

Interactive comment on “Virtual water highway: water use efficiency in global food trade” by H. Yang et al.

H. Yang et al.

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The authors would like thank the anonymous referee 2 for the constructive and insightful comments and suggestions on our paper. Our responses to the referee's general and specific comments are provided below:

- Response to the comments about the overlap of our paper with a paper by Chapagain et al. submitted to HESS...

The initial work of this paper started in 2003. At that time, the issues relating to water use efficiency embodied in the international food trade were drawing much attention in the virtual water community. This partly explains some overlaps between our research and the study by Chapagain, Hoekstra and Savenije, (the paper was submitted to HESS shortly before ours). The similarities in the estimates of virtual water volumes and the water saving at the global level are also not suppressing because both studies have included the major food crops. This is particularly so when the comparison is

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made at the global level. Down to the country level, however, the difference is larger.

- Response to the comments on the methods in quantifying the virtual water flows.

In the earlier version and the revised version of the manuscript, we acknowledged that the estimation of the volumes of the virtual water trade used the virtual water contents estimated by Hoekstra and Hung (2003). The reason is given in the text (see Section 2.1 for detail).

Nevertheless, in the revised manuscript we take the referee's suggestions on the 'two ways forward'. One major change is a substantial shortening of description of the methods in estimating virtual water contents, while providing references wherever necessary. We kept the discussion on the amplification of the virtual water flows from the source to destination. Such a visualization of the amplification is rather novel and has not been seen in previous publications. Another major change in the revised manuscript is the substantial extension of the discussion on the meaning of 'water saving' for the countries with different water endowments. Section 3.3 and Section 5 are devoted to the detail of the discussion. An important point we made is the water saving achieved at the global water is not necessarily socially, economically and environmentally beneficial to individual countries. Concerning the negative impacts of virtual water influx on the poor countries with plenty of water resources, we made the following remarks:

'Much of the virtual water import is in fact to non-water scarce countries. Many of them are poor. Increasing food production by better agronomic practices and field management, including bringing water resources into use, is one of the important ways to improve the rural income and livelihood (Rockström et al., 1999; Rosegrant et al., 2002). The flux of food import to these countries often undermines this effort as farmers cannot compete with the cheap and often subsidized food surpluses from the major exporting countries. The food influx to poor countries depresses local prices and reduces domestic production (Rosegrant et al., 2002). Poor and small farmers are hit the

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most. In this case, virtual water import could be detrimental to food security in these countries. Imagining a reduction of cheap food import, local prices and production in poor countries may rise, improving the utilization of local water resources. This would lead to a lower level of virtual water trading and narrowing gap of crop water productivity between importing and exporting countries. This reduced scale of water saving would have been a result of overall improvement of the efficiency of the use of world water resources.

At the end, we pointed out the complexity in the assessment of efficiency gains in the international virtual water trade and the need for a broader perspective concerning trade-offs of virtual water trade on different geographical scales and on both sides of the trade equation.

- Response to the comments on the errors in the calculation of crop virtual water contents.

In Section 3.1 (the revised version), the possible sources of errors in the estimated virtual water contents are specified. The possible overestimation of virtual water content (and therefore underestimation of crop water productivity) caused by assuming the water demand is fully met is acknowledged. However, the extent of the uncertainty is not quantified because this could be alone a full research paper.

- Responses to the suggestion on reflecting the scale effects in the research:

This suggestion is taken. We believe that there is a need to consider the scale in order to make a meaningful assessment of magnitude of water saving. In the revised manuscript, the discussion is extended to examine the effects of virtual water trade on the countries with different water resources. An increased complicity is expected when the perspective goes down to the local scale. However, this is beyond the scope of this paper due to the length limitation.

Specific comments: p.3, line 23: The typo is corrected. p.8, line 16: The point is

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clarified in the text. p.9, line 27: The suggestion is taken. p.10, lines 13-15: The suggestion is taken. p.12, equation (11): The typo is corrected. p.13: The suggestion is taken. The subscript 'rf' is changed to 'gw'. p.13: equation (14): The term At is defined. p.20, Table 2: The footnote is clarified. p.23 and 25: The scale is removed. p. 26, Figure 5: The text is clarified.

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