

## ***Interactive comment on “Internal and external green-blue agricultural water footprints of nations, and related water and land savings through trade” by M. Fader et al.***

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The paper adds to the growing body of literature in this field. The innovation in this paper particularly lies in the inclusion of both water and land (although the paper doesn't yet take full advantage of this in terms of drawing conclusions about possible trade-offs to be made between land and water footprints when making decisions that affect both). The paper is rather comprehensive: it uses a model with high resolution, includes all major crop categories and makes a distinction between green and blue water consumption and looks at the virtual water content per crop category and country. It quantifies international virtual water and land flows as well as at the savings related

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to these virtual water and land flows. Finally the paper quantifies water footprints of countries related to crop consumption per country. The paper is a bit unbalanced by focusing more on water than land, not only in terms of analysis but also in terms of embedding in the literature. I have a water background myself, so I cannot add very much regarding the land component of the paper, but it is clear to me that much more relevant previous work has been done in the field of land use studies, particularly in the ecological footprint literature. The authors would improve the paper by reviewing the literature on EF and referring how this work relates to that.

Apart from this general remark and a number of specific comments (see below) that will strengthen the paper, it is clear that this paper needs to be published. It enriches the existing literature in the field.

Specific comments

In abstract, introduction and 4.3 it is said that the water footprints of nations are calculated; better formulate more precise: the water footprint of nations insofar related to the consumption of crops. [I admit that later on I read the disclaimer in section 5.2, but that's a bit late, also when presenting the results better not write 'the water footprint of countries' when only the wf related to the consumption of crops is meant].

Intro: When the authors write that “The grid-based study of Mekonnen and Hoekstra (2010) is restricted to wheat and does not consider plant physiologic water stress under irrigated conditions” I am not sure what they mean. That study does account for the effects of water stress on yield under non-optimal irrigation.

In section 2.2 it says: “Only raw commodity classes were used.” That means that not all trade flows of crop products have been included and thus results in a conservative estimate of international virtual water flows and thus a bias in the estimation of water footprints of nations (too high estimate for net exporters of the excluded crop products; too low estimate for net importers of the excluded crop products).

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Section 3.3 & 4.3: A major omission in the analysis of water footprints of nations is the exclusion of trade in animal products. Virtual water flows related to trade in animal products were included in: Chapagain, A.K. and Hoekstra, A.Y. (2008) The global component of freshwater demand and supply: An assessment of virtual water flows between nations as a result of trade in agricultural and industrial products, *Water International* 33(1):19-32 [this publication deserves inclusion in the refs anyway]. Excluding trade in animal products in the estimation of water footprints of national consumption implies that crops that are used as feed for animals that produce meat or other animal products for export will count for the water footprint of national consumption of the country considered, which should not be the case. Reversely, when animal products are imported into a country the water footprint of the importing country is higher than follows from the results of this study. It would be good to add this disclaimer somewhere in the discussion of the results.

In 4.4.1 about water savings reference should be made to other earlier studies. Proper ref is made to Oki and Kanae (2004), De Fraiture et al (2004) and Yang et al (2006), but not to: Chapagain, A.K., Hoekstra, A.Y., and Savenije, H.H.G. (2006) Water saving through international trade of agricultural products, *Hydrology and Earth System Sciences* 10(3): 455-468. The latter seems to be the most comprehensive of the four studies.

Section 5.2. It reads: "Moreover, future studies would have to relate the current consumption to the resource base, i.e. assess whether virtual water export aggravates water scarcity in the exporting country". This sort of analysis has been done a number of times already, see for example Van Oel, P.R., Mekonnen M.M. and Hoekstra, A.Y. (2009) The external water footprint of the Netherlands: Geographically-explicit quantification and impact assessment, *Ecological Economics* 69(1): 82-92.

Regarding the worldwide high-resolution estimation of the virtual water content of crops, a very similar study was published end 2010: Mekonnen, M.M. and Hoekstra, A.Y. (2010) The green, blue and grey water footprint of crops and derived crop prod-

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ucts, Value of Water Research Report Series No.47, UNESCO-IHE, Delft, the Netherlands, <http://www.waterfootprint.org/Reports/Report47-WaterFootprintCrops-Vol1.pdf>. I guess that the authors hadn't seen this report when finalizing their manuscript, but since the similarities are so striking it is worth making in section 4.1 some rough comparison and reference.

Refs:

The ref to Chapagain, A. K., Hoekstra, A. Y., Savenije, H. H. G., and Gautam, R.: The water footprint of cotton consumption, Research Report Series 18, 2005. can better be replaced by a ref to the published article: Chapagain, A.K., Hoekstra, A.Y., Savenije, H.H.G. and Gautam, R. (2006) The water footprint of cotton consumption: An assessment of the impact of worldwide consumption of cotton products on the water resources in the cotton producing countries, *Ecological Economics*. 60(1):186-203.

The ref to Mekonnen, M. M. and Hoekstra, A. Y.: A global and high-resolution assessment of the green, blue and grey water footprint of wheat, Value ofWater, Research Report Series Nr. 42, 2010. can be replaced by a ref to: Mekonnen, M.M. and Hoekstra, A.Y. (2010) A global and high-resolution assessment of the green, blue and grey water footprint of wheat, *Hydrology and Earth System Sciences*, 14(7), 1259–1276.

Rockstrom et al (2009) is not a complete reference.

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