Authors' response to Interactive comments on "Trade-offs between crop-related (physical and virtual) water flows and the associated economic benefits and values: a case study of the Yellow River Basin"

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Response to Referee #1:

Dear Referee #1,

Thank you for your valuable comments and suggestions on our manuscript. We provide our responses directly below the comments:

In recent years, trade has become more and more important in international and interregional exchanges, along with the circulation of goods, forming a virtual water flow with commodities as the figurative. This manuscript presents an interesting topic of integrated water flow and economic benefits in crop trade-offs, and gives the readers a new viewpoint of virtual water. In addition, this manuscript proposes a novel algorithm for estimation of the economic net benefits of green and blue water use for crop production based on the water footprint (WF) accounting. The results and advices are useful for the policy making and contribute to management practices. Before publication article should be carefully edited and some parts of the article should be improved according to presented remarks. The remarks are presented below.

1). Page 9, Line 20-21, "the selected year (2003, 2004 and 2006, which were dry, average, and wet year)" is not consistent with the Line 22-23 "Compared to the wet year of 2003,".

Response: We are sorry for the mistake. It should be written as "the selected year (2003, 2004 and 2006, which were wet, average, and dry year) in Line 20-21, Page 9. We also found the same mistake in the abstract Line 7 Page2. We will carefully check through the text to avoid such error.

2).Figure 3 in Page 24, there must be a mistake, dry year is 2006, not 2005.

Response: We will correct this in the revised manuscript.

3)Page 11, Line 20, "We considered only the increased irrigation network efficiencies in responses in the responses in the amount of annual", is it a mistake that "in responses in the responses in"?

Response: Sure, the repetition will be deleted in the revised manuscript.

4). The significance of studying the income benefit of green water footprint is not clear, and the Yellow River basin is so large, space-time precipitation is extremely uneven, so it is possible to discuss the income benefit of green water footprint in different in province scale so that the analysis of the problem is more targeted and applicable.

Response: We agree with Referee #1 that there is no clear interpretation on the significance of studying the income benefit of green water in the text, other than just one sentence "green water, which represents most water consumed by agriculture" in Line 29, page 3. There are two reasons why it is important to assess the economic benefits of green water used in agriculture. First, although green water is free for farmers, human food demand cannot be met without green water (Falkenmark and Rockstrom, 2006). In global green-blue water consumption in crop production, 98% is green (Mekonnen and Hoekstra, 2011). For the Yellow River Basin (YRB), green water accounts for 72% of crop production as averaged over the current considered three years (Table 3). Undoubtedly, green water contributes to the value generation in crop fields thus has economic value (Hoekstra et al., 2001). Secondly, a recent study shows that about 18% of the green water footprint overshoots local sustainable levels, in which 5% happened in China (Schyns et al., 2019). Improving not only the irrigation efficiency (i.e. blue water productivity), but also the green water productivity is key for sustainable cropping. In order to save both green and blue water and get more economic income simultaneously in agriculture, acknowledging only the net benefits of blue water is insufficient. Estimating the economic benefits of green water is equally important. We will add the explanation on the importance of green water and its values for water managers and farmers in the Introduction section in the revised paper.

In terms of the spatial-temporal difference in the net benefits of green water among different provinces in the YRB, we show the values for the whole basin per year in Table 3 and the maps for the average year 2004 as an example in Figure 2. But it is true that we did not discuss in detail in the text, especially on the spatial differences in provincial net benefits of green water. Figure 2 shows that for irrigated crops, the provincial net benefits of green water were defined by the local cropping patterns. For rainfed crops, the net benefits of green water were in line with the level of local precipitation. The wetter the region, the higher the net benefit of green water in the rainfed fields.

5). The advices in Page 14, "So that modifying cropping pattern could be one of the suggested measures, while being of long-term effects, to maximum the economic benefits of physical and VW flows" is too rough, it is better to propose how to change the crop pattern is different provinces such as the statement in report "WATER FOOTPRINT OF COTTON, WHEAT AND RICE PRODUCTION IN CENTRAL ASIA" (Aldaya et al., 2010).

Response: Yes, there is lack of specific suggestions on modifying cropping pattern in the text following the mentioned sentence in page 14. As suggested by Referee #1 and

learning from statements in Aldaya et al. (2010), we will add sentences as followed: Currently, in the YRB, majority high-value crops like apple, cotton and oil crops are concentrated in the provinces Shaanxi, Henan and Shandong in the lower reaches that suffer severe blue water scarcity (Zhuo et al., 2016). Shifting some of the current cultivation of these high-value crops into the provinces in the upper reaches and growing more grain crops in the lower reaches, may help to alleviate the significant trade-offs of the local water and economic efficiencies without reducing or even improving the crop yields.

References

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