HESS-2023-12
Title: The degree and depth limitation of deep soil desiccation and its impact on xylem hydraulic conductivity in dryland tree plantations
Author(s): Nana He et al.
MS type: Research article
Iteration: Minor revision

Public justification (visible to the public if the article is accepted and published):

Dear Xiaodong Gao, Nana He and co-authors,

thank you for applying the requested changes according to my comments in the text. I have had a careful look at the response and unfortunately, it has not resolved my main concern. Accommodating the issue requires some adaptation in the way the results are discussed and interpreted.

In several instances, it is stated that a strong response, e.g. the reduction of the xylem conductivity occurs „when the moisture limitation and the RWU maximum depth are reached due to low soil water availability in deep layers. “ (hypothesis in the last sentence of the introduction, Lines 85-86 of the track changed version of the submitted manuscript). I have pointed out similar instances in my last response. This phrasing does not match the methods and results presented in the manuscript. The manuscript presents per site and tree cover type one value of xylem conductivity, moisture limitation, and maximum root water uptake depth. There is no temporal resolution, and therefore only an instantaneous value of maximum root water uptake depth is available per treatment. Thus, we do not know whether the trees could explore deeper layers next year, or whether they have reached their physiological limit. The phrasing that the observed maximum „has been reached“ strongly suggests an evolution over time, where a physiological maximum is approached, but cannot be surpassed. But this information is not available and the phrase is therefore misleading. Moreover, the sentence, and others in the manuscript (e.g. Lines 356-357, 453-454, 465-466 in the track changed version of the revised manuscript), lose meaning, when removing the phrase „has been reached“.

Thus the hypothesis needs to be adapted. Based on the experimental setup, I would have expected

a hypothesis that relates to expected differences in rooting depth and xylem conductivity between the sites, as the sites represent gradients in aridity, tree species or tree age, etc, and the manuscript could test whether or not those expected patterns can be confirmed. Maybe this is what is meant by the phrase, but in the current version, the meaning is obscure. Can you please take another look at this and bring the hypothesis and argumentation in the discussion and conclusion in line with the methods and results?

Best regards,

Anke Hildebrandt

Response: Thank you very much for your time and constructive comments on our paper. We have modified the hypothesis as follows (Lines 82-83). Concurrently, the relevant parts, including Abstract (Lines 27-30), Results (Lines 316-318; 350-358), Discussion (Lines 365-371; 406-411; 420-424; 450-451; 457-463), and Conclusion (Lines 471-474) of the manuscript have also been correspondingly corrected in the latest revised version. We hope that the revisions in the manuscript will be sufficient to make our manuscript suitable for publication in *Hydrology and Earth System Sciences*.

Lines 27-30:

"Furthermore, the mean values of native percentage loss of hydraulic conductivity of planted trees' branches xylem reached 74.9-96.5% in the plantations where the moisture limitation and the maximum RWU depth were observed during study period, indicating that tree mortality may occur. The findings help predict the sustainability of planted trees in semiarid regions with thick vadose zone."

Lines 82-83:

"…therefore, we also assume that the xylem hydraulic conductivity of planted trees varies among tree species and sites, as the sites represent gradients in aridity."

Lines 316-318:

“During the study period, the maximum RWU depth reached 18.0-22.0 m for *M. pumila* orchard at different sites; and 18.4-18.8 m for *R. pseudoacacia* forests in Changwu and Yan’an while it was deeper than 25 m in the drier site of Mizhi.”

Lines 350-358:

“To further clarify how the moisture limitation and the maximum RWU depth under the influence of deep-layer soil desiccation affects the hydraulic conductivity in plants, we explored the variations of hydraulic conductance of branches for different tree species and sites (Fig. 7). Please note that the data used for analysis here is from only the plantations where the moisture limitation and the maximum RWU depth were observed (Figs. 4 and 5). The *NPLC* was higher than 50% for all tree species and sites and showed clear variations between tree species and sites. The *NPLC* ranged from 74.9-96.5% for *R. pseudoacacia* trees and 83.0-92.7% from *M. pumila* trees. Particularly, the *NPLC* of *R. pseudoacacia* trees in Mizhi was significantly higher than that in other places ($p<0.05$), indicating that the *R. pseudoacacia* trees in Mizhi has greatest mortality risk in relation to the severe deep-layer soil desiccation.”

Lines 365-371:

“Although DSM (>200 cm) decreased with an increase of planted trees age, and even reached the lowest limitation during the sampling period, shallow soil moisture (<200 cm) did not change significantly (Figs. 2 and 4). This is ascribed to surface or shallow layer soil moisture, which is usually greatly influenced by rainfall infiltration and evapotranspiration. However, DSM is often in a negative balance, being consumed by deep-rooted trees and unable to be replenished for a long time (Fang et al., 2016; Gao et al., 2020). As the critical water resource for plants to cope with extreme droughts, DSM of various sites reached the lowest limitation during the study period, seriously threatening the sustainability of tree growth under future climate conditions.”

Lines 406-411:

“In all, the RWU of plantations in other regions reached their maximum depth during

our sampling period, even though *R. pseudoacacia* forests in the Mizhi can obtain water through root extension. The above- and under-ground biomass allocation mechanism of plantations determines their root-to-shoot ratios (Mokany et al., 2005). Thus, the fine root dry weight density of the plantations in Changwu and Yan'an explains the reason why their water absorption range reaches 18.0-22.0 m during the study period."

Lines 420-424:

"The result showed that branch xylem of similar aged trees suffered embolism to different degrees in the plantations where the moisture limitation and the maximum RWU depth were observed (Fig. 7). This is consistent with the hypothesis that the xylem hydraulic conductivity of the planted trees varies among tree species and sites."

Lines 450-451:

"Our study shows that there were the soil moisture limitation and the maximum RWU depth in 24-28-year-old plantations, including *M. pumila* and *R. pseudoacacia* forests during the study period."

Lines 457-463:

"…the maximum RWU depth of other plantations was within the sampling depth during the study period. Furthermore, the trees suffered serious embolism of which the degrees were dependent on tree species and sites in the plantations where the moisture limitation and the maximum RWU depth were observed. Therefore, plantations of 24 years and above face the greatest risk of dieback and death in drought years or prolonged dry periods, especially in semi-arid regions. The results provide practical insights into the sustainable development of vegetation restoration on the LOP under future extreme climate conditions."

Lines 471-474:

"Furthermore, the native percentage loss of hydraulic conductivity of planted trees' branches was between 74.9% and 96.5% in the plantations where the moisture

limitation and the maximum RWU depth were observed, and showed clear variations between tree species and sites, indicating that dieback and tree death may occur.”