

Interactive comment on “HESS Opinions: A Planetary Boundary on Freshwater Use is Misleading” by Maik Heistermann

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I would like to thank Prof. Gerten for his comments. Since he is one of the main proponents of the PB concept, specifically the freshwater PB, I particularly appreciate his willingness to openly respond to the opinion paper under discussion.

In his response, the referee mainly reiterates points that had been presented in Rockström et al. (2009) and Steffen et al. (2015), in the following also referred to as the "PB literature". He does not present any new evidence that would corroborate the existence of a freshwater PB and its quantitative estimation. Quite the contrary, Prof. Gerten himself states that *"it is true that the current approach to determine a PB for human freshwater use does not convey quantitative evidence that regional regime shifts in hydrological systems 'could push the entire earth system away from its current state'"*

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(p. C2, ll. 5-7). On the same page, he points out that *"indeed it is arguable to use the global consumptive blue water use as a proxy [...] to capture the very complex ways by which humans alter the global water cycle; but instead of defeating the concept it can also be argued that we need better metrics to describe the global hydrological impact of human activities, ideally capturing how these interact with anthropogenic climate and land cover change"* (p. C2, ll. 18 ff.).

To be honest, I'd prefer to continue the discussion once the PB community has identified and corroborated such *"better metrics"*. Until then, however, I'll put both of the above statements on record.

And, of course, I will respond to Prof Gerten's statement that he would *"like to rectify some points and refer to some recent developments that the author should reflect [...], as otherwise the concept of PBs and also the concept of water footprints is partly misrepresented"* (p. C1/C2). In the following, I have tried to rephrase the referee's points as (bold) headers, and to address them subsequently.

No single PB dimension should be considered in isolation

The referee claims that *"all 9 PBs are closely coupled [...] and no single dimension should be considered in isolation"* (p. C2, ll. 10-11). Indeed, the PB literature fervently emphasizes the interactions between the different PB dimensions (or processes). The implication is that "everything is connected", so that feedbacks and cascades can quickly built up to disaster. According to the referee, *"hydrological changes need to be seen in the context of climate and land use changes"* (p. C2, ll. 8-9). Who would disagree about that statement? Deliberately or not, the PB proponents tend to tie such commonplaces to unfounded hypotheses ("existence of a planetary freshwater boundary"). Between the commonplace and the hypothesis, however, is a fundamental knowledge gap, and that gap cannot be filled by speculation. It can only be filled by fundamental research, as I already pointed out in my response to the comment of Prof. Savenije (RC2). It is also misleading to sell that knowledge gap as a *"zone of*

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uncertainty" (p. C2, l. 15).

The PB literature repeats, again and again, that the different PBs are interlinked and should not be considered in isolation. Yet, the prominent PB figure, reproduced as Fig. 1 in the opinion paper, suggests otherwise. Furthermore, neither Prof. Gerten nor the PB literature present any systematic approach on how to deal with these interlinkages. *Will the transgression of the freshwater PB create substantial risk of destabilizing the Holocene state of the Earth system?* No? Then what is the idea of defining that boundary in the first place? *Everything's connected?* Then how can you squeeze such a system into nine supposedly well-defined boundaries? The lack of concept is inherent to the problem. You cannot have it both: a well-defined threshold for freshwater consumption and a system in which freshwater is tightly integrated with other key components of the Earth system. Accordingly, Steffen et al. (2015) admit that *"a systematic, quantitative analysis of interactions among all of the processes for which boundaries are proposed remains beyond the scope of current modeling and observational capacity."* How true!

Planetary and basin-scale freshwater boundaries should be viewed together

I have to repeat my statement from the previous paragraph: you cannot have it both - planetary and basin-level freshwater boundaries. Prof. Gerten himself admits that *"it is not yet satisfactorily solved how to adequately add up the regional transgressions in many places to a global value"* (p. C3, ll 3-4). While I would like to let this statement speak for itself, let me clarify that the problem is obviously ill-defined: **if** there was evidence of some "basin/regional-level tipping points in freshwater use" (no evidence, yet!), why should it be cast into a single global number?

If you disagree with the PB concept: what is the alternative?

Prof. Gerten asks *"how to respond to the question whether and to what degree water problems are a global phenomenon, whether there is a 'global water crisis'?"* (p. C3,

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ll. 20-22) and demands *"convincing alternatives should [hydrologists] disagree with the current PB approach"* (p. C3, ll. 16-17). Let me recycle my answer to a similar demand made by Prof. Sivapalan (SC1 of this discussion): The opinion paper intends to clarify that the concept of a freshwater PB is scientifically flawed, and that it is - as acknowledged by its main proponents! - not based on scientific evidence. I am convinced that we're better off without the concept a freshwater PB, even if it was not replaced by an "alternative way forward".

