

Interactive comment on “Water saving through international trade of agricultural products” by A. K. Chapagain et al.

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First of all, my apologies for what has turned out to be a long text and which also is not completely in line with the structure requested for the HESSD. As a very first remark, before anyone enters in my lengthy comments, I should perhaps clarify that I really enjoyed reading the paper and that I realize that my comments may be well beyond what the authors can reasonably be expected to digest. Nevertheless, I hope the authors can read through my comments to pick out those items that they find useful to improve their work.

General Impression

The paper is well written and makes a useful contribution to science by presenting work on a further refinement of the methods to assess virtual water trade (VWT) flows.

The paper departs from a review of available studies in the area of virtual water trade and identifies some of the remaining research gaps, such as the need to take into account the opportunity costs and the difference between green and blue water in assessing VWT savings and losses. The paper sets out to make a more accurate estimation of global water savings through virtual water trade, taking into account climate, yield and cropping patterns per country. Although I must admit I am not an expert in doing such calculations, I trust the calculations to be reliable based on the description of the method used. The paper succeeds in achieving its goal, it shows the main outcomes and has very useful tables and illustrations. Thus, I consider it to be a good paper and definitely worth publishing. However, I have some points that I would like to raise for some of the sections in the paper, a more general point on its structure, and a final note for discussion.

I. Comments on specific sections in the paper

Section 2: Method (p.2223-2224)

1. The presented method represents an improvement over existing studies and is presented in a clear and straightforward manner, without excessive detail. What could be added, is mentioning databases they have used for establishing climatic data and cropping patterns. 2. The introduction raises some expectation that aspects such as blue-green water and opportunity costs are taken up in this paper, but they are not explicitly taken into account in the presented method. So perhaps it could be mentioned more clearly in the introduction already that these will remain outside the scope of the (core of) the paper. They are addressed, but only for some specific examples and only qualitatively. 3. For livestock water use, the presented method has some very important limitations that probably should be acknowledged. The issue of opportunity costs is paramount in interpreting the significance of the virtual water content of their feed.

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The example of beef from the pampas in Argentina is probably well-known, but even in African (or other) drylands, livestock grazing may be the best option to convert rain-water and soil moisture into something that has a nutritional value for human beings. This poses additional difficulties to the meaningful calculation of livestock virtual water contents.

Section 3. National water savings (2224-2225)

4. In this section, some very important points are made, qualitatively, regarding the opportunity cost of water in the water saving countries. One is that water scarcity is not necessarily the main driver for virtual water trading - it may be driven by scarcity in other production inputs (such as suitable land), or simply by fact that country does not have the climatic conditions for production of certain imported crops (Germany). (I find the Egyptian example to be mainly theoretical only - although Egypt has inspired the development of the VWT concept and the concept has a clear potential in this country because of the high blue water content in its agricultural production, its food-trade policies seem driven by political much more than the economic considerations discussed here)

Section 4. National water losses (2226-2227)

5. The example from Thailand. The last sentence reads: “Though it is a crude estimation of the opportunity cost of rice export, it indicates that the volume of national water loss could have produced higher economic benefits to the nation”. This statement begs the question of how the water used for rice production could provide higher benefits to the nation. The authors state in the same paragraph that “rice cultivation in Thailand is done during the rainy season”. I was under the impression that in this period there are no real water shortage problems, and in the absence of acute water shortage problems, the question is why Thailand should want to optimize on its water use in the rainy period (rather than on other production input factors), and what it could meaningfully grow if not rice. And, the fact that Thailand is saving resources globally

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by its rice exports, as is shown later in the paper, adds further to the confusion here. It left me wondering: if rice cultivation fits the country's physical, social and institutional capital, if it doesn't infringe unduly on its fresh water resources, and if it contributes to water savings globally, then why suggest they may use their water better otherwise? But perhaps I am not aware of some important specifics in the situation or some of my assumptions are wrong. Thus, for this specific example on the opportunity costs of water use in Thailand, I would like to ask the authors to clarify their statement: how they think Thailand could make better use of its water and why it should be interested in doing so.

Section 5. Global water savings (2228)

6. The authors account for climatic conditions in their calculations of crop water requirements. For the USA, as well as for other large countries, it seems quite important where in the country the crops are grown. Is this taken into account? 7. The second example of Japan may need to be rephrased; I am not an expert on water in Japan, but I have the impression that water scarcity concerns do not seem to be a high priority in most periods and therefore the water import may not be very important. Rather, it may simply be a positive externality that comes along with a decision that is driven/necessitated by other considerations (and indeed land availability may be one).

Section 6. Blue water savings and green water losses (2230 - 2231)

8. This section is presented fairly late in the paper, but does not contain additional data or outcomes, rather it describes a methodology for assessing blue and green water savings and losses and its use for assessing a trade-off point for one specific country (Australia). It seems this would fit better in an earlier part of the paper? (Methodology section?). It is a bit unsatisfying in that it mentions a method, and, together with the paper's introduction, raises the expectation that the authors actually include green and blue water in their study, but in actual fact they just acknowledge its importance but they do not include it in their global assessments. This is not a big problem, as long as they

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acknowledge the resulting limitations (which they do), but with the current introduction and with putting this section at the end of the paper, they raise the expectation that they cover it more extensively than they do.

Section 7. Discussion (p.2232-2233)

9. A minor point: the reference to the international trade theory described by Wichelns. I don't know the paper by Wichelns and I can even guess what it may be getting at, but nevertheless, the notion of an "absolute" versus a "relative" advantage seems strange to me. One would think that the concept of "advantage" by definition points to a relative concept; one has an advantage over someone else, or not? How can one meaningfully talk about advantage in an absolute sense?

