Answer to comments Editor

The original comments of the editor are in black color and indicated by “R:”. Replies by the authors (“A”) are colored in green. Actions are introduced by “Action:”, changes done in the manuscript are in italics.

Comment:

Dear Authors

The reviewers are overall satisfied by your replies. Please include the following minor corrections to the manuscript: I will consider the publication after these comments are integrated.

L11. Please add reference to the DSI. The abstract should stand independently of the rest of the text (see guideline of NHESS).

--- Action: Thank you for your recommendation, we have done the required changes.

L25 (BoN, 2018) should be outside the quotation marks.

--- Action: Thank you for your recommendation, we have done the required changes.

L55-56. “…it indicates…(Dai et al., 2004)”. Please reword the sentence, which is not well structured at the moment.

--- Action: Thank you for your recommendation, we have rephrased the sentence as follows.

“Its strengths and weakness have been well investigated by Dai et al. (2004) and is extensively used in the USA to indicate meteorological droughts (Heim, 2002).”

L72. Differently…

--- Action: Thank you for your recommendation, we have done the required changes.

L80. (That which should…) Please rephrase.

--- Action: Thank you for your recommendation, we have rephrased it to.

“In the soil moisture deficit anomaly index (SMDAI), the deficit is calculated as the difference between the soil moisture at field capacity (which allows optimal and non-water-limited plant growth) and the actual soil moisture.”

L91. I suggest to invert (a) and (b), since this is the order in which the two sub-section are then discussed successively.

--- Action: Thank you for your recommendation, we have done the required changes.

L98-108. Please clarify which component is “static”, if any (i.e. do not account for inter-annual or intra-annual fluctuations).

--- Action: Thank you for your recommendation, we have done the required changes.

In L109: *“The globally small amount of livestock water use is the only temporally constant water use and is determined from the number of livestock and livestock-specific water use values (Alcamo et al., 2003). Water use for households, manufacturing and cooling of thermal power plants are constant throughout the year but change from year to year.”*

L149. Cammalleri et al. (2016) scale soil moisture between “wilting point” and “critical point”, not saturation. Please clarify.

--- For DSI (Cammalleri et al.,2016), the soil moisture deficit is larger than zero only if soil moisture drops below 50% of field capacity. However, in SMDAI, this is the case only if the soil moisture deficit is larger than zero. Further, we have further adapted the following sentence for more clarity:

L154: “With our approach, which is consistent with the way of computing actual evapotranspiration from potential evapotranspiration in WaterGAP, d-values at low soil moisture saturation are lower than those of Cammalleri et al. (2016), while they are much higher at high soil moisture as Cammalleri et al. (2016) assume that deficits only occur if soil moisture is less than 50% of field capacity.”

L151. Please remove “saturation”.

--- Action: Thank you for your recommendation, we have done the required changes.

L153. “…while at high saturation they are higher”. This is surprising to me, since Cammalleri et al. define d=1 at critical point, which is much lower than saturation. I would expect to have much less d=1 in you approach as well (similar to zeros). Please clarify.

--- Action: For clarification, we have modified the sentences as follows:

L154: “ With our approach, which is consistent with the way of computing actual evapotranspiration from potential evapotranspiration in WaterGAP, d-values at low soil moisture are lower than those of Cammalleri et al. (2016), while they are much higher at high soil moisture as Cammalleri et al. (2016) assume that deficits only occur if soil moisture is less than 50% of field capacity.”

L211-L214. Please simplify and remove eq. (5). This can read as simple as “EFR is calculated for each calendar month as80% of mean monthly streamflow…, assuming…”

--- Action: Thank you for your recommendation, we have rephrased it to

“Following Richter et al. (2012), EFR is calculated for each calendar month as 80% of mean monthly streamflow under the naturalized condition ($\overline{Q_{nat}}$), assuming that 80% of the natural mean monthly streamflow that would have occurred in the river without human water use and man-made reservoirs needs to remain in the river for the well-being of the river ecosystem”

L258. Please add few lines specifying the locations where the ECDF is used (i.e. Australia, south Africa, etc.). Also, looking at figure S4, it seams to me that ECDF is used in more than 1/3 of the areas. Please check the values reported in the text.

--- Thank you for your suggestion. We checked the values reported in the text, the individual percentages (27.12 for SMDAI and 39.94% for QDAI) are correct. The percentages are computed for 57043 grid cells were considered in this study.

L274. Please remove “saturation”. You can use soil water content instead of soil moisture.

--- Action: Thank you for your recommendation, we have done the required changes.

