Reply to Anonymous Referee # 3

Overall assessment by Referee #3:

This is a very interesting study on the possible implications of ecosystem root-zone storage capacity changes induced by vegetation adaptation to climate change. The authors use a top-down approach based on the Budyko model. I believe that the study is novel and the insight provided by the study is valuable. The methods are innovative and useful for the Hydrology and earth system science community. However, there are several aspects in the methodology that need to be further explained/clarified to improve the quality of this contribution.

Reply:

We thank Referee #3 for his/her positive assessment of our manuscript. We provide a reply to each of the valuable comments below.

Comment 1:

Lines 144-145 refers to a monthly bias-correction factor applied to improve the consistency between the "E-OBS dataset in the center of the basin when compared to an operational dataset" which is "based on local precipitation data provided by the Service Public de Wallonie for the period 2005-2017". Though there are some additional details in the supplement this comment is very vague here, so it would be good to add some further clarification on the rationale for the use of the bias- correction factor, and why it "improves consistency".

Reply 1:

We agree with this suggestion and will clarify in the main text that we correct the E-OBS dataset to better represent the local precipitation data provided by the Service Public de Wallonie. As also detailed in the Supplement, we use a monthly correction factor in the center part of the basin because the E-OBS data underestimates the interpolated station data with more than 20%.

Comment 2:

Lines 227-228 state: "The water-balance method requires daily time series of precipitation, potential evaporation and a long-term runoff coefficient to estimate transpiration, as it depletes the root-zone storage during dry spells." Dry spells can be interpreted as interannual periods (a dry spell could potentially last more than one year in certain regions), but here you are only considering seasonal dry periods… so please clarify.

Reply 2:

The reviewer is completely correct. We will clarify that, in our study area, the dry spells are seasonal as storage deficits become zero again in the fall and winter when excess precipitation drains away as direct runoff or recharge.

Comment 3:

Lines 231-235: The explanation on the use of equation (4) and the estimation of the associated variables is not clear. The problem might be that at this stage in the manuscript, the model used for

the estimation of the hydrologic variables has not been presented yet (it is later presented in section 4.2 and schematized in Figure 3). It is then difficult for the reader to understand how is PE estimated based on the other variables in this equation (as EI and SI are not available from observations). It is therefore important to explain how EI and SI are estimated (here and not later, perhaps linking to the use of the model here, mentioning that the details will be described later). Please also explain if there is an implied iterative process. That is, in order to estimate EI and SI from the model (shown also in Figure 3), the value of Sr, max needs to be set, right? But it is obtained after using equation 4 (which uses the results of the model). I find the explanation of the methodology in this aspect unclear, so this needs to be further clarified.

Reply 3:

The estimation of the root-zone storage capacity with the water-balance approach is an independent step, which is not necessarily linked to the use of a specific model structure. However, it is correct that we use the same interception module as in the model to estimate the interception evaporation in the water-balance approach. The module consists of a reservoir with a maximum interception storage I_{max} to determine effective precipitation ($P_E = max(0, S_I – I_{max})/dt)$) and interception evaporation ($E_I = min (E_P, (S_I - I_{max})/dt)$). We will include these formulas in the revised version of the manuscript. The value of $S_{R,max}$ does not need to be set to run the interception module to estimate E_I and S_I, as interception processes occur before precipitation reaches the root-zone. Therefore, after estimating the effective precipitation, the value of $S_{R,max}$ in the water-balance approach is estimated, which does not require an iterative process. We will clarify this part in the revised version of the manuscript.

Comment 4:

Line 249: I think it should be “By fitting the extreme value distribution of Gumbel to the series of annual maximum storage deficits”

Reply 4:

Yes, thank you, we will change this!

Comment 5:

Lines 249: Why Gumbel?

Reply 5:

We used the Gumbel distribution as it is frequently used for estimating hydrological extremes. In particular, it was previously shown to be a suitable choice for the estimation of the root-zone storage capacity through the water-balance approach by several other studies (Gao et al., 2014; Nijzink et al., 2016; de Boer-Euser et al.; 2016, Wang-Erlandsson et al., 2016; Bouaziz et al., 2020; Hrachowitz et al., 2020). We will clarify this in the revised version of the manuscript.

Comment 6:

Line 271. What do you mean by “native” simulated … ?

Reply 6:

With “native”, we mean that we did not apply a bias-correction to the simulated historical climate data. We will clarify this in the revised version of the manuscript.

Comment 7:

Figure 5 a is not clear (difficult to visualize). Perhaps a change on the colour scheme used for the lines (more contrasting colours) could help.

Reply 7:

We agree with the reviewer that all the curves in Fig 5a are difficult to visualize. The color scheme used in Figure 5 is consistent with the color scheme used in the other Figures. However, we think it might be sufficient to only show the dashed curves representing the median ω_{obs}-values and remove the 35 curves of the other catchments that are indeed not clearly visible in the Figure. We will adapt this in the revised version of the manuscript.

Comment 8:

Line 421 states: “The ensemble of parameter sets retained as feasible after calibration mimics the observed hydrograph…”. I think that you are trying to say: The simulated values of Q obtained using “the ensemble of parameter sets retained as feasible after calibration mimics the observed hydrograph…”.

Reply 8:

Yes, this is correct, thank you, we will adapt this.

References

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