To Reviewer #3,

The manuscript simulated and analysed the effect of vegetation greening on water yield for the South-to-North diversion project (SNWDP). The manuscript is presented in a clear way and method and analyses are internally logical and consistent. However, the manuscript's narrow scope and sole focus on 'watershed management' does not account for critically important connectivities in the water cycle over land, or discuss the overall sustainability benefits or trade-offs of land and water management options. While limitations in scope are necessary to all scientific studies, here, the limitations and the insufficient acknowledgements thereof have resulted in potentially misleading statements about the effect of vegetation greening on runoff and lead to misinterpretations in terms policy/management implications.

Response: We thank the reviewer for the insightful comments, and we totally agree that we should provide a balanced account of the ecosystem goods and services provided by forests rather than solely focusing on watershed management. We recognize the multiple positive ecosystem goods and services associated with vegetation greening, but we also think it is important for policymakers to understand the feedbacks and potential unintended consequences from greening on water yield. We also agree that we should make the limitations of this study clearer and more explicit. We have addressed the reviewer's concerns in the revision, as discussed in detail below.

The authors write for example: "Overall, our study suggests that afforestation could potentially reduce local WY, thus weakening the capacity of the water supply to SNWDP." and "Our study suggests that improved watershed management (e.g., forest management and reducing water use) is needed to address the effects of vegetation greening and climate change on water supply capacity in watersheds serving as water sources for large water diversion projects."

The authors might not mean this, but it is easy to interpret this as an argument for limiting re-greening and reducing vegetation. The slight absurdity in such sentence formulations can perhaps be illustrated by applying the same logic to the model simulation results of (Kleidon, Fraedrich, and Heimann 2000), who found that a global 'desert world' yields 37 000 km^3 per year runoff whereas a 'maximal green world' yields 28 000 km^3 per year of runoff. Of course, Kleidon et al., (2020) also noted that both precipitation over land and total evaporation from land were substantially higher in the 'green world' scenario. However, with the authors' logic and narrow focus on 'water yield', would they have stated that 'the presence of terrestrial vegetation potentially weakens the capacity of the water supply'?

I recommend the authors to (1) either expand their scope (to test how the results would be affected by accounting for moisture recycling including greening in upwind areas, and/or CO_2 fertilization under different assumptions), or (2) substantially revise the framing and conclusions of the paper. To test the sensitivity of the results to moisture recycling and greening in upwind moisture supply areas, the authors could for example make use of publicly available data of atmospheric moisture flows (Tuinenburg and Staal 2020; Tuinenburg, Theeuwen, and Staal 2020; Link et al. 2020). Sensitivities to CO_2 fertilization could potentially be investigated by testing different parameterizations in the models.

If option 1 is considered out of the scope, I recommend the authors to revise the title, the abstract, discussion, and conclusions so it is among others clear that i. the vegetation change considered are only within the basin; ii. that key processes and feedbacks such as moisture recycling are missing from the simulations which are likely to reduce the water yields risks reported (see for example Weng et al. (2019) that shows that strategic location of reforestation in upwind areas can in fact help support water use demands, and Wang-Erlandsson et al. (2018) that shows that irrigation in India and other countries contributes to precipitation over China by increased moisture supply); and iii. that overall ecosystem services and trade-offs (e.g., Onaindia et al. 2013) provided by reforestation or restoration projects have not been considered herein (please consider discussing these). I find the authors' current recommendations to be cautious of over-reliance on the water supply of the SNWDP project under future greening scenarios to be motivated and relevant. The authors could also elaborate on what they mean by consideration of 'forest management', for example referring to examples of reforestation approaches that provide relatively high ecosystem service benefits with low evaporation rates. Elaborating on these points could help make the paper more nuanced and insightful, and less prone to being mis-interpreted.

References

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Tuinenburg, Obbe A., and Arie Staal. 2020. "Tracking the Global Flows of Atmospheric Moisture and Associated Uncertainties." *Hydrology and Earth System Sciences* 24 (5): 2419–35.

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Wang-Erlandsson, L., Ingo Fetzer, Patrick W. Keys, Ruud J. van der Ent, Hubert H. G. Savenije, and Line J. Gordon. 2018. "Remote Land Use Impacts on River Flows through Atmospheric Teleconnections." *Hydrology and Earth System Sciences* 22 (August): 4311–28.

Weng, Wei, Luís Costa, Matthias K. B. Lüdeke, and Delphine C. Zemp. 2019. "Aerial River Management by Smart Cross-Border Reforestation." *Land Use Policy*.

We thank the reviewer for the clear, insightful, and constructive comments and suggestions.