L283. can be further explored.

--- Action: Thank you for your recommendation, we have done the required changes.

L284. This high percentage needs to be discussed. Possible reasons? It is also worth to highlight that SMDAI resemble psoil in this case only because dsoil is quite high everywhere. This is not always the case.

--- For SMDAI, the soil moisture deficit is larger than zero if soil moisture drops below field capacity while for DSI (Cammalleri et al.,2016). this is the case only if soil moisture drops below 50% of field capacity. SMDAI resembles psoil if dsoil is similar to psoil. With a relatively high dsoil as compared to the DSI approach, SMDAI is just more likely to be larger than psoil as compared to the DSI approach. We have already highlighted that dsoil in our approach is likely to be higher than DSI approach.
L 154: *“Consequently, we identify very few months and grid cells with a deficit of zero, likely less than we would do if we would have implemented the deficit definition of Cammalleri et al. (2016).”*

L321. “…on more individual variable…”. Please add “(i.e…..)”. I thin it is worth a further reminder for the readers on the variables that play a role.

---Action: Thank you for your recommendation, we have adapted the sentence accordingly.

“QDAI depends on more individual variables (i.e., Q_{ant}, WU_{sw} and EFR) than SMDAI (i.e. S and S_{max}).”

L342. I suggest to replace “sensible” to ‘reasonable”.

--- Action: Thank you for your recommendation, we have done the required changes.

L348-L353. This paragraph seems a little out of place to me, since a dedicated section to this topic is successively presented. I suggest to shrink this paragraph, and reference the successive analyses.

--- Thank you for your suggestion. We prefer to keep the paragraph here because it refers directly to the two example grid cells discussed above. While in section 3.4 we do a global analysis of QDAI to different assumptions about EFR

L378. “if for many….”. Please check this sentence, which is currently unclear.

--- Action: Thank you for your recommendation, we have done the following changes:

"Besides, grid cells with intermittent flows also show a high percentage of no-drought conditions, if for any calendar month there are at least six months (i.e., at least 20% of the months) with Qant = 0 (Figure S7)."

to

"Besides, grid cells with intermittent flows also show a high percentage of no-drought conditions, as for any calendar month with at least six months without streamflow pQ is always equal to zero (Figure S7)."

L396-397. Please rephrase and remove the incorrect term "more amount of soil moisture…".

--- Action: Thank you for your recommendation, we have done the following changes:

"With Smax2, more amount of soil moisture is kept in the soil and soil deficits, expressed relative to Smax, can be observed to increase or decrease with doubled Smax (Figure 7b)."

to

"With doubled S_{max} , mean monthly soil moisture increases, too. In most grid cells, the soil moisture deficit increases as compared to standard S_{max} (Figure 7b)."

L397-398. "Differences are mostly small…". Is this a sign that d is not that sensitive the absolute changes in Smax? So, for higher Smax also S will be higher? If this is the case, I think it is worth to be highlighted.

--- Action: Thank you for your recommendation, we have highlighted it in the following sentence.

L412: "With doubled S_{max} , mean monthly soil moisture increases, too. In most grid cells, the soil moisture deficit increases as compared to standard S_{max} (Figure 7b)."

L408. I would say "defined" rather than "computed".

--- Action: Thank you for your recommendation, we have done the required changes.

L445-455. This description needs to be moved to the methodology section. Here you should report only the result of the comparison, but not the description of the SSFI.

--- Action: Thank you for your recommendation. We have moved the description to a new section 2.6 in methodology.

L474. As already highlighted in the previous review rounds, this analysis is a little lacking and not fundamental for the goal of the paper. I suggest to remove this section, and correct the text (e.g. abstract) accordingly.

--- Action: Thank you for your recommendation. We have removed section 3.6. There was no need to adapt any other text.

L508. outputs.

--- Action: Thank you for your recommendation, we have done the required changes.

L509. …but also on the concurrent deficit….

--- Action: Thank you for your recommendation, we have done the required changes.

L520. Please expand a little on these “additional indicators”. Are you referring to more detailed information on water use?

--- Action: Thank you for your comment, we have adapted the sentence as follows:

“In local drought risk studies, additional indicators of ecological or societal vulnerability should be added, for example vegetation/crop type or income levels.”

L528. data are available. Please, also add a sentence of the availability of the outputs of this study (SMDAI and QDAI).

--- Action: Thank you for your comment we have added a sentence on the availability of SMDAI, QDAI and other analysis outputs

“The outputs from this study are available at https://doi.org/10.6084/m9.figshare.14213852 ”