

***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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**Summary**

Fader et al. presented a rather complicated accounting of water resources manifested in traded agricultural products. The authors follow the logic of distinguishing green and blue water resources and tabulating the rainfed (green) vs. irrigated (blue) water contents in various traded crops. While, I think the proposed accounting is rather cumbersome, I am open to entertain the conclusion that it is my own fault not seeing the value of the presented work. The fundamental goal of the paper, which is to demonstrate how trade actually lowers human footprints both in terms of water and land use

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is rather important. I recommend the publication of the paper in its present form in a hope that the scientific community either will be able to make more out of it than I do or help to polish the presented concepts further.

**Detailed Comments**

Green and blue and virtual waters are interesting concepts at first glance that could guide better water resource management, but after closer look one loses confidence that these distinctions are indeed that useful. First of all, the distinction of green and blue water seems to be somewhat arbitrary. For instance, this paper appears to consider rice as primarily an irrigated crop. While this is the common perception in the western world, I had a colleague from Nepal many years ago, who convincingly argued that rice is not an irrigated crop beside the initial inundation (which is often satisfied from local water resources). In Nepal and I suppose in many part of China, Korea or Japan the rice paddies are actually dominantly rain fed. It is also unclear, where rain harvesting fits into the green/blue water distinction.

The incompleteness of the virtual water concept also was raised at a recent Global Water Systems Project meeting in Bonn, where the second author presented some aspects of this work. Apparently, virtual water and virtual land alone cannot explain some of the agricultural trades. Perhaps, one should introduce yellow/red and virtual radiation analogous to the green/blue and virtual waters, where yellow radiation represents solar radiations allowing crops to grow without greenhouse, while red radiation is the artificial heat or radiation needed to grow certain crops in less favorable climate. The yellow/red radiation complementing green/blue water can explain countries like Israel, which imports cereals, while exports high value irrigated crops (fruits and vegetables, etc.) to water rich countries (like Canada, which obviously cannot grow plants like olive trees).

Ultimately, green/blue water seem to miss the value of water. Focusing strictly on water efficiency is misleading since countries with abundant water resources are prob-

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ably rightfully ignorant about the virtual water content of their agricultural products. To some degree, green-water is a confusing concept. For instance, the water demand to grow wheat in Canada is a fraction of growing the same crop in Egypt, Libya or Algeria, therefore the virtual water value of the Canadian wheat in those countries is much higher. I suppose, one could calculate the water requirement to produce particular crop in importing countries and account virtual water trading accordingly. Even, if the water requirements are the same in the exporting and importing countries the availability of the water and the impact of allocating the demanded water to crop production could be drastically different. Virtual green-water uptake in a region could be similar to the water uptake by the natural ecosystems and as a consequence irrelevant from water resources perspective. The deviation from the water requirement of the natural ecosystem vs. the cultivated land might be a better metric. Land area appropriated for agricultural production is more likely to matter in terms of human footprint.

I tried to build a glossary of terms and acronyms introduced in this paper (see below) and I have to say it is mind boggling. I wonder, if it is the best way to communicate the ultimate goal for sustainability, which is to satisfy human consumptions while minimizing the disruption of natural ecosystems.

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## **Glossary**

CFT – Crop Function Types

WFP – Water footprint (external and internal)

VWF – Virtual Water Flow

VWC – Virtual Water Content

BVWC – Blue Virtual Water Content

GVWC – Green Virtual Water Content

BVWE – Blue Virtual Water Export

GVWE – Green Virtual Water Export

BVWI – Blue Virtual Water Import

GVWI – Green Virtual Water Import

BVWB – Blue Virtual Water Balance

GVWB – Green Virtual Water Balance

VL – Virtual Land

VLE – Virtual Land Exported

VLI – Virtual Land Imported

VLB – Virtual Land Balance

IWFP – Internal Water Footprint

EWFP – External Water Footprint

BIWFP – Blue Internal Water Footprint

GIWFP – Green Internal Water Footprint

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BEWFP – Blue External Water Footprint  
GEWFP – Green External Water Footprint  
WS – Water Saving  
LS – Land Saving  
WR – Water Released  
LR – Land Released  
NWS – Net Water Saving  
NLS – Net Land Saving  
Y – yield

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