EGU24-15520, updated on 17 Mar 2025
https://doi.org/10.5194/egusphere-egu24-15520
EGU General Assembly 2024
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# The influence of irrigation on root zone storage capacity

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Vegetation plays a crucial role in regulating the water cycle through transpiration, which is the water flux from the subsurface to the atmosphere via vegetation roots. The amount and timing of transpiration is controlled by the interplay of seasonal energy and water supply. The latter strongly depends on the size of the root zone storage capacity ($S_r$) which represents the maximum accessible volume of water that vegetation can use for transpiration. $S_r$ is primarily influenced by hydro-climatic conditions as vegetation optimizes its root system in a way it can guarantee water uptake and overcome dry periods. $S_r$ estimates are commonly derived from root zone water deficits that result from the phase shift between the seasonal signals of root zone water inflow (i.e., precipitation) and outflow (i.e., evaporation). In irrigated croplands, irrigation water serves as an additional input into the root zone. However, this aspect has been ignored in many studies, and the extent to which irrigation influences $S_r$ estimates was never comprehensively quantified. In this study, our objective is to quantify the influence of irrigation on $S_r$ and identify the regional differences therein. To this aim, we integrated two irrigation methods, based on irrigation water use and irrigated area fractions, respectively, into the $S_r$ estimation. We evaluated the effects in comparison to $S_r$ estimates that do not consider irrigation for a sample of 4511 catchments globally with varying degrees of irrigation activities. Our results show that $S_r$ consistently decreased when considering irrigation with a larger effect in catchments with a larger irrigated area. For catchments with an irrigated area fraction exceeding 10%, the median decrease of $S_r$ was 17 mm and 22 mm for the two methods, corresponding to 12% and 17%, respectively. $S_r$ decreased the most for catchments in tropical climates. However, the relative decrease was the largest in catchments in temperate climates. Our results demonstrate, for the first time, that irrigation has a considerable influence on $S_r$ estimates over irrigated croplands. This effect is as strong as the effects of snow melt that were previously documented in catchments that have a considerable amount of precipitation falling as snow.

A manuscript associated with this abstract is available as preprint:

van Oorschot, F., van der Ent, R. J., Alessandri, A., and Hrachowitz, M.: Influence of irrigation on root zone storage capacity estimation, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2023-2622, 2023.