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Interactive Comment

Interactive comment on "Review and classification of indicators of green water availability and scarcity" *by* J. F. Schyns et al.

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We thank Referee #1 for the time and effort put in this elaborate review. We are glad that the referee sees our contribution as "most welcome and laudable" and appreciate the comments. In the following, we sequentially respond to the topics (headings) raised by the referee.

GREEN WATER AVAILABILITY, INPUT AND OUTPUT

There exist indeed various definitions of green water: as an inflow (precipitation, e.g. as in the mentioned study by Weiskel et al. (2014)), as a stock (soil moisture) and as an outflow (actual evaporation). We agree that the prevalence of multiple definitions is interesting to discuss in the paper. We will add a reflection on these different definitions

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in Section 2.3 in the revised version of our paper.

Despite the various definitions of green water, scholars who have tried to quantify green water availability in water scarcity assessments mostly defined it as actual evaporation over land (Rockström et al., 2009;Gerten et al., 2011;Kummu et al., 2014), i.e. as an outflow. Our definition of green water availability is thus in line with these studies, as noted by the referee.

Since we define both green water availability and demand as a flux, green water scarcity is indeed dimensionless. We think it is appropriate to compare availability and demand in the same units and express green water scarcity dimensionless. This is also common in indicators of blue water scarcity (e.g. (Vörösmarty et al., 2000;Smakhtin et al., 2004;Wada et al., 2011;Hoekstra et al., 2012)).

The referee points our attention to the indicators developed by Weiskel et al. (2014). This paper introduces a green-blue index that indicates whether vertical precipitation and evaporation fluxes dominate in a hydrologic unit (compared to horizontal blue water flows), which in tandem with a precipitation map can indicate whether such a unit has potential for rainfed agriculture. Furthermore, the hydrologic-unit evaporation ratio by these authors is an aridity indicator, which measures actual evaporation over precipitation, applied to the level of a hydrological unit. We will gladly include these indicators in our classification (as absolute green water availability indicators).

WATER QUALITY

We agree that it deserves to be mentioned that the concept of water quality in the case of green water differs from the case of blue water; in the case of green water we talk about soil water properties, relevant for instance for plant growth. We will add some reflection on what means water quality in the case of green water in Section 2.4.

GREEN WATER DEMAND

The phrasing “human demand for green water, associated with the production of biomass for human purposes" on the first two lines of page 5528 appears to be confusing. As indicated by the last part of the sentence, we mean the demand for green water associated with the production of biomass for human purposes. The referee rightfully notes that this demand is mostly indirect as also mentioned in the introduction of the paper (so with "human water demand" we meant to refer to "crop water demand" and other demands for green water for production purposes). We will remove the superfluous and confusing word "human" as adjective in "human water demand" in this context.

Furthermore, the referee raises the point that biomass production is not in all cases entirely attributable to humans. Indeed, the intensity of land use determines which part of the green water flow is related to human production and which part not. For cases where the land-use is partly nature and partly for human production (e.g. a semi-natural production forest), the green water demand related to human production would need to be expressed as a fraction of the total green water flow. Methods to do so for a production forest are discussed by van Oel and Hoekstra (2012). One could for example compare the actual harvested wood yield with the maximum sustainable yield of the forest as an indication to which degree the full capacity of the forest is appropriated for human production. Furthermore, one could allocate the forest evaporation over the various forest functions (incl. biodiversity conservation) according to their economic value. For clarification, we will add a note on this issue after defining the green water footprint on page 5537.

GREEN WATER SCARCITY

Under this heading the referee draws our attention to an aridity indicator by Vörösmarty et al. (2005) we did not yet include. We thank the referee for doing so and we will be happy to include it in the list of aridity indicators.

We agree that in Section 3.2 of the paper more attention can be paid to the concept of green water scarcity from the perspective of non-optimal green water accessibility for

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the plant in the root zone. The related transpiration efficiency ratio between productive (transpiration) and unproductive (soil evaporation) vapour flow was already included in the discussion, but we will expand on this by also discussing the processes that influence the green-blue partitioning and the transpiration efficiency and how these processes (and hence green water scarcity) are influenced by humans.

GREEN WATER FOOTPRINT

See the second comment under the heading “GREEN WATER DEMAND”.

FUTURE RESEARCH

We agree with the referee that our indicator review would benefit from some more discussion. We will add to our review more reflection on the indicator classes and the rationale behind them. Specifically, we will discuss per category of indicators (where not already done so): which insights are they able to provide and which not; for which purposes are they useful (rationale behind development); which processes, both natural and human, are of influence on the indicators.

Lastly, the referee points out that our study appears in the beginning of a new era in which old concepts are becoming outdated. In the past, water planning, management and research have had a focus on blue water. Indeed, tipping-point phenomena are both green and blue water related and require management by combined water and land stewardship. Therefore we hope this paper is a stepping stone towards the inclusion of green water in quantitative water scarcity assessments, which will improve our understanding of these phenomena.

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