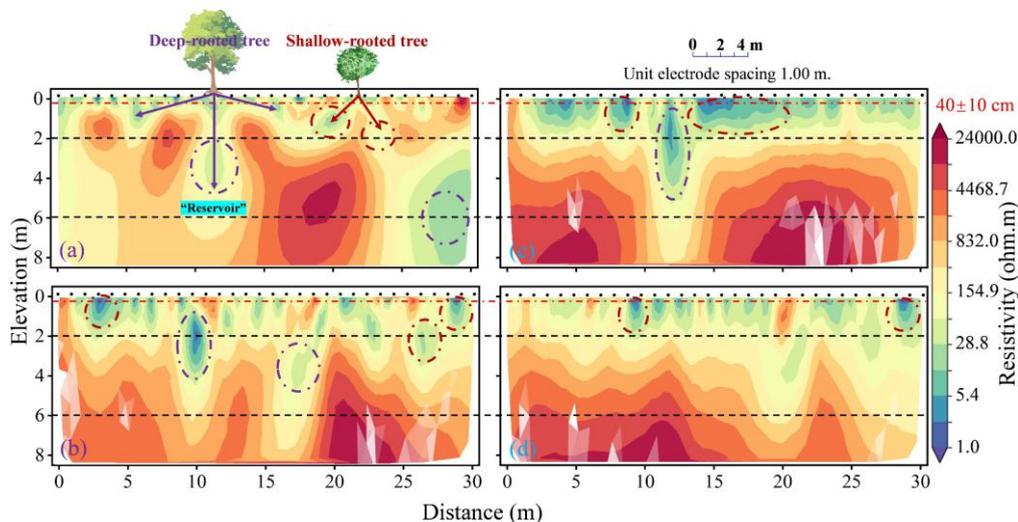


Figure 9. Subsurface resistivity profiles obtained from Electrical Resistivity Tomography (ERT) inversion within plant root zones. ERT surveys were conducted in two plots, yielding four profiles. Each profile consisted of 32 electrodes with a spacing of 1 m, achieving an exploration depth of approximately 8 m (black dashed lines indicate different subsurface depth intervals). Panels (a) and (b) show resistivity inversion results from one plot, while panels (c) and (d) correspond to the other plot.

Note: Colors represent resistivity values (unit: $\Omega\cdot\text{m}$) on a logarithmic scale, ranging from low resistivity (dark blue) to high resistivity (red). The red dashed line indicates the average soil depth in the study area (approximately 40 cm), and the black dashed lines serve as reference lines for exploration depth. The purple elliptical dashed lines delineate low-resistivity anomalies beneath deep-rooted plants (inferred as deep water storage zones), while the dark red elliptical dashed lines indicate water storage zones beneath shallow-rooted plants.