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Discussions

Interactive comment on "Assessing Green and Blue Water: Understanding Interactions and Making Balance between Human and Nature" *by* Ganquan Mao et al.

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The authors of this paper aim to improve the understanding of the hydrological interactions between green and blue water, and the relation between water for agriculture versus water for natural ecosystems. They study an arid endorheic river basin in China and use a coupled groundwater-surface water model. I have five major concerns with this manuscript:

1) The literature review on the one hand is very lengthy – going into many directions that seem not so relevant for this paper – while on the other hand key references are not included or not discussed properly. In the end it remains vague what the exact

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contribution of this paper is and where the novelty lies.

Perhaps the most relevant study which is not mentioned is the one by Weiskel et al. (2014). They used a detailed distributed water balance model to simulate green-blue water fluxes across the US and develop a classification of hydrological regimes/units based on these green-blue water fluxes. Another study that looked into the interaction between green and blue water fluxes is the one by Chukalla et al. (2015). They developed a method to separate cropland evaporation into green and blue fractions based on the ingoing and outgoing fluxes of the water balance. Other recent studies of relevance that could be included are: Lathuillière et al. (2018) and Xu & Wu (2018). The paper by Schyns et al. (2015) is referred to in an odd context in the manuscript (page 3, lines 21-23).

It is not clear what is the (novel) contribution of this manuscript. The conclusion section contains some claims on the novelty of the research which are strongly overstated: (a) “This study for the first time assesses the water resources by considering not only the blue and green water but also their interconnections.”; and (b) “This study also investigated the blue and green water from both water supply and water consumption perspectives, while conventional studies focus only on one of them”. Regarding statement (a), the studies by Weiskel et al. (2014) and Chukalla et al. (2015) considered this in a detailed manner. Basically, all studies that use a hydrological model or vegetation or crop growth model with a proper water balance in there take into account the interaction between green and blue water (e.g. Rost et al. (2008); Hanasaki et al. (2010)). Regarding statement (b), papers on combined green-blue water scarcity have studied green and blue water consumption versus green and blue water availability (Rockström et al., 2009; Gerten et al., 2011; Kummu et al., 2014). See also Schyns et al. (2015).

2) The definitions of green and blue water in this manuscript deviate from previous studies for unknown reasons, and the definitions are mutually inconsistent. Since the focus of the manuscript is on the interactions between green and blue water flows (as put forward prominently in the title and introduction), this is a serious methodological

flaw, which really makes me question the scientific quality of this work.

Various definitions of green water exist (see Schyns et al. (2015) section 2.3), though most studies define the green water flow as actual evapotranspiration (or more preferably called evaporation (Savenije, 2004)) from land, excluding the part of evaporation that is the result of blue water resources that have been redirected to the soil moisture through irrigation, capillary rise, or natural flooding. The authors have chosen their own definition of green water: "The green water resources from precipitation are calculated by summing up the infiltration simulated by the model for a certain period (e.g. annual scale), as the infiltrated water from precipitation will be stored in the unsaturated soil and eventually be used by the terrestrial ecosystems." This definition is incomplete and inconsistent with how blue water is defined. Water that infiltrates into the unsaturated zone of the soil will in part evaporate – through soil evaporation and through plant transpiration – and in part it will add to groundwater and surface water through percolation and interflow. Rockström and Falkenmark (2000) refer to this as the 'second partitioning point'. It is thus not true that the "infiltrated water from precipitation will be stored in the unsaturated soil and eventually be used by the terrestrial ecosystems" as the authors state. Infiltrated water will in part contribute to blue water resources. Furthermore, the authors' definition of green water does not include the intercepted rainwater that evaporates. Evaporation of intercepted rainwater is also part of the green water flow, albeit a non-productive vapour flow (Rockström and Falkenmark, 2000).

The authors have the following definition of blue water: "The blue water resources from precipitation are calculated by summing up the model simulated surface runoff, subsurface runoff and the groundwater recharge." Since infiltrated precipitation contributes to subsurface runoff and groundwater recharge as explained above, the used definitions of green and blue water are inconsistent and double-counting occurs.

The authors speak of irrigation and capillary rise as a transformation of blue to green water, and use the following definitions of green and blue water consumption: "The green water consumption refers to the evaporation in terrestrial pixels and the blue

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water consumption refers to the evaporation in open water pixels." I find this highly confusing, since it suggests that irrigation (and capillary rise) is accounted for by the authors as green water consumption, while previous studies all see this as blue water consumption (e.g. Oki & Kanae (2006); Rost et al. (2008); Liu & Yang (2009); Hoekstra & Mekonnen (2012); Hanasaki et al. (2010); Siebert and Döll (2010)). In fact, this means that this manuscript treats all agricultural water use as green water. An example from the paper: "...while the second highest green water consumption ecosystem is farmland (24.4%) partly due to the intensive irrigation" (page 7, lines 29-30). Moreover, the quoted definition suggests that open water evaporation is a form of blue water consumption, while in fact open water evaporation is purely natural, unless we are talking about open water evaporation of man-made reservoirs (Hogeboom et al. (2018)).

The definition of water availability that is put forward is also not clear: "The water availability in this study refers to the amount of received water resources for a certain period." What is meant by the received water resources? Simply precipitation?

3) The second objective of this manuscript is to study the relation between water for humans versus water for nature, as put forward in the introduction and the manuscript title. However, this is only addressed superficially without even mentioning the term 'environmental flow (requirements)' in the manuscript.

4) None of the three major findings presented in the conclusions are new insights. Three major findings are presented in the conclusions. The first one basically says that irrigation is important, since in arid areas soil moisture stemming from precipitation is insufficient for agriculture. The second one confirms this and mentions that the green-blue partitioning depends on the land use. The third one says that natural ecosystems may be under pressure when human water demand increases, and when water availability decreases the ratio of water use to availability increases (if demand remains the same). I fail to see what is new about these insights.

5) The overall writing style is not on par with the level of a high quality paper, as indi-

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cated by the above examples of overstatements and definitions that are not fully clear. Also many (vague) claims are made without proper justification. Some examples from the conclusions section: "It allows us to explicitly assess the green and blue water resources beyond the water balance, while the traditional methods using lumped or semi-distributed model might be insufficient."; "Such sophisticated research framework allows us to take into consideration of all the important factors into water resources assessment as possible."; "The detailed analyses of green and blue water dynamics bring us a step further to understand the human and nature water use dynamics."; "It provides essential implications for water management under the changing environment that aims to make the balance between humankind and nature and towards sustainable development."

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