First, we need to explicitly state that we do not advocate limiting greening and reducing forests. We do not recommend that afforestation should be halted or stopped in this region, because afforestation has many other benefits despite reducing water yield. As discussed in the manuscript, afforestation significantly reduced sediment and improved water quality in this region. However, what we stressed is that there is a tradeoff between water quality improvement and water resource availability for water diversion projects. Our study was indeed conducted from the perspective of water yield alone. What we found is a risk of water supply reduction due to afforestation and thus a need for comprehensive watershed management to deal with such a risk and to manage that tradeoff.

We realize that we did not deliver as clear a message as we intended about the effects of afforestation in the region thanks to the reviewers' comments. As a result, we have revised the manuscript according to the reviewer's second suggestion.

1) Introduction. We substantially reframed the second and third paragraph of the Introduction. We talk about the afforestation (greening) induced tradeoff ecosystem services. We did not narrowly stress the negative effects of afforestation (greening) here, but first stated the broader benefits of afforestation on reducing sediment in the streamflow and improve water quality, as well as other ecological benefits. Then we talk about the water supply capacity to the water diversion project, and indicated the amplified uncertainties in water availability due to afforestation (greening).
2) We made the following revisions in the Discussion:
    a) In "4.1 Reduced water yield and drought amplification from greening", we discussed the greening effects more conservatively. Specifically, we stressed that "However, as the latest round afforestation efforts are about to conclude, implementation of afforestation projects will likely soon slowdown in China, and combined with potential limitations from future water stress, the greening trend will not likely continue at their same levels in the UHRB." And the discussion about the future leaf area increases was removed.
    b) The "4.2 Reduced capacity of water supply to SNWDP from greening" was revised as "Trade-offs among ecosystem goods and services induced by greening" and its content was reframed. Specifically, to emphasize the "trade-off" instead of water availability alone, we substantially discussed water quality improvement, as well as other ecosystem goods and services due to greening in the first paragraph of 4.2. Then we shortened the discussion on how greening reduced water availability and moved the discussion about water supply capacity to the water diversion project to section 4.3.
    c) In "4.3 Implications for water diversion projects", we provided more discussion on watershed and forest management. Specifically, we moved the discussion about water supply capacity to the water diversion project from 4.2 to combine with the initial first paragraph of 4.3 to discuss the water supply concerns of

water diversion projects. Then we offered more specific recommendations for alleviating effects of greening on water supply. For example, we suggest that using natural regeneration with local tree species rather than artificial plantations to control erosion and conduct ecological restoration. Forest management such as stand thinning to reduce water use and fire risk and increase resilience of the ecosystem should be also considered as part of the integrated watershed management.

d) We added "4.4 Limitations" to discuss the limitations of this study in terms of experiments and external impact factors. We first discussed the possible influences of the interaction between vegetation and climate due to limitations of the experimental design. We then substantially discussed the uncertainty from possible moisture recycling. The enhancement of local ET had the potential to increase P. However, the P in the UHRB is primarily controlled by the Monsoon, which comes from the Pacific Ocean in southeast. The significant and widespread greening was also observed in the southeast China and evaporated a larger amount of moisture which might be brought to the UHRB and potentially induce a P increase. If this happens, such precipitation should already been capture by the precipitation data. In the last part of 4.4, we discussed the possible effects of increasing atmospheric CO_2 on water cycle.

3) Accordingly, we revised the conclusion to stress the "trade-off" and suggest that the "improved watershed management (e.g., forest management and reducing water use) is needed to maximize the ecosystem service benefits in watersheds serving as water sources of large water diversion projects."

As to the option 1 suggested by the reviewer, this would be a great direction for future studies as we believe that it will be interesting to investigate the effects of greening in the upwind area on regional precipitation and the hydrologic cycle. However, as recognized by the reviewer, it is beyond the scope and capacity of this study, mainly because of the following challenges: 1) As Tuinenburg et al., (2020) found, the only 33% of P in the Yangtze River Basin (where the UHRB located) is evaporated from land. Even if we know how much P in the UHRB was from the upwind area, it is challenging to find the amount of P that comes from the extra ET from greening. 2) There is a lack of high-resolution moisture data currently. Tuinenburg et al., (2020) developed a high-resolution (0.5°×0.5°) global atmospheric moisture product, but its resolution is still too coarse for watershed studies (like UHRB). It would bring significant uncertainties to use the 0.5° resolution data in a 250 m-resolution study.

Ref.:

Cao, S., Sun, G., Zhang, Z., Chen, L., Feng, Q., Fu, B., …& Wei, X. (2011). Greening China Naturally. Ambio, 40(7), 828-831.

Tuinenburg, Obbe A., Jolanda J. E. Theeuwen, and Arie Staal. 2020. "High-Resolution Global Atmospheric Moisture Connections from Evaporation to Precipitation." Earth System Science Data 12 (4): 3177–88.