10. The paper ends with: "there is an urgent need to address the global water scarcity problem". This presents VWT as a means to address the global water scarcity problem, which may be precisely why the concept of virtual water trade has so much difficulty to gain acceptance with policy makers. In my view, there is no global water scarcity problem, rather, there are many local and regional water scarcity problems (I don't know its contents, but from the abstract and title of a forthcoming book: "Water Crisis - Myth or Reality", by Peter Rogers et al. I am guessing that it would support this point). Addressing the local and regional water problems may be done through the use of VWT, but perhaps this requires targeted studies, for specific countries or regions, to see how they could save water through VWT and what other productive uses they could then find for the water savings. To make the transition from academic insight to information of more direct relevance to policy makers, starting from a specific country, and taking into account many more variables than just water use, may be a useful starting point.

II. Suggestion related to the general structure of the paper

11. The last comment above flows logically into a suggestion on the structure of the paper. The analytic findings give an interesting insight into water savings and losses

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through international trade. However, the policy assertions based on these calculations (such as the suggestions that countries could do better with regard to their water use, or are making the right decisions in importing virtual water), leave room for debate in my opinion.

12. This has to do, at least in part, with the issue of green and blue water and of opportunity costs more generally, for appropriately weighing the benefits of virtual water trade. This is also acknowledged in the paper's introduction, and indeed this is critical. Unfortunately, these opportunity costs are hard to assess, especially when one takes a global perspective. Probably a meaningful assessment of the opportunity costs involved, and a more accurate assessment of policy implications for specific countries, would require a more in-depth study of virtual water trade for a specific country or a small group of countries, to enable a better understanding of various factors that drive agricultural production and trade decisions in a country, as well as possibilities to put water to other productive uses, and their impacts (which are all likely to be highly country-specific).

13. A general suggestion therefore would be to separate more clearly the presentation of the calculations on global savings through virtual water trade, which is where the paper makes a valuable and undisputed contribution, followed by a discussion of the difficulties involved in translating these outcomes into policy recommendations in a separate "discussion" section (and what is now called "discussion" could be more of a concluding section). This discussion section could be presented, already in the introduction, as an attempt to shed some light on how the issues of opportunity costs and green/blue water affect the interpretation of the presented figures on VWT. This would also solve the problem of, at the one hand suggesting these issues are taken up, while at the other hand not having them at the core of the analytic work presented. It would, in my view, also make it less important that some of the discussions here seem a bit hypothetical, as it is merely illustrating how the inclusion of opportunity costs and green/blue water consideration could play out. And still, for some of the examples they

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could show that, even with all the uncertainties and limitations, the global data still make a strong case for either imports or exports of virtual water. In my view, this would separate (undisputed) findings more clearly from discussion, thus making the paper less prone to controversies over the policy implications of the VWT calculations, which are now spread over various sections of the paper. But of course, this is partly a matter of personal preference.

III. A last note for discussion

14. This last part of my response is not so much meant as a review, but just as something I would like to table for discussion. It is not at the heart of the paper, but still, I found it worthwhile to identify it here as some sort of an annex.

15. In the introduction (on p.2222), the authors argue that the implementation of economic principles could help improve water use efficiency: “At a local level, that of the water user, water use efficiency can be increased by charging prices based on full marginal costs,...” and “At the catchment or river basin level, water use efficiency can be enhanced by re-allocating water to those purposes with the highest marginal benefits” The way in which these statements, which up to now have had only theoretic significance for water management, are casually made as universal truths raises some questions. If marginal cost pricing and allocation based on marginal benefits are potentially useful, then one first needs to find an answer to the question how to assess them. The market theory with its reference to marginal costs has been designed with private goods and specific conditions in mind. In these cases, one does not need to bother with assessing marginal costs and benefits, as they are kept in equilibrium by the invisible hand of the market. Unfortunately, for water being the common pool resource that it is, markets cannot be relied upon for keeping the balance. So then what are the methods to assess the full marginal costs (and benefits) of water use in agriculture (and other sectors)? And who is to decide what is to be included in these costs and benefits, in order to ensure that allocation on the river basin level takes into account water use efficiency from the societal point of view? And given the analytic

inaccuracies in assessing full marginal costs and benefits, what are the implications of attempting to “get the price/market right” or to allocate water to those purposes with the highest marginal benefits in the face of imperfections? Besides these practical difficulties, one could even argue the theoretical merits of these arguments, as basic economic theory already shows that the requirements for well-functioning markets are not present for water. This raises the question how far one can go in making the practice to fit the theory - and when one should decide to adapt the theory to the practice. This is not to say that pricing or market incentives may not be used to improve water use efficiency, but these are less strict and much less wide ranging than “full marginal costs” and “highest marginal benefits”.

16. Combining this “marginal costs” item with the more general references in the paper to the use of VWT concepts to address global water allocation issues, makes one wonder what the position of the authors is in the debate on the usefulness of economic principles to guide water allocation decisions. Somehow the virtual water trade argument seems very much in line with an argument for using economic principles and international trade to guide water allocations globally. But of course in reality these principles can only be relied upon for a very limited extend for agricultural water management. The authors acknowledge this in various places in the paper, but nevertheless, they also give me the impression that they have a somewhat ambivalent position and that, despite the imperfections, markets could and should still be used to “optimize” virtual water flows (or at least to increase the global water use efficiency). I am left a little bit puzzled about where the authors stand with regard to using economic theory to guide water resources management.

17. As said, it is not central to the paper, and it may sound a little bit like picking on words, but I feel that some more can be done to think this through; if the girl is special, then what can and what can't one expect from economic theory in guiding water allocations? I am guessing that this might also be useful somehow for making a future step in translating VWT analyses into policy recommendations.

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