

# ***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.***

## **Anonymous Referee #2**

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### General comments:

This paper provides a comprehensive review of Amazonian, and specifically south and south-eastern Amazonian, water resources within the framework of green and blue water accounting. This guiding framework unites a large and disparate body of work on land use, ET, precipitation, and river runoff, and connects that work to forest and agricultural water management options and future research. With minor changes, primarily to improve clarity, this review will be useful to those working at the intersection of land use, climate, and hydrology in Brazil.

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Specific comments:

The title's focus on irrigation is not entirely representative of the focus of the review, which is broader. I'd recommend cutting "What could irrigated agriculture mean for Amazonia?" from the title.

In general, the introduction provides adequate motivation, but does not provide a clear roadmap and summary of what this review accomplishes (see technical corrections).

Use of the term 'ecohydrology' to describe the approach and/or framework of the paper may be confusing to some readers. My understanding is that the body of work the authors reference may be more commonly known as the 'water footprinting' framework (or just blue and green water accounting). My understanding is that the field of ecohydrology is more specifically focused on climate-soil-vegetation dynamics and related theory, the literature for which is not referenced in this paper. See: (1) Rodriguez-Iturbe, I. "Ecohydrology: A Hydrologic Perspective of Climate-Soil-Vegetation Dynamics." *Water Resources Research* 36, no. 1 (2000): 3–9. doi:10.1029/1999WR900210; (2) Rodríguez-Iturbe, Ignacio, and Amilcare Porporato. *Ecohydrology of Water-Controlled Ecosystems: Soil Moisture and Plant Dynamics*. Cambridge: Cambridge University Press, 2005.

The back-of-the-envelope calculations nicely motivate the call for future research on irrigation, but their presentation is a bit simplistic compared to the detail of the preceding literature review. Two brief discussion items could help address this issue - those are described below.

First, there is debate about the quantification and efficacy of improvements to productive green water use (option C - what is also commonly referred to as agricultural water use efficiency and productivity). Debates on this matter tend to arise in local contexts, but are relevant to any policy proposal that seeks to address water management problems with irrigation. See for example a California, USA case wherein the benefits of irrigation efficiency improvements are debated on theoretical grounds: (1)

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Frederiksen, Harald Dixen, and Richard Glen Allen. "A Common Basis for Analysis, Evaluation and Comparison of Offstream Water Uses." *Water International* 36, no. 3 (2011): 266–82. doi:10.1080/02508060.2011.580449; and response (2) Gleick, Peter H., Juliet Christian-Smith, and Heather Cooley. "Water-Use Efficiency and Productivity: Rethinking the Basin Approach." *Water International* 36, no. 7 (2011): 784–98. doi:10.1080/02508060.2011.631873.

Second, there is no mention of water quality or 'grey water' trade-offs implicit in policy options that exploit trade-offs between green and blue water to address water quantity challenges. All but one policy option (D) are likely to result in some impact to water quality (pollutant loads in soils and streams). This is worth mention, as green, blue, and grey water trade-offs should be included in any analysis that weighs the costs and benefits (to people and the environment) of different policy options.

Technical corrections:

Page 2, lines 11-12 and 30-33: I don't think these sentences summarize what this review does. I don't think the authors "evaluate this framework" in the contexts described (line 11-12), or "review what the green and blue water ecohydrological approach can bring...", but instead use the concept of blue and green water to frame a literature review and discussion of proposed water management and policy options, and to guide future research.

Page 3, line 30: awkwardly phrased and/or typo at "a blue water redirect"

Page 5, line 1: the  $R^2$  given for relationship between latent heat and VPD and NDVI do not show "strong correlation" - or if they do, the way this sentence and surrounding sentences are written is confusing. The next sentence (lines 1-3) makes sense for the first study referenced (Zeng et al., 2012), but not necessarily for the second (Fisher et al., 2009). I don't entirely understand the point the authors are trying to make other than that there is a mechanistic relationship between surface energy budgets, water availability, and vegetation which is shown in empirical studies.

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Page 5, line 7: Perhaps consider inserting something like "consumption" or "outflow" after "Declines in green water", or replacing "green water" with ET, for clarity.

Page 5, line 10-11: This sentence is a little unclear - perhaps (1) insert "at regional scales" after "precipitation recycling" and (2) replace "affect" with "decrease" to make it clear that the opposite of the previously described dynamic can occur because of feedbacks at multiple scales.

Page 5, line 18: The wording "a global compensation of ET with land cover and uses" is confusing. Perhaps consider instead something like "only a small net loss due to land use and cover change"

Page 5, line 26 - Page 6, line 29. The first part of this section appears to be a summary review of the global literature, which then transitions into a discussion of blue and green water trade-offs in south-eastern Amazonia. The relationship between the points made in the first part (global summary) and the latter part (SE Amazon), and more specifically the transition, is not entirely clear. On page 6, line 29 a contrast is made: "... different green and blue water realities than those described above" and it's not clear if the "above" are the global findings in general, or the countries referenced on page 6, lines 21-22 and 26. If the point is that the global findings are not especially relevant to the Amazon region, perhaps this section could be shortened, and only findings that are relevant (either directly, or in contrast) to Amazonia could be discussed since the global literature on green and blue water accounting has been summarized extensively elsewhere. Lastly, if the discussion of global findings are retained - on page 6, line 26-27, relevant (and more recent) literature includes: (1) Suweis, Samir, Joel A. Carr, Amos Maritan, Andrea Rinaldo, and Paolo D'Odorico. "Resilience and Reactivity of Global Food Security." *Proceedings of the National Academy of Sciences* 112, no. 22 (June 2, 2015): 6902–7. doi:10.1073/pnas.1507366112; (2) Suweis, Samir, Andrea Rinaldo, Amos Maritan, and Paolo D'Odorico. "Water-Controlled Wealth of Nations." *Proceedings of the National Academy of Sciences* 110, no. 11 (March 12, 2013): 4230–33. doi:10.1073/pnas.1222452110.

Page 7, line 19: Given the  $R^2$  value, perhaps delete "highly".

Page 8, line 28: delete "the" before "1988-2014", or add "period" after.

Page 12, line 13: either a missing or extra parenthesis.

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