

Interactive comment on “Freshwater resources under success and failure of the Paris climate agreement” by Jens Heinke et al.

Jens Heinke et al.

heinke@pik-potsdam.de

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We wish to thank the anonymous reviewer for her/his comments. Below, we provide detailed responses and propose changes in the manuscript.

Comment: It is good that a manuscript is concise. However, in the description of the results I find it not really concise, as in the mean time the description of data used and methodology lacks information. A more detailed description of the latter is needed to better understand the results.

Response: We will improve the presentation of results and the description of methods in the revised manuscript. Reviewer 1 has provided a number of detailed suggestions

C1

how the manuscript can be improved in this regard.

Changes in manuscript: Improve methods and results section, clarify main objective of the paper.

Comment: Climate change projections: What I find particularly missing in the manuscript is the topic of sea level rise. Under all average global temp rise due to climate change, the sea level will rise. The authors discuss temp rise until 5degrees C, so different sea level rises will occur. Why has this not been accounted for in the manuscript? E.g. coastal flooding will occur without appropriate adaptation. Is this included in the 10-year flooding scenario of the authors? Please discuss. Add a new section under section 4 on issues like this and other uncertainty/limitations of the study.

Response: While coastal flooding due to sea level rise is an important threat to human settlements, it has no link to terrestrial freshwater resources as such. In contrast, river flooding does not only pose a threat to human settlements but also—and that is the rationale for including it in the paper—to water management infrastructure built into or along rivers. However, we see that the link between increases Q10 and potential threats to water management infrastructure (i.e., change in magnitude or return time of Q100 and Q1000 floods) could be made clearer.

Changes in manuscript: Clarify link between increases Q10 and changes in magnitude and/or return time of Q100 and Q1000.

Comment: The metric MAD, whether or not in combination with the water crowding indicator: The authors write on page 2 lines 22-23 on the important topic of "... seasonal shortages and changes in variability". They quote that it is important to address this. However, by using a metric like MAD, I do not see at all that seasonality or changes in seasonality due to climate change are addressed. Like in mountain regions, winter can have more water availability due to climate change but summer less. In a mean annual

C2

metric this is not accounted for. Also in the water crowding indicator this seasonality is not represented. Please discuss, and again in a new section under section 4 "other uncertainty/limitations of the study". A new publication in STOTEN about water stress partly discusses these issues - <https://doi.org/10.1016/j.scitotenv.2017.09.056> . Please discuss relating to this paper.

Response: The inability of MAD metric to account for changes in seasonal and interannual distribution is addressed in the paper by using two additional metrics (ND and Q10) that capture important aspects of such changes (longer drought periods and larger floods). Despite its shortcomings with respect to seasonality, MAD is still a valuable metric which provides insights in the change of mean water availability. We consider the combination of three metrics covering different aspects of hydrological change as one of the main achievements of this paper. Transgression of certain threshold for all three metrics are jointly referred to as 'severe hydrological change' in the paper and are analysed both separately and jointly in the light of global mean temperature increase. With regard to water crowding, we agree that this indicator has its shortcomings but with the current availability of socioeconomic scenarios for the future it is barely possible to compute more complex metrics. It is important to note that the purpose of the water scarcity metrics discussed in the mentioned paper is to monitor progress towards SDG 6.4. This a completely different application that can build on actual observations and statistics. However, discussing the limitations of the water crowding indicator certainly supports the correct interpretation of the results presented in the present paper and will be added in the revised manuscript.

Changes in manuscript: Add discussion of shortcomings of water crowding as a metric for water scarcity.

Comment: Page 2 Line 4 "the water supply" delete "the"
Changes in manuscript: Apply proposed change.

C3

*Comment: Page 2 Lines 32-34: "more significant". Why? I do not see this. Why is this change in water scarcity more significant in already stressed than unstressed regions. Is an increase in water stress not important in any region? Are water users and the environment not affected in both situations? Please justify this statement or alter it. **
Page 3 Lines 2-4: same comment

Response: Indeed, severe hydrological change will always affect people and the environment. But in a situation with ample water availability has enough leeway to compensate for the negative effects on societal water supply. When all water is already appropriated this is much harder. However, 'more significant' may not be the best wording to describe this relationship.

Changes in manuscript: Rephrase and clarify.

Comment: Population growth: give more information on quantities and assumptions in the scenario's used

Response: SSP storylines are described in the relevant literature and are not important for the understanding of the results in the present paper. However, we will add a paragraph that mentions names of the scenario and characterizes them briefly.

Changes in manuscript: Add section with short SSP scenario description.

Comment: Page 7 Lines 1-17: Does the water crowding-indicator account for ground water and environmental flows? Please discuss, again referring to <https://doi.org/10.1016/j.scitotenv.2017.09.056>

Response: Renewable groundwater is implicitly accounted for in the discharge figures from LPJmL. Environmental flows are not accounted for. We will clarify these aspects in the manuscript.

Changes in manuscript: Add a note on groundwater and environmental flows.

Comment: page 8 line 11: increase in MAD, or is it decrease? Discuss in more detail -

C4

more precipitation but also ET, so what happens with resulting MAD

Response: This is a typo, it should read: “[. . .] affected by a severe decrease in MAD, [. . .]”. Potential drivers of hydrological change will be discussed in the introduction.

Changes in manuscript: Correct typo, add discussion of drivers of hydrological change.

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