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Interactive comment

Interactive comment on "Global scenarios of irrigation water use for bioenergy production: a systematic review" *by* Fabian Stenzel et al.

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This is a very interesting and well written contribution to the literature on bioenergy and water use. However, I do have several concerns that are generally not well addressed in this paper and frequently also in this literature in general.

1) From my perspective, the analysis of water use should ultimately be significantly more complex than the analysis conducted herein. The approach in this article is essentially a linear type approach: the more biomass material is grown; the more water is used. However, as indicated in publications that focus on the concept of precipitation recycling, this is not a straightforward (linear) proposition. I suggest the authors consider the following referenced literature (van Noordwijk and Ellison 2019; Ellison et

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al. 2019) in order to begin thinking about alternative strategies for measuring the water impact of biomass production.

From this perspective, the principal impact of growing biomass material is on the atmospheric moisture regime and its potential downwind impact. Thus, for example, as long as forests are not removed in order to grow the biomass material, the upwind production of additional biomass material could potentially have positive impacts on downwind water availability (if growing more biomass material leads to the production of more atmospheric moisture). However, if less atmospheric moisture is produced (than was previously the case), this will presumably lead to the opposite downwind effect on water availability. The local impact of these processes, however, is likely to be the reverse.

In this sense, the issue of geospatial location, mentioned in lines 185-190, is tremendously important. And it is very useful to have a clear sense both of where bioenergy resources are produced, as well as where they could be produced, in particular due to their potential impact on large scale hydrologic cycles and processes.

I realize that most or all of the reviewed studies that provide the foundation for this paper have not considered such atmospheric dynamics. But I think it preferable to note that this is a real disadvantage of most of the current studies analyzing bioenergy resource production and water availability.

I am not sure what the best answer to this problem really is. I am not necessarily expecting the authors to completely revise their approach. But I think some reflection on the relative value and importance of water as atmospheric moisture vs river runoff is called for, but entirely neglected in this type of work.

2) As someone who works a lot with forests, I was surprised to hear the bioenergy discussion so strictly focused on cropland products (rapeseed, oil palms, sugarcane, maize, Miscanthus and switchgrass). From my perspective, much of the focus is instead on forest residues as the principal bioenergy resource. Moreover, since forest

residues will otherwise become an emission if left to decay on land, their impact on emissions is generally more or less equivalent (as a bioenergy resource or as land source emission). Thus, I was wondering what share the cropland type resources make up relative to other bioenergy resources, in particular forest residues? If forestry and harvest will happen anyway, then the forest residue impact on water is presumably marginal. Is this considered in any way in any of the analyses? Likewise, in the Nordic countries these days, waste is also increasingly used as a bioenergy resource and has led to falling prices for biomass-based material.

3) It would be meaningful to be clearer about the water boundaries within which additional biomass material might be produced. By this I mean that it would be helpful to have clear statements in the text of the total amounts of available, usable water, out of which crops and biomass resources are grown. This would make it easier to interpret the numbers on total water use.

4) I find the language in the text a little confusing when it addresses blue and green water. From my experience, water is essentially always blue until it has either been turned into a gas and thereby made green (evapotranspiration from forests, croplands and other vegetation), or has been polluted through industrial processes (grey water). The text occasionally seems to confuse this language. Thus, for example, speaking of rainfall as green water is unusual, since the blue/green terminology is usually applied to how rainfall is partitioned between the atmosphere and river runoff.

5) The land use competition issue and the availability of land for crops and bioenergy resource production is key and could be more fully addressed. How much additional land is available for this bioenergy production? And what does this mean for water use? If bioenergy resource production is additive (and does not displace croplands), the impact of course is much greater.

6) It is somewhat unclear in the paper whether the production of biomass material should be added to the impact of cropland water use, or replaces this? This could

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perhaps be made somewhat clearer in the text.

Ellison, D, L Wang-Erlandsson, R van der Ent, and M van Noordwijk. 2019. “Upwind Forests: Managing Moisture Recycling for Nature-Based Resilience.” Unasylva, 251, 70 (1).

Noordwijk, Meine van, and David Ellison. 2019. “Rainfall Recycling Needs to Be Considered in Defining Limits to the World’s Green Water Resources.” Proceedings of the National Academy of Sciences, April, 201903554. https://doi.org/10.1073/pnas.1903554116.

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