

Review for HESS-2022-120: Comparing water uptake patterns of two plantations using stable isotopes in Chinese Loess Plateau

Dear editors, dear authors,

After careful consideration of the submitted manuscript I recommend that the presented analysis needs to undergo numerous and extensive revisions (see more detailed comments below). At the same time, I encourage the authors to refine the analysis and re-submit an improved manuscript to present this novel data set. I hope that the remarks in this document help them to do so in an efficient manner.

- The paper addresses the vertical patterns of depth of root water uptakes (RWU) by two tree species located in the Chinese Loess plateau. It investigates how these RWU patterns change over the season and also comparing a dry with a wet year. The paper sets out to compare RWU obtained with different methods: MixSIAR, Direct Inference (both based on isotopic signatures in soil and xylem waters) and a method based on the change in soil water storage. This comparison is most welcome in the research community and lies in the scope of HESS. However, tackling this requires in-depth discussion of the assumptions underlying these methods and the corresponding limitations.
- The researchers collected an excellent data set with many replicates that allows to have robust conclusions. The data set is novel to my knowledge and should definitely be published! This involved a lot of field work and has value in it. It is great to see, that the aggregated values are reported in the supplementary material. (Although, raw values would be even better.)
- Scientific methods and assumptions are not clearly stated and the limitations of these methods could affect the interpretations and conclusions. The analysis is subject to ambiguities and lacks clear figures, which leads to the provided materials not robustly supporting the claims and findings the authors make in the discussion (e.g. confounding factor P in ΔSWS , or figure 6 not clearly supporting 1.353-354, among others). Improvements to the analysis and illustration of the presented data are needed in order to assess how well they support the claimed findings.

General comments

- The article is clearly structured, but suffers from imprecise language and formulae. This hampers its clarity and reproducibility. Further, many figures should be tweaked to better support the comparisons and care should be taken to the consistent reporting of units.
- The results and discussion of the Meteoric Water Lines (slopes and intercepts) is not adding significantly to the outlined research questions or discussed findings and could be removed. An exception to this is the visible evaporative enrichment in soil and xylem water that highlights differences between the dry and humid year and the fact that the dual isotope plots indicates possible source waters of xylem seem to be sampled exhaustively.
- In order to interpret ΔSWS , one has to notice that it is a combined effect of multiple processes, which can be simplified to $\Delta SWS = P - ET$. Thus, precipitation P is a confounding factor that can influence estimates of evapotranspiration ET based on ΔSWS . This confounding factor P has differing impact given the amount and duration since last reasonably large rainfall when ΔSWS is measured. This severely limits the possible comparisons that can be made based on ΔSWS . For example, P is the same when the authors compare the same seasonal period between *P. tabulaeformis* and *R. pseudoacacia*.

However, it is not the same e.g. when the authors compare across years or across seasonal periods. This should be stated more explicitly and authors should either a) limit their comparisons to the ones unaffected by this, b) clearly discuss the impact, or c) try to remove the effect of P in ΔSWS to allow comparison of ET. (This affects various lines in the manuscript, e.g. l.381-382 in the discussion.)

- The authors mention the drought resilience of *R.pseudoacacia* based on the species' ability to increase the relative contribution from deeper soil layers to RWU in drought years (l.39-41). What would additionally be interesting is to see if this resilience allows to maintain a comparable total amount of transpired/absorbed water in dry vs wet years (e.g. $ET = \Delta SWS - P$). I would be interested by an additional, more detailed analysis combining the mixSIAR based RWU (relative contributions) with the total amounts of actual ET (derived as $ET = \Delta SWS - P$, assuming no deep percolation as a first approximation), to estimate if total contribution from 40-200cm was increased in absolute terms in 2019 compared to 2020 (l.39-41).

