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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Changing global cropping patterns to minimize blue water scarcity in the world's hotspots" *by* Hatem Chouchane et al.

Anonymous Referee #1

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General comments

The authors determine for a large number of crops how crop production could be shifted among the countries of the world to produce the same amount of each crop globally while minimizing the highest value of a country-scale indicator of blue water scarcity, without any extension of the total national cropland but a with a certain maximum allowed extension of cropping area in the countries, both for rainfed and irrigated production.

Mainly for reasons described as limitations of the study by the authors themselves (lines 368-378 but also 379-383) I think that the results of the study are not informative

and even misleading. This is due to the scale of the study which inclusively considers countries as homogeneous units of analysis, regarding land and water productivities as well as blue water availability.

The novelty claimed in the manuscript is consideration of blue water scarcity. Unfortunately, blue water scarcity is only considered as one value per country, computed as the ratio of total blue water use in the the country and blue water availability in the country. This is problematic as their are important crop-producing large countries like India, China and the US (but also Australia) with humid and semi-arid climate zone, where irrigated crop production and thus blue water use is concentrated in the semi-arid/arid regions of the country while blue water availability is high the humid parts of the country. This is why these countries, in which large regions suffer from irrigation-induced water stress and even groundwater depletion, do not appear among the 21 countries with the highest water scarcity (Table 2) for which the authors show to what extent blue water consumption and thus blues water scarcity could be reduced by shifting crop production to other countries (with lower blue water scarcity). One result is that in the optimized distribution of crop production among countries, both China, India and Australia increase their blue water consumption (Fig. 2 bottom). I do not find it plausible that the thus optimized distribution of crop production among countries "minimizes blue water scarcity in the worlds's hotspots" (as is formulated in the title).

I think it is a prerequisite for publication of the study that the authors show the results of a sensitivity analysis regarding the spatial analysis units. Blue water availability values as well as irrigated areas are available at a spatial resolution of 0.5° by 0.5°, and this information could be used to see how the optimization results change if the blue water availability in the irrigated areas/cropping areas are taken into account instead of average country values. You could have a look at Yano et al. 2015 (Yano S, Hanasaki N, Itsubo N and Oki T 2015 Water scarcity footprints by considering the differences in water sources Sustainability 7 9753–72) where water scarcity at the country and for irrigated areas are computed separately and compared. Blue water availability from

various global hydrological model available at www.isimip.com could be used.

In addition, it is necessary to broaden the literature review. For example, the work of Taikan Oki and his group have not been considered. Please review Oki et al. 2017, Environ. Res. Lett. 12 044002 and some of the references therein. Oki and Kanae 2004 already showed global water savings by global trade.

Specific comments

L76: Jalava et al. 2016 also studied the effect of food loss reduction (https://doi.org/10.1002/2015EF000327)

L79: Explain more clearly to a broader audience what the definition of virtual water is (also: does not only relate to food).

L102ff. Explain more clearly the study of Davis et al. 2017a, and compare their methods and results to your study (e.g. in the discussion section). L111: Define clearly here that "cropping patterns“ mean the distribution of production of a certain crop among the nations/countries but not within.

L118: Expand methods section with respect to considered crops/crop groups, algorithm for optimization, e.g. how was ensemble of potential cropping patterns produced?

L139: BWS only takes into account irrigation water use but not the other use sectors. Define blue water footpring.

L159: Explain why you chose to minimize (only) the highest national blue water scarcity.

L220-364. Please shorten the lengthy description of the changing cropping patterns and comparative advantages shown in figures and tables but try to explain the results.

L367ff Also discuss the real-life meaning and consequences of optimized global cropping patteren, in particular reduced blue water consumption in the countries listed in Table 2. E.g. if BWC is reduced from 1900 to 280 million m3/yr in Libya, crop production (Fig. 4) and income would be strongly reduced, too. Could the production/income

loss be somehow related to GDP to understand the problems that would result from the analyzed global-scale optimization?

L408 ff. I would not use the grammatic form of "will“, e.g. in "Cereal production will get reduced in Africa“. Maybe better: "If blue water scarcity was globally optimized, cereal production would be reduced in Africa according to our analysis.“

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