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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A seawater desalination scheme for global hydrological models" *by* Naota Hanasaki et al.

Anonymous Referee #2

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"A seawater desalination scheme for global hydrological models" by N. Hanasaki et al.

The paper presented by Hanasaki et al. developed a new modeling scheme for seawater desalination water use that can be applicable to existing global hydrological models. The newly developed desalinated water use scheme was then applied to project future desalinated water use under different socioeconomic (SSPs) and climate change (RCPs) scenario. It was found that future desalinated water use is expected to increase substantially (about 2-15 times), however, the future estimates vary significantly depending on different socioeconomic pathways. To my knowledge, this study provides most comprehensive results for historical and future desalinated water use estimates and projections across the globe. The author used the latest and very comprehensive data source, DesalData (http://desaldata.com/), and incorporated them into a global hydrological model. Existing global or large-scale studies on desalinated water use

typically use the data from FAO AQUASTAT, WRI EarthTrend, EuroStat, and available country statistics, which often have very limited global coverage. The authors combined the desalination data with other socioeconomic data (GDP, population, production cost, etc) to construct the Seawater Desalination Model (SDM). The paper is topical and presents interesting and useful findings, and it is concise and mostly well-written. The newly developed SDM is useful for large-scale modeling framework, and appears to be quite applicable to other GHMs. However, I do have some comments regarding the methodologies that were applied in SDM as detailed in the following.

1. The methodologies described in Section 2.4 is the key part of this study. The section is concise, however, it currently lacks rationales for those conditions and assumptions (A-C) made in the SDM. The methodologies appear to be quite arbitrary at its present form. Since this study focuses on developing a new desalinated water use model, these key parameters need to be described more thoroughly. I urge to expand Section 2.4 and provided further explanations of each key parameter, condition, and assumptions that have been incorporated in the SDM. These information are very useful for other large-scale hydrological modelers. Without further explanations, the novelty of this study is very limited. In addition, I suggest to combine Section 3.1 into Section 2.4. Section 3.1 is basically the method and background information that derived the key parameters.

2. Some assumptions made for the SDM are not entirely reasonable. For example, the cost of desalinated water use is decreasing and the efficiency of desalinated water use is improving in recent years. For future projections (towards 100 years later), further technological improvement is expected to reduce the cost drastically. The assumption made based on a historical trend may not be applicable for the future, e.g. desalinated water use for irrigation. In addition, fossil groundwater reserves are actively used in the Middle East and Northern Africa (MENA) despite the near zero natural recharge. The authors may include fossil groundwater use estimates to isolate the impact on desalinated water use. I would suggest to at least discuss these uncertainties further.

3. The uncertainty inherent in future water use estimates needs further discussion with some quantitative information (e.g., Wada et al., 2016).

Wada, Y., Flörke, M., Hanasaki, N., Eisner, S., Fischer, G., Tramberend, S., Satoh, Y., van Vliet, M. T. H., Yillia, P., Ringler, C., Burek, P., and Wiberg, D.: Modeling global water use for the 21st century: the Water Futures and Solutions (WFaS) initiative and its approaches, Geosci. Model Dev., 9, 175-222, doi:10.5194/gmd-9-175-2016, 2016.

4. I find the results presented are very interesting, and in particular, the substantial ranges in future desalinated water use estimates among different SSPs are intriguing. However, currently the paper focuses primarily on a global scale estimate but I think it is more beneficial to focus on regions and highlight the change in desalinated water use per country in MENA or other parts of the world. For example, the information like "As shown in Table 4, the volume of seawater desalination was estimated at 3.7 km3yr-1 with a cost of 1.5–14.0 109 USD, equivalent to 0.0025%–0.024% of total global GDP." is no so informative, in my opinion. This type of information should be provided at a country basis, since the regional heterogeneity of desalinated water use is extremely large.

5. Global figure like Figure 5 is not so informative, and I suggest to zoom in to some regions like Figure 4. This is a global scale study, but it should highlight more the regions of interest. The majority of the map is blank in Figure 5. The information density is very low.

6. Additional information on surface water availability per country (in some tables) for the future period would be useful to highlight the importance of desalinated water use. Water availability is generally projected to decrease over e.g., the Mediterranean.

7. I suggest the authors to make a similar table like Table 4 but focusing on some regions (Middle East, Mediterranean, etc). Table 4 is useful for a global comparison, but additional information on regional desalinated water use is also very useful including historical estimates and future projections like Table 1.

8. When you describe "14,000 USD", please be careful that this indicates per capita GDP only. Please check this throughout the manuscript.

9. The term "modern GHMs" is not clearly defined and not commonly used. This is rather confusing, what it is exactly indicating, e.g. model representations, framework, human components, etc. This should be corrected.

10. I think this study is important highlighting the significance of desalinated water use for coming decades. The paper can be a bit restructured with more regional focus.

In principal, I would recommend this paper to be considered for publication after some revisions.

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