

Interactive comment on “A global water scarcity assessment under shared socio-economic pathways – Part 1: Water use” by N. Hanasaki et al.

Anonymous Referee #2

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The paper presented by Hanasaki et al. concerns the first part of a two-part paper. I have read this manuscript with interest. The paper is overall well-written. However, I do have some major concerns regarding how the paper is structured in relation to the second part of a two-part paper, as well as minor comments.

1. Abstract: “...the irrigation area in 2085 varies between 270 and 450 km²,...” Is the unit correct?
2. Abstract: “. . .the irrigation area in 2085 varies between 270 and 450 km², industrial water between 246 and 1714 km³ yr⁻¹, and domestic water withdrawal between 573 and 1280 km³ yr⁻¹.” How about describing irrigation water withdrawal, rather than irrigated areas here, consistent with industrial and domestic water withdrawal?

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3. Abstract: “The water use scenarios can be used for global water scarcity assessments by identifying the regions vulnerable to water scarcity and analyzing the timing and magnitude of scarcity conditions.” I would change to “The water use scenarios can be used for global water scarcity assessments by identifying the regions vulnerable to increased water use and analyzing the timing and magnitude of scarcity conditions.”
4. Page 13882,: “The study is presented in two-part papers.”?
5. As far as I understand, the paper concerns modeling water withdrawal (although the title indicates water use) only, and there is no model development for water consumption. Please clarify this point and revise where appropriate.
6. For Section 2, I would suggest the authors to shorten further about the narrative scenarios well documented by O’Neill et al. (2012), and to focus more on how your water use scenarios correspond to which SSP and RCP scenario.
7. “Higher values indicate socio-economic factors that would make it more difficult to reduce emissions.” “Higher values indicate socio-economic factors that would make adaptation more difficult.” Not very clear, please rephrase.
8. I do not really see the necessity or justification including literature review (Section 3) about sectoral water withdrawal. These information are well-presented in previous literature. This section should be omitted or considerably shortened. The paper should focus on novel aspects of development of water use scenarios presented in Section 4.
9. Section 4 should also be shortened and focus on new aspects of model development.
10. Irrigated areas expand within the grid cell, or over the present extent of irrigated areas (area equipped for irrigation) only (no horizontal expansion). Is this a good assumption considering available land within the grid cell and other land use types, e.g. urban area, rainfed crop area, natural vegetation? And, is livestock water withdrawal included? If not, please change agricultural to irrigation water withdrawal. Regarding

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the paper 2, rice is irrigated during 100% of the cropping period. Farmers generally stop irrigating rice a few weeks before the harvest (~late development stage). If you irrigate rice (~25% of all irrigated areas) during all cropping period, your irrigation water demand for rice is likely overestimated.

11. "To make the results grid-based, we assumed that industrial water withdrawal is geographically distributed proportionally to the population." This means that industrial water withdrawal has a very similar distribution with domestic water withdrawal which is based on population data. In general, industrial activities are concentrated near urban areas. Including rural population when downscaling industrial water withdrawals will likely make mismatches in the gridded industrial water withdrawal. I would suggest to use gridded urban population maps or night-time light intensity to distribute industrial water withdrawals over the grids.

12. Which data is used to geographically distribute domestic water withdrawals to a grid scale? Population data from CIESIN?

13. In Section 6, after presenting water withdrawal scenarios, there are long descriptions about the uncertainty and comparisons with earlier studies for each water withdrawal sector. These descriptions make difficult to read the results presented in the paper. 'Comparisons with earlier studies' and 'Uncertainties in....' should be substantially shortened and should be possibly discussed all sectors together in a more concise manner.

14. This type of extrapolation of future water withdrawals suffers from the weakness that expansion of irrigated areas and increase in water use intensity only occur over the present irrigated area or population extent, thus not horizontal expansion (no irrigated areas are developed if no irrigated areas exist at the present (Siebert et al., 2005). Within the country or region variations remain the same. This also substantially affects the results of global water scarcity assessments. The authors should at least discuss this limitation that comes from the series of assumption used in this study.

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15. All-in-all, the authors did a good job and presented an interesting work. However, I think the paper will be much stronger when the assessments presented in a two-part paper are combined and presented in one paper. This paper (part 1) can be significantly shortened omitting those sections describing literature review. The new aspects presented in the paper 1 can be inserted into the companion paper (part 2), making one combined paper. In this way, the newly developed water use scenarios based on the SSPs can be presented with water scarcity assessment in a much more coherent manner. The impact of socio-economic development incorporated in water use scenarios can be easily recognized in resulting water scarcity. Since this paper focuses on global water scarcity assessment under the SSPs, joining a two-part paper into one paper combining the development of water use scenarios under the SSPs and the assessment of water scarcity seems to be a logical choice. The authors can use supplement if the paper requires additional spaces.

Fig. 2: The axis legends are unclear.

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