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Reply on RC2

Franciele Maria Vanelli et al.

Author comment on "To which extent are socio-hydrology studies truly integrative? The case of natural hazards and disaster research" by Franciele Maria Vanelli et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-638-AC2>, 2022

Dear Maurizio Mazzoleni,

We are very grateful for your review. Please find our response to each one of your comments and questions below. To aid the visualization of the changes, we will submit a "track changes" version of the manuscript where we highlighted the changes made.

1) "This study aims at performing a systematic literature review of socio-hydrological studies for identifying the main gaps and discussing a research agenda for addressing them. The paper deals with a timely and important topic. I have really enjoyed reading this paper, and I believe it provides a significant contribution to the field of socio-hydrology. However, I do have a number of comments before the paper can be considered for publication. Below are my main concerns."

Thank you for the careful reading of our manuscript. We appreciate the constructive feedback. In this document, we answer each comment and question.

2) "It is not really clear to me the procedure used for the selection of the 44 papers. I understand that the focus of the study is on natural hazards (i.e. floods and droughts). However, why agriculture, water consumption, and groundwater were used as exclusion criteria? Those are crucial components for drought impact and have a great influence on human-water dynamics. For example, Garcia et al. (2016) showed that drought awareness can significantly shape per-capita water demand, which in turn affects water use, reservoir volume, and consequent water shortage during drought periods. Similar examples can be found in Van Emmerik et al (2014) and Gonzales and Ajami (2017), which were not included in your review. Why did you decide to neglect these components of interdisciplinarity and key aspects in human-water dynamics? They may not explicitly include the term "socio-hydrology" but they are definitely important studies for unraveling human-water dynamics, i.e. the focus of socio-hydrology."

Including more studies will definitely strengthen your review.”

We agree with you that the more comprehensive a review is, the better their outcomes tend to be. However, we consider the following points:

(1) in a systematic review, a clear and sometimes narrow research scope needs to be defined in order to have a reasonable number of articles that can be manually read. A search in the Web of Science database using the term “human-water” and “socio-hydrology” leads to 700 and 310 results, respectively. Including all these articles using a traditional systematic review approach would not be feasible. To address this gap, future studies could apply systematic mapping or bibliometric analyses. These techniques allow addressing a larger number of articles as suggested by the reviewer. However, they tend not to provide a deep and more detailed overview of the studies addressed.

(2) recently other systematic reviews were performed concerning socio-hydrology in general, for instance, Fischer et al. (2021) and Herrera-Franco et al. (2021). Yet, even though, recent studies (e.g. Di Baldassarre et al., 2018; Vanelli and Kobiyama, 2021) discussed the potential contributions of socio-hydrology to study disaster risk reduction, no review has specifically focused on natural hazards, risks and disasters.

(3) although socio-hydrology focuses on human-water dynamics, not at all studies in the general literature about human-water dynamics assume socio-hydrology as the viewpoint. In some cases, perspectives other than socio-hydrology can be applied (e.g. socio-ecological system, nexus approach).

With these 3 points in mind, we decided to focus our research on socio-hydrological studies in the fields of natural hazards, risks and disasters. Thus, the starting point was the definition of socio-hydrology as the search term. In the following step, we defined inclusion criteria to achieve our goal: understanding the relation between socio-hydrology and natural hazards, risks and disasters research. In this context, we included only socio-hydrological studies that explicitly mentioned natural hazards, risks, or disasters. This decision was based on the complexity of the coupled human-water system because all processes are interlinked and interconnected. The rationale for decisions taken as well as complete documentation of the reviewed articles are provided in the manuscript (See Section “2 Methods” and Supplementary Material).

We are aware that we might miss some relevant articles that did not fit to inclusion criteria. This is a common problem with any systematic review (Ivanova et al., 2020). Therefore, we added a new Section about the study’s limitations (“5 Potential study limitations”). We also added the references you suggested as examples of relevant articles that deal with natural hazards but did not mention our search terms and inclusion criteria. The modified text read as follows:

“5 Potential study limitations

While the present study provided an inter and transdisciplinary account of barriers in socio-hydrological research applied to natural hazards, risks and disasters, some caveats should be considered when interpreting the obtained results. First, although we used a comprehensive set of keywords, we may have missed relevant articles during the screening process of review (Figure 1). For instance, (Van Emmerik et al., (2014), Garcia et al., (2016), and Gonzales and Ajami, (2017) address aspects related to natural hazards and awareness, which are relevant for understanding socio-hydrological phenomena. This is a common problem with any systematic review, as researchers risk missing important references given the language, search terms, and inclusion criteria used (Ivanova et al., 2020). Meanwhile, despite their drawbacks, systematic review procedures provide a deep and more detailed overview of the studies addressed than other techniques like systematic mapping or bibliometric analyses.

Second, we focused only on articles that mention socio-hydrology in the title, abstract, and/or author's keywords. However, studies that deal with understanding human and water interactions without mentioning socio-hydrology could contribute to a deep understanding of how these interactions are considered in disaster and risk research. In future studies, besides socio-hydrological studies related to natural hazards, risks and disasters, human-water dynamics studies can be reviewed aiming to analyse and compare the methods used. It can be interesting to compare how human-water interactions are addressed through different lenses (e.g. nexus approach, socio-ecological system, complexity theory).

