Comment on hess-2022-87

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Community comment on "Poor correlation between large-scale environmental flow violations and freshwater biodiversity: implications for water resource management and the freshwater planetary boundary" by Chinchu Mohan et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-87-CC1, 2022

With much interest I have read the paper with the proposed title "*Poor correlation between large-scale environmental flow violations and freshwater biodiversity: implications for water resource management and water planetary boundary*", now open for discussion.

The authors provide an analysis with a state of the art approach and datasets. They have published valuable and groundbreaking work on global hydrological modelling, environmental flows and planetary boundaries in the past.

Here they put as aim (lines 107-108) " *In order to scientifically underpin large scale EF policies, the existing assumption of the inverse relationship between freshwater biodiversity response and EF violation must be tested regional and global scales*"

However, in this paper I see a mismatch between the analysis conducted on the one hand and the interpretation/discussion on the other hand.

The authors only look at environmental flows. They acknowledge that the violation of environmental flows influences aquatic biodiversity (eg lines 84-86). As they discuss in lines 368-374, other factors influence aquatic biodiversity: climate change, river fragmentation, large-scale habitat degradation, landscaping/river scaping, alien species introduction and water pollution. They however do not account for these factors in their analysis.

They find a poor correlation between environmental flow violations and freshwater biodiversity. But this is off course logical, as they do not account for these other factors. One can have a certain level of environmental flow violation in a location, the freshwater biodiversity will differ enormously whether there is also (non) point pollution or not, whether a barrage without fish passage infrastructure has been constructed, whether an alien species has been introduced and so on. This will also be the case for a local river assessment. The issue of scale is irrelevant. What the authors prove here is that there is a poor correlation, when not accounting for all these factors, in the spatial resolution of their assessment, which is data limited because of the large scale.

Their analysis actually proves that those other factors are very significant in aquatic biodiversity decline. I here see the value of this work.

To make a general conclusion on the relation between environmental flow violations and freshwater biodiversity, a multi regression analysis should be conducted accounting for all these factors. However, such would be a very comprehensive work, requiring many data, which partly exist, such as pollution level or fragmentation level. But off course, it is not upon the reviewer to request such extensive extra work.

This topic is briefly discussed lines 453-472, but it is essential for all your conclusions and discussion

I do not follow the reasoning in section 41. It is clear that there are many different EF methodologies, and that more holistic EF estimation methods are required for water management. But this has been expressed by many (recent studies), such as https://doi.org/10.1016/S2542-5196(21)00234-5 or many others. It is not the authors of this study who prove that with their analysis. I doubt whether for more holistic EF methods better correlations can be found, as long as the many other factors are not taken into account.

I also do not see why this analysis has implications for a water planetary boundary (section 42). What you only show is that global assessments, due to data restrictions and assumptions, lead to quite some uncertainty. But that does not mean the current bottom-up methodology using EFs would be lacking, it just means the boundary has a wide uncertainty range. EF do provide a meaningful boundary for freshwater biodiversity. That is why it is used in SDG indicator 642, a very significant upgrade from the millennium goal on water scarcity. You actually have a methodology that has global monitoring obligations for UN member states, thereby making it directly policy relevant. Due to the fact that you do not account for the other factors affecting aquatic biodiversity, and therefore do NOT prove inconsistency in "…universal relationship with freshwater biodiversity" (line 416-418) I do not see any justification for the statement "We suggest that to reconsider the use of environmental flows in defining water planetary boundaries" (line 421-422). A multiregression analysis would be required, but then, water pollution is eg already covered in other planetary boundaries (on N and P), or a recent new planetary boundary on chemical pollution https://doi.org/10.1021/acs.est.1c04158, all affecting aquatic biodiversity. So does the planetary boundary on climate change. It is clear that one indicator can not grasp all, see e.g. also https://doi.org/10.1016/j.scitotenv.2019.133642

To conclude, I recommend that the authors re-evaluate their section 4, as well as conclusions, abstract and title. As an example, for the key research points (with in capital letters recommendations):

- No significant relationship between environmental flow (EF) violation and freshwater biodiversity indicators was found at global or ecoregion scales using globally consistent methods and currently available data, WHEN NOT ACCOUNTING FOR OTHER FACTORS AFFECTING FRESHWATER BIODIVERSITY
- Several basins show a slight positive correlation between EF violation and biodiversity indicators, which could be attributed to the artificial introduction of non-native species. HOW IS THE INFLUENCE OF FACTOR NON-NATIVE SPECIES PROVEN? WHAT WITH THE OTHER FACTORS?
- A generalized approach that incorporates EF considerations but ignores the lack of a significant EF-biodiversity relationship at large scales can underestimate the stress on

the ecosystem at smaller scales which correspond with eco-hydrological processes that determine ecological impacts from EF violation. NOT CLEAR, AS YOU DO NOT ACCOUNT FOR OTHER FACTORS. ALSO, THESE OTHER FACTORS ARE ESSENTIAL FROM LOCAL TO GLOBAL SCALE, THEY WILL DETERMINE AT ALL SCALES THE CORRELATION between environmental flow (EF) violation and freshwater biodiversity. WHAT YOU PROBABLY MEAN IS WHAT GLOBAL MODELS ARE ABLE TO CAPTURE. But then, future data availability will only improve making multi-regression assessments

Some specific comments:

Lines 363-374: again, poor correlation by ignoring these other factors. Lines 364-368: no, the other factors are determining. Line 368: no, not only for larger-scale relations, also on a local level. The sudden introduction of a point source pollution can plumet aquatic biodiversity on a very small scale, and therefore also on this small scale, even with very detailed data availability, the other factors need to be accounted for when looking at correlations

Ps I also think that putting a title like "*Poor correlation between large-scale environmental flow violations and freshwater biodiversity*", is not helpful for implementing EFs in the field or policy agendas. As said, its inclusion in SDG indicator 642 is a major advancement and international success. Your title could be misused for not acting on preserving or rehabilitating EFs. When not put in context, some could use it as a slogan not to act on EFs.