Response to comments from reviewer RC2

Note that reviewer's comments are in italic black, and responses in plain blue font.

The study on "Changing global cropping patterns to minimize blue water scarcity in the world's hotspots" provides a new view of possibility to reduce crop-related blue water footprint and diminish the severe blue water scarcity worldwide. Plenty work has been done in this study; however, I feel that some parts in the text require careful revisions and improvements before it can be further considered for publication in HESS.

We appreciate the positive appraisal of the commentator and the useful comments that will be addressed in the following response.

1. *Line 31, you mentioned in the abstract 'changing spatial cropping patterns and international crop trade...", but just showing the 'spatial cropping patterns' changes. It could be much better to look at further on hotspot countries in terms of the responses in trade patterns (just changes in crop trade balances).*

We did consider but decided not to discuss trade balance changes in the paper, to keep the central messages of the paper clear; we agree that the abstract should not suggest otherwise. Discussing changes in international trade patterns will go along with discussing which changes in the cropping pattern would rather increase current trade flows, and which would dampen or reverse current trade flows. The basic underlying message would not be different than in the current manuscript, but the comparison to the reference situation is more complicated than for the cropping pattern.

2. *Line 111, in the introduction of study content, information on how many types of crops considered is lacking.*

The following will be added: "We considered 125 crops of the main crops groups (cereals, fibres, fruits, nuts, oil crops, pulses, roots, spices, stimulants, sugar crops and vegetables) (for an extensive list of crops used see (Chouchane et al., 2019)); optimization was performed using the linear optimization routine from the Optimization Toolbox of MATLAB".

3. Line 112-113, the first and second constrains seems conflict each other.

The way how constrains are written now may cause a bit of confusion. A clearer description reads:

"First, **total** rainfed and irrigated harvested areas in each country should not grow beyond their extent in the reference period 1996-2005. Second, the harvested area per country per crop can only expand by a limited rate (which will be varied)".

We thank the reviewer for spotting that and we added the word "total" in the two lines he referred to clearly make the difference between total harvested areas that should not grow beyond the total available harvested areas in the reference period and per crop per country harvested area that could be extended which may result in shifts in cropping patterns.

4. How do you define the 'cropping pattern' ïij§

By cropping pattern, we mean the allocation of crops to rainfed and irrigated land to the countries in the world, where both rainfed and irrigated area of each crop in each country is allowed to be expanded up to a modest maximum rate, while respecting the bounds of current total rainfed and total irrigated area per country.

5. In the analysis, how the green water limits were considered? I am wondering if there are some places with increasing green WFs but have insufficient green water availability?

This is a relevant question from a sharp observation. Green water limitation is considered implicitly in the study through consideration of rainfed harvested area and irrigated harvested area separately and by considering rainfed land productivity. Furthermore, the alpha factor is separately applied to the rainfed and irrigated land. Increasing rainfed production could also be the result of shifting crops to more productive crops (higher rainfed land productivity). This can implicitly increase green water consumption, even when that increase is limited by the alpha factor and the differences in green water consumption by crops. The relevance of the effect can be estimated directly from the results of the optimization, and will be added in a resubmitted version.

6. Line 213, for China you show an 4% increase in BWC. It looks tiny for the whole country, but could matter when such increases in BWC happend in a very severe blue water scarce places within the country. At least some discussion regarding this should be in somewhere of the text. In addition, I am also worry about the assumptions of increasing harvested area per crop so that it could resulted in increases in harvested area in each country, or I could be wrong in understanding the first assumption. Given that for example in China, the national policy is controlling not reducing the total crop harvested

area to a level with no possibility to increase anymore... The issue is also important for developing countries facing rapid urbanization in land. Maybe better to discuss this in some points.

We thank the reviewer for his suggestion. We will add the following in the discussion:

"Changing cropping patterns have reduced global blue water footprint by 9%. However, not all countries benefit the same in the optimized set, India and China, for example, will have a slight increase in their blue water consumption by 5% and 4% respectively. This supports the findings of Davis et al. (2017a) who observed that water scarcity persists in many important agricultural areas (the US Midwest, northern India, Australia's Murray-Darling Basin, for example), indicating that extensive crop production in these places prohibits water sustainability, regardless of crop choice (Davis et al.2017a). In big countries such as India and China, a 4 or 5 % increase in their BWC may seem tiny. However, it could have a negative impact if it occurs in very severe regions of these countries."

About the reviewer's second concern in this comment, the harvested area per country is a constraint in our model. The harvested area for a specific crop could extend by 10% but the total harvested area will remain the same, unless the optimization indicates global production is achieved with less area. Countries will increase the harvested area of the crops in which they have a comparative advantage in terms of blue water and land use and decrease the harvested area of the crops in which they have a comparative disadvantage, this should keep total harvested area per country less or equal to the reference period.

The paper does not consider potential crop land expansions (rainfed or irrigated) to produce additional food to fulfil growing demands, neither does it study effects of improved agricultural practices that may relieve pressure on land and water resources. We agree that the discussion issue raised by the author is relevant in general, but want to restrict specific discussion issues to the scope of the paper.

7. I get confusions when reading the Discussion. It looks too much limitations to get published, too 'optimized' beyond the real. It may be nice to look into the mass of results and pick some countries with results that really meaningful for local national water management. Please carefully consider about how to interprate in the discussion part. Another limitation should be in caution is the issue related to green water availability, scarcity and limits.

We will shorten the description of the results in the discussion and highlight the most important changes.

minor comments:

1. *Line 61, better to give the full name of WEF, either in the reference list.*

WEF refers to the World Economic Forum. We will add the full name.

2. *Table 1, the initial sources of harvested areas or productions should be listed as well.*

The initial source of the harvested areas and productions is FAOSTAT (FAO, 2015). This is now added in Table 1.