Third, there is a bias in the classification of the articles into monodisciplinary and interdisciplinary. We considered the author affiliation as a proxy for their discipline. However, nowadays, an increasing number of researchers work in interdisciplinary projects whose affiliation department does not reflect their expertise. Hence, although the present results can be a sufficient indicator of the current disciplinarity scenario, the studies' interdisciplinarity should be investigated when possible. This could be done by, for instance, analysing the publications record of each author.

Nevertheless, despite these potential limitations, the present study is the first to present a systematic review of socio-hydrological studies applied to natural hazards, risks and disasters. The sample of included articles provides sufficient information to stimulate discussion aiming to address challenges in this field of knowledge."

3) "Have you considered the option to include studies that deal with understanding and modeling human-water dynamics without being considered as socio-hydrological studies? For example, Haer et al. (2020)? It would be really interesting to compare these studies with socio-hydrological studies to discuss differences in both physical and social methods used to represent human-water dynamics."

We agree with your comment and consider that many articles are not called "socio-hydrological" studies but could be considered such. However, for reasons delineated in comment 2, manually reviewing all human-water dynamic studies (about 700 articles only in the Web of Science database) would not be feasible. In addition, not all human-water dynamic studies assume a socio-hydrology perspective because they can consider other lenses, for instance, socio-ecological systems, coupled human and natural systems (CHANS), or nexus approach. Thus, we had to define a clear focus, which is understanding the current state of the art regarding socio-hydrological studies in natural hazards, risks and disasters research. The suggested comparison is interesting and meaningful. We added it as a recommendation for future studies in the new above-mentioned Section: "5 Potential study limitations". See the modified text below:

"Second, we focused only on articles that mention socio-hydrology in the title, abstract, and/or author's keywords. However, studies that deal with understanding human and water interactions without mentioning socio-hydrology could contribute to a deep understanding of how these interactions are considered in disaster and risk research. In future studies, besides socio-hydrological studies related to natural hazards, risks and disasters, human-water dynamics studies can be reviewed aiming to analyse and compare the methods used. It can be interesting to compare how human-water interactions are addressed through different lenses (e.g. nexus approach, socio-ecological system, complexity theory)."

4) "Based on the commentary of Di Baldassarre et al. (2021), multiple approaches should be implemented for better understanding and representing

human-water dynamics. In your review, you compared a number of categories (e.g. type of natural hazard investigated, spatial and temporal scales of the social and physical systems, physical and social components, etc.). Would it be beneficial for this review also to include a comparison between socio-hydrological studies using quantitative vs qualitative observations?"

We are not sure if we understood your question correctly. One of our study's main points is indeed to analyse quantitative and qualitative data gathering sources and processing methods. Section "3.5 Trends regarding the methods used to understand coupled social and physical systems" is dedicated to this discussion.

5) "Line 241: What do you mean by "calibrate societal memory"? In the models you cited, awareness variations influence demography, which in turn affect flood losses, and not the other way around. Also, calibration in modeling applications has a different meaning than the one you are referring to. I suggest you modify the sentence accordingly in order to avoid misunderstandings."

Thank you for raising this point. We modified the sentence as follow in order to clarify the text:

"Among these studies, 34.1% calculated "Societal memory/Risk awareness/Risk perception" based on the proportion of flood damage, assuming that the individual memory is a function of disaster's exposure (e.g. Albertini et al., 2020; Di Baldassarre et al., 2013; Buarque et al., 2020)."

6) "Line 276: use "system dynamic" modeling rather than the term "stylized model". Why are you considering that only Sugeng et al. (2019) used system dynamic modeling? Also Di Baldassarre et al. (2013, 2015) used system dynamics model. I suggest that you define the different types of modeling techniques at the beginning of this section. The fact that Sugeng et al. (2019) used Vensim software (i.e. stock and flow representation) does not mean that the other socio-hydrological studies did not use system dynamics as they used differential equations, which are equivalent to the stocks and flows formulation in vensim."

We performed the classification based on the explicit information written by the article's authors. In this regard, Sugeng et al. (2019) explicitly mentioned the use of system dynamic modelling, while Di Baldassarre et al. (2013, 2015) do not mention this term. Nevertheless, we agree with your comment. Thus, we removed the sentence above-mentioned and the term "stylised model". Given that all studies included in the review are illustrations or representations of the dynamics of the coupled human and water systems, we removed the class "System dynamic" aiming to avoid misunderstandings. We modified the graphs and included these articles in a new category called "Empirical numerical modelling".

7) "Line 377: Are you sure that socio-hydrology uses the same methods and perspectives as traditional hydrology? In my opinion, approaches like system dynamics and ABM were just recently introduced for socio-hydrological applications"

Thanks for the comment. We did not affirm that socio-hydrology uses the same methods and perspectives as traditional hydrology. Instead, we posed a question with the intent of stimulating reflection on the topic. Based on our systematic review results, we identified several gaps and found that indeed, socio-hydrology research tends to be monodisciplinary. We thus ask the reader "If socio-hydrology uses the same methods and perspectives as traditional hydrology, can we expect it to deliver different and new insights into complex human-water systems?". This question aims to encourage researchers in a critical viewpoint. We modified the sentence to clarify our point. If the editor deems the question too contradictory, we can remove it entirely.

Furthermore, system dynamics and agent-based models are techniques well-established before socio-hydrology development and they are used in a range of disciplines other than socio-hydrology. For instance, NetLogo is a multi-agent programmable modeling environment, where several sample models of different disciplines can be found, including hydrological studies.

"This raises the question for reflection: if socio-hydrology uses the same methods and perspectives as traditional hydrology, can we expect it to deliver different and new insights into complex human-water systems?"

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