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Interactive comment on "What could irrigated agriculture mean for Amazonia? A review of green and blue water resources and their trade-offs for future agricultural production in the Amazon Basin" *by* M. J. Lathuillière et al.

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Specific comments:

-"I'd recommend cutting "What could irrigated agriculture mean for Amazonia?" from the title

This is now the second comment we've received regarding the title. As discussed with anonymous reviewer 1 (AR1), we were hoping to bring forward our main question about additional water vapour flows that would be generated by irrigation within the more general aspect of agricultural water management. We are now considering moving the

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position of the question to follow the outline of the paper and suggest this new title: “A review of green and blue water resources and their trade-offs for future agricultural production in the Amazon Basin: What could irrigated agriculture mean for Amazonia?”

-“My understanding is that the body of work that the authors reference may be more commonly known as the ‘water footprinting’ framework (or just blue and green water accounting)”

We view the separation of green/blue water as essentially an ecohydrological perspective because: (1) it provides a new focus on the role of soil moisture in what Rodrigues-Iturbe (2000) described as a “keystone of numerous fundamental questions which may be instrumental in the quantitative linkage between hydrologic dynamics and ecological patterns and processes” (Water Resources Research 36(1), 3–9, doi:10.1029/1999WR900210) and includes the recycling of regional precipitation as a key ecosystem service (Ellison, D. (2012) On the forest cover-water yield debate: from demand- to supply-side thinking, Global Change Biology, 18, 806âĂŠ820, doi: 10.1111/j.1365-2486.2011.02589.x.); (2) it provides a much needed framework to link water and carbon cycles in the context regional and global challenges (Dolman, A.J. et al. (2014) Fifty years since Monteith’s seminal paper: the emergence of global ecohydrology, Ecohydrology 7, 897-902, doi: 10.1002/eco.1505).

It is true that the terminology of green/blue water appears frequently in the ‘water footprint framework’ which focuses exclusively on human appropriation of water resources and does not necessarily include natural ecosystems in the same way the green/blue water literature cited in our manuscript has addressed it. A water footprint assessment is a logical consequence of what we are describing in this manuscript and is currently in preparation for the region. At this time, we feel that adding another research “theme” and terminology to the paper could bring about more confusion. This would be particularly true for an audience more familiar with Amazonia’s water resources which does not necessarily use terms such as as green or blue water.

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-“The back-of-the-envelope calculation nicely motivate the call for future research on irrigation (. . .) First, there is a debate about the quantification and efficacy of improvements to productive green water use (. . .); Second, there is no mention of water quality trade-offs.

We appreciate these comments based on experience in different regional contexts from which our manuscript could benefit some nuances in the two points you bring up. There are still many unknowns in water use for agriculture in South-Southeastern Amazonia that many details will be missing when looking at the different options in Table 3. So far, most (if not all) ET estimates for agricultural water use (and pasture) in Mato Grosso are based on models rather than measurements published in peer-reviewed journals. This is not the case for natural ecosystems which have been studied (and continue to be) as shown in Table S3. With this discrepancy in mind, and given that agriculture is almost entirely rain-fed, it is difficult today to understand exactly how much more yield improvement could be achieved through green water management, especially for soybean, maize, cotton, sugar cane, and rice. Our experience tells us that yields will likely increase due to other inputs (e.g. fertilizer or genetics), although we are starting to see shifts in water management that could be quite significant.

Second, you are absolutely right to mention water quality aspects which have not been addressed in this paper, again for lack of information on this point. We’d expect the addition of lime, fertilizer and pesticides to soybean, pasture, maize and cotton fields to have impacts on nearby water bodies. The case of eutrophication comes to mind with the average state wide application of 0-5 kg N ha$-$1 and 28-34 kg P ha$-$1 of fertilizer in the case of soybean (Lathuillière, M.J. et al. (2014) Environmental footprints show China and Europe’s evolving resource appropriation for soybean production in Mato Grosso, Brazil, Environmental Research Letters 9(7), 074001, doi: :10.1088/1748-9326/9/7/074001) but so far, field studies have not seen this leading to water quality impacts in Mato Grosso (e.g. Riskin, S. et al. (2013) The fate of phosphorous fertilizer in Amazon soya bean fields, Phil. Trans. R. Soc.

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B 368, 20120154, doi: 10.1098/rstb.2012.0154). Possible irrigation, especially in the dry season in Southeastern Amazonia, would likely increase any pollution load currently assimilated by soils, perhaps with even greater consequences on aquatic ecosystems due to lower streamflow during the dry season. So far, measurements made by the Environmental Secretariat of Mato Grosso (SEMA) designate water quality of most rivers upstream of the Amazon river between 2012 and 2014 as "GOOD" (or a mark of 4/5) or "REGULAR" (3/5) with monthly variations (SEMA, Relatório de Monitoramento de Qualidade da Água – Região Hidrográfico Amazônica – 2012-2014, http://www.sema.mt.gov.br/index.php?option=com_docman&Itemid=82).

In short, we will add both of these helpful points to the discussion of Table 3 in the revised manuscript in order to nuance the proposed options.

Technical corrections:

Page 2, lines 11-12 and 30-33: Thank you, we will review this sentence entirely.

Page 3, line 30: We will review this sentence.

Page 5, line 1: Here, we illustrate the mechanisms controlling evapotranspiration (ET) which can be atmospheric or biological in nature (and both exist across the Amazon region). You are right in pointing out that there is no strong correlation when looking at NDVI or VPD; this comment was directed to net radiation only when looking at Zeng et al. (2012), so we will have to rephrase slightly here. Also, we believe that the confusion in this paragraph comes from the different scopes of Zeng et al. (2012) (global) and Fisher et al. (2009) (tropical regions) which show different mechanisms. We will have to clearly separate these two papers to reduce confusion in the results that they are showing.

Page 5, Line 7: Thank you, we will consider this in the revised version of the manuscript. We have

been very careful in the paper to refer to green water consumption as ET and avoid

the term “green water flow” which we find does not represent the physically measured process.

Page 5, Line 10-11: We agree with these suggestions.

Page 5, Line 18: We agree with this suggestion.

Page 6, Line 26 to Page 6, Line 29: We seek to highlight an important parallel for the application of the green/blue water perspective. The perspective has often been useful in the Sub-Sahara African context with the proposal to upgrade rain-fed agriculture to improve food security. We argue here, that the perspective can also be useful in regions of similar climate to Sub-Saharan Africa but considering different future agricultural production options. The references you have provided merit some attention before refocusing this paragraph to smooth the transition we want to make between global analysis of water use for agriculture, the Sub-Saharan Africa context and a “new” context in Southeastern Amazonia.

Page 7, Line 19: We agree with this suggestion.

Page 8, Line 28: We agree with this suggestion.

Page 12, Line 13: Thank you.

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