Specific comments

- To clarify figures and make them better support the results please consider:
 - make x-axes comparable by having same limits (concerns Fig.3, Fig.4, Fig5 (SWC))
 - adding title and units on x axes (Fig.3, Fig.6) (Fig.3 How is the x-axis in Fig 3 linked to SWC?)
 - consider a horizontal layout with a row for *R.pseudoacacia* and another row for *P.tabulaeformis*, (agreeing with the suggested table below) (concerns Fig.3 and Fig.6)
 - For figure 6: I feel that using the area to represent the total relative contribution of each layer makes it difficult to compare their values. I argue that using bar width to represent total relative contribution (in combination with a constant height of the rectangles) would better support your discussion of total relative contributions. (Indeed you're not discussing relative contribution per unit depth, which is currently shown by the rectangles' widths.)
- Revise language (especially tenses in figure descriptions but also correct conjugation of verbs)
- Be careful to remain consistent in your terminology. E.g. refer consistently to "twig xylem water" instead of "stem water".

Find further specific comments pertaining to the indicated lines below:

Intro

l.61-62: Please clarify what you mean by "depict all water sources". Further it'd be nice to see a discussion on the limitations, e.g. the confounding factor of P that limits the interpretation of $RWU = ET - P - \Delta SWS$. And what comparisons are allowed or not considering this confounding factor.

l.70-73 and l.79-81: Please try to be more concise and clear in the English. For the reader it is not easy to understand the message of these lines.

Materials and Methods

l. 118: How was the number of two trees per plantation decided? Does this mean you took multiple twigs then from the same tree? Were the results between the two trees consistent? This could be added as a small sentence to the results.

l.148: how are the four "aggregate" layers linked to the HCA shown in figure S1? It would be nice to have some more background information on how you applied Ward's method (applied to what variable? Z-scores?)

I.150-155: Does "l" refer to the "aggregate soil layer" (0-20, 20-40, 40-100, 100-200cm?) while "i" is the sample depth (i.e. the ones state in lines 130-131) ? Maybe revise the English to make this distinction clearer in the text.

I.164-167: Pleaser provide more details to the MixSIAR model, e.g. did you use any prior assumption on the root distribution to constrain solving the overparametrized system? How did these root distributions look like?

I.170-176 Please revise the formula a) generally (units, explain Δ) and also b) in view of the comments to lines 150-155. Unclear points include (should h be h_i ? Maybe include the double index l to explain how you computed quantities shown in figure 3? Was d_i constant over time or did you really consider Δd as your formula suggests with the parentheses?)

I.185-186: Please provide more explanations why you look at Pearson correlation between variables (also affects I.233-234, 276-280, Table 2, and I.333-342). To understand I.333-342 a better explanation of the hypotheses underlying the correlation analysis between ΔSWS and ΔRWU . It would also be nice (on line.185-186) to have further details on the subgroups within wich you computed correlations. These analyses could lead to a better process understanding of the water cycle but could be more clearly linked to the research question regarding forest restoration schemes or more clearly linked to the interpretation of the other analyses.

Results

I.201 Please mention that the reported values in the text are "(not shown)" in the figure 3 as such. Further you might add that in 2019 as well as in 2020 total changes in SWS between August and October were much bigger than changes in SWS between July and August.

I.201-210: This paragraph could greatly benefit from more clarity by reworking the text (both structure and language) to make it easier to follow the various comparisons. A support in form of a table or figure would definitely be helpful. Additionally the confounding factor/ambiguity induced by P should be more highlighted for the respective comparisons. E.g. would the time since last rainfall affect the observed decrease/increase in ΔSWS (or "rates of increase of SWS") with depth or is the observed ΔSWS robust with respect to that because you consider depths of up to 2m ? A discussion of this would be needed.

