

This paper presents an analysis of the water embodied in trade that was used to dilute nitrogen pollution. This is a well-written paper and an interesting idea; however, there are several major issues with the methodology and interpretation of the results that preclude it from publication at this time. Additional pollutants (i.e. phosphorous, others) should be considered in order to quantify polluted water (i.e. “grey water”) flows. Major assumptions and shortcomings of the methodology should be included, with implications for the main results. Claims that trade leads to more agricultural pollution should be removed, since no causation can be inferred from the analysis. The inequity analysis should be clarified and compared with other papers in the literature (e.g. Craswell et al 2010) that indicate lack of access to nutrients is the equity issue.

Major Comments:

There are major problems with the grey water footprint methodology used:

- (1) The grey water footprint here is a theoretical volume that must be applied to dilute the concentration of agricultural chemicals. This volume is not applied in practice, so there is nutrient leaching from agricultural fields. For this reason, this quantification is not an accurate representation of actual water pollution.
- (2) It is misleading that “agricultural pollution” and “grey water” are the terms used throughout the paper, when only nitrogen runoff is considered. The title and terminology throughout the paper should be adjusted to be more precise and specifically represent nitrogen pollution only.
- (3) A time invariant measure of nitrogen application was used, but the paper presents grey water trade over time, which is not even mentioned as a caveat.
- (4) A set fraction of the applied nitrogen is assumed to run-off the agricultural lands, where a more sophisticated methodology could be used.

It is problematic that nitrogen is the only nutrient considered in this study. Other papers have examined the implications of trade for phosphorous (see Schipanski et al 2012, Craswell et al 2010), so this nutrient should be included too, particularly to keep the terms “agricultural pollution” and “grey water”. Until you include other pollutants, how can you claim that they will not change the trend? (i.e. please remove P11230 L9-11)

The methodology section is incomplete and many of the major assumptions are not clearly stated. The methodology on the grey water footprint calculations should be included in greater detail. The problematic assumptions, such as the time invariant data and assumption of a runoff threshold, should be explained and addressed. The commodities used should be included (rather than referring to Carr et al 2013). More information is needed on how Gini coefficients are calculated and what they mean (rather than referring to Seekell et al 2011).

The USA was presented as the largest exporter of grey water (i.e. USA subjects itself to nitrogen runoff). However, the entire discussion focuses on the inequality of the trade system. The discussion focuses on how highly developed countries off-shore their nitrogen pollution, which does not reconcile with the results of the USA as the major exporter. Please explain.

Similar to the above point, inequality in internal grey water networks was shown to dominate inequality (P11229 L3-6). However, the discussion focuses on external inequality (P11230 L12-15). Please explain. Also, if most inequality is driven by internal footprints, does that mean that food trade actually leads to off-shoring of pollution in some unfair way? Please explain how your findings on inequity relate to the paper by Craswell et al 2010, who indicate that lack of access to nutrients is the equity issue, rather than over-use of the nutrient, as indicated in this paper.

There are several places in the paper where it is claimed that trade leads to increased water pollution. However, just because a correlation exists, this does not indicate causation. It is possible that there would be more water pollution without global trade. For example, the world without trade may lead to an agricultural system with increased nitrogen inputs. In other words, trade may be leading countries to become more efficient in their internal grey water footprint (see Copeland and Taylor 2005, who causally show that trade reduces pollution in some cases). While it may be true that nitrogen inputs have increased over time, it is not clear that trade is driving this trend, so please remove all statements that trade is leading to more pollution unless you can identify a causal mechanism (i.e. P11231 L17-19; last sentence of abstract; others)

Terminology:

Externalize: In many places you use the term “externalize” in reference to trade. However, I think it would be better to use the term “off-shore” or “transboundary externality”. This is because “externality” is commonly used to refer to a negative impact of production, such as pollution. In other words, the production of pollution is already an “externality” to growing food. Now, you want to talk about the production of this pollution externality specifically in the non-consuming country, so please use another term to avoid confusion due to dual meanings of “externality”.

Minor Comments:

P11224 L11 and P11229 L20-21 Please cite papers that actually present analysis of blue and green virtual water transfers. The papers that you cite here do not present work on blue or green flows.

P11225 L25 and P11228 L17 Strength vs degree does not indicate network clustering.

P11228 L4 Here and in other places you state that the global grey water network is becoming more connected, when it is actually the food trade network globalizing. Whenever you are referring to the non-weighted properties of the network, it is best to refer to the actual commodity trade network, since this is what the trade links are based upon.

P11229 L17-18 What are you referring to here? Grey strength? Grey GWF? Please reference the appropriate graph (i.e. Fig 4A or 4C?)

P11230 L19-20 It is not clear what causes the structure, please remove this statement.

P11230 L23 It appears that Mekonnen et al 2010 provide a constant grey water footprint across goods. Do they provide commodity specific grey water footprints? If not, please remove this sentence. If so, please include some data.

References:

Copeland and Taylor (2005) Trade and the environment: Theory and evidence, Princeton University Press.

Craswell, E.T, Vlek P.L.G, and H. Tiessen (2010) Peak phosphorous – implications for soil productivity and global food security,
<http://www.iuss.org/19th%20WCSS/Symposium/pdf/0712.pdf>

Schipanski, M.E. and E.M Bennett (2012) The influence of agricultural trade and livestock production on the global phosphorous cycle, *Ecosystems* 15: 256-269.