Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC3
https://doi.org/10.5194/hess-2021-240-RC3, 2021

Comment on hess-2021-240

Anonymous Referee #3

Referee comment on "Vegetation greening weakened the capacity of water supply to China's South-to-North Water Diversion Project" by Jiehao Zhang et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-240-RC3, 2021

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.

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.

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