The PB concept has already helped to rise awareness for environmental problems

Prof. Gerten makes the following statement which I consider as symptomatic: *"I personally disagree with the author that its [the PB concept's] increasing recognition is a development of concern – because it rather increases awareness among policy-makers and business people that integrated and increasingly global perspectives on environmental issues including water issues are needed."* This statement is well in line with lots of similar statements that I've heard not only with regard to the PB concept: "Why bother, as long as it helps rising awareness for environmental/water issues among policy makers". In my opinion, that notion is based on a grave misconception of our role as scientists. While there are quite some definitions of "science" or "scientific method", they all boil down to *developing and testing hypotheses, based on experimental or observational evidence*. If we find compelling and alarming evidence, we should communicate that evidence to policy makers in order to support knowledge-based decisions. However, scientists should not try to put the cart before the horse, and forge supposedly "scientific" concepts in the absence of evidence, just in order to push issues up the political agenda. That mindset makes us vulnerable - to those who actually do not want to see these issues on the agenda. The notion that there is some scientific "fast track" to rise awareness will seriously backfire, not only to the PB community, but to any scientist, policy maker or citizen who is willing to sincerely advance sustainable development. Surely, there is no way to stop anyone from reaching out to policy makers.

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However, a race for attention is a race to the bottom. In that race, scientific credibility will most certainly drop behind. That is why we, the scientific community, need to be vigilant, and also unrelenting, if we detect such flaws.

Putting aside credibility, I think we can currently observe how the seemingly beautiful PB concept falls apart when people try to break it down to anything useful. Diffuse notions such that "no single PB should be considered in isolation" and that "basin-scale and planetary freshwater boundaries should always be viewed together" are illustrative symptoms.

In a video message to the upcoming PB conference (watch it on <https://pb-conference2017.de>), Prof. Johan Rockström says: *"That is why the advancements of the planetary boundaries framework - which has gone through so much scrutiny, which is today well-founded, robustly, in the international Earth system science community - defines science-based quantified boundaries [...]"*.

I am wondering how it would sit with the conference hosts if Prof Rockström instead stated that *"there is no doubt that many of its [the PB concept's] aspects and quantitative approaches are still premature"* and that *"the current approach to determine a PB for human freshwater use does not convey quantitative evidence that regional regime shifts in hydrological systems 'could push the entire earth system away from its current state'"* (both statements quoted from Prof. Gerten's referee report).

Minor (or marginal) issues

Prof. Gerten claims that *"the PB concept [...] is an attempt [...] to detect whether and where there is a point beyond which the global situation may no longer be 'acceptable' (certainly an ethical question too, which is why also ethicists try to develop the concept further, see Ziegler et al. 2017)"* (p. C3, ll. 6 ff.). To my understanding, that is in contradiction to the PB literature. Steffen et al. (2015) emphasize that the *"framework [was implemented] through an expert assessment and synthesis of the scientific knowledge*

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of intrinsic biophysical processes that regulate the stability of the Earth system" and that the *"precautionary approach is based on the maintenance of a Holocene-like state of the Earth system."* Isn't it a major claim of the PB framework that the "safe operating space" should not be subject to discussion of what is "acceptable" or "ethical"?

Furthermore, Prof. Gerten expresses reluctance towards the subject of section 4, or more specifically, towards putting in context the PB and water footprint (WF) concepts (*"I'm not sure what this criticism is actually about"* (p. C4, ll. 10-11). So let me clarify: section 4 demonstrates that both concepts imply the necessity of "global water governance", while *explicitly* noting that the two concepts are differently motivated (as emphasized by the referee). I am more than willing to adopt Prof. Gerten's wording in that *"the PB concept is about critical environmental limits to water use while the water footprint concept is about the actual magnitudes of that use"* (p. C4, ll. 16 ff.). However, I strongly object Prof. Gerten's statement that *"if correctly understood, both [concepts] do not at all invite to 'globally offset water-related environmental impacts'"* (p. C4, ll. 19-20). I am not implying that Prof. Gerten himself approves the idea of "water-offsetting". But what - on earth - if not a *"planetary freshwater boundary"* would plant the idea in people's heads that water use could be globally offset? It is thus much too convenient to simply argue that *"it can never be ruled out that some people try to abuse such concepts for their own purpose"* (p. C4, ll. 4-5). And as for the water footprint, A. Hoekstra himself introduced the "water neutral" concept (Hoekstra, 2008), and the Water Footprint Network was e.g. involved in the Coca Cola Company's efforts towards the "100 percent water replenishment" goal (The Coca Cola Company and The Nature Conservancy, 2010).

Conclusion

Summing up, I would like to go back to Prof. Gerten's demand that I *"should reflect [some points and recent developments] [...] as otherwise the concept of PBs and also the concept of water footprints is partly misrepresented"* (p. C1/C2). Based on the

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arguments in this - admittedly lengthy - response to the referee's comment, I do *not* see the necessity to reflect any additional points in the opinion paper. And I am *not* convinced at all that I have "misrepresented" the PB and the Water Footprint concepts in any way, either.

All the more, however, I would like to thank Prof. Gerten, again, for his willingness to participate in this controversial discussion which I think is in fact useful and necessary.

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