I.213-219: Please explain better the relevance of reporting the slope and intercepts of the LMWL and SWL, as well as the ranges of the observed isotope values (I.221-230). Where they do not contribute to the findings regarding the research question, they could be removed (see general comment further up.) This also applies to correlation with soil water (I.232-234)

I.242-261: These result sections would benefit from a summary in tabular form, where you might compare RWU depths from the direct inference method, RWU modes from the MixSIAR method and largest ΔSWS for the 6 periods and the two plantation types. See below example as suggestion (values to be verified...):

	Dry year			Humid year		
Plantation species	Jul 19	Aug 19	Oct 19	Jul 20	Aug 20	Oct 20
Direct inference: RWU depth (cm)						
R (black)	60?	80?	50	10,70,150?	40?	20?
P (orange)	50	60	70	120?	20?	20?
MixSIAR model: Depth of RWU mode (cm)						
R.pseudoacacia	40-100	100-200	40-100	100-200	40-100	0-20
P.tabulaeformis	0-20	0-20	100-200	100-200	40-100	0-20
Change in SWS: Depth of largest decrease in Δ SWS (cm)						
R.pseudoacacia	...					
P.tabulaeformis	...					

Discussion

I. 331-332: Also here above table could help clarify when and where MixSIAR agrees with Δ SWS and when and where it does not. It appears to me the conclusion that they agree well is mostly based on the observation of water use from 100-200cm in R.pseudoacacia (in July and August 2019). See also remark regarding I.353-354. I.322-324

I. 333-340: Please explain better the hypotheses underlying the correlation analysis between Δ SWC and Δ RWU and what you want to test with it. E.g could the same have been done instead with Δ SWS (Δ SWS = $\bar{\Delta$ SWC} * 10 * \bar{d} * h / \rho) ?

I.353-354: How is this claim supported by the MixSIAR figure 6 that implies 65% of xylem water coming from 100-200cm for P in July 2020 or 26% for P in October 2020 ? Is this claim only based on figure 3 based on Δ SWS method? (I. 331-332)

Conclusions

I.378-380: as stated earlier it is still unclear why correlation of $\delta^{18}O$ values with other variables is analysed and (why this is stated as such in the conclusion).

Technical corrections

Abstract

I.34: suggest to remove "with contrasting soil moisture dynamics"

I.35-36: what does correlation of δ with T_{air} and P mean? How to interpret this?

I.38: "more effectively" what does it mean?

I.43: "inclined to absorb soil layer" what does it mean?

Intro

I.53: replace "potential" with "danger"?

I.92: Please try to avoid confusion in the English formulations e.g. distinguish "soil δ " from "soil moisture content" and be more explicit in the "relevant variables".

I.94: By "spatial" you mean "vertical"? Would this be a more appropriate formulation?

I.101: Refer to a year instead of the "Grain for Green" project.

Materials and Methods

I.138: cryogenic extraction: could you report the efficiency separately for soil and twig samples?

I.146: how did you measure the precision of the CRDS analyzer? Do you have an estimate of the accuracy?

I.161: with "significant" do you mean "relevant" or "large"?

I.157-165: please clarify at the very beginning of the paragraph what data set was used for the analysis and all the figures (except Fig S2). I understand it was the "raw" (and supp-I.10 do you mean "unweighted average method")

Results

I. 205-210: "Both plantations increased SWS ..." is unclear? Is this saying that Δ SWS from July-October for each single depth and for both years was positive? Please add units to the "rates of increase" stated in the text and consider showing/adding these numbers in tabular form to follow more easily the claims.

I.242-244: State more clearly that these are results from direct inference approach.

Discussion

I.267: Do you mean "kinetic fractionation" (as opposed to "equilibrium fractionation") instead of "unbalanced fractionation"?

I. 290: Consider replacing "rare rainwater infiltrated" with "on rare occasions rainwater infiltrated".

I. 333: Consider adding "[the relationship between] the changes in [SWC and RWU]".

I.357: Please explain what you mean by conservative.

I.359: Consider replacing "trees with high density were planted" by "trees were densely planted"

I.365: "Compare to the R. pseudoacacia" is redundant at the beginning of the sentence.

I.370: "better" in the sense to consume less water and allow more deep infiltration?

Figures

I. 531: Consider replacing "google map" with "Satellite view (Google Maps)"

I.577: Consider clarifying caption: "Grey and blue lines represent the Global (GMWL [add formula]) and Local (LMWL) Meteoric Water Lines, black and orange represent the Soil Water Line of the R... and P... sites, respectively."

I.588: Consider adding "[in xylem] (shown as vertical lines) [and soil water]"