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Response to Anonymous Referee #2

Dear reviewer,

Thank you very much, we are grateful for your constructive, detailed, and in-depth suggestions and helpful comments for improving our manuscript. Below, each reviewer's comment (indicated by "RC") is followed by our answer (indicated by "AC"). The proposed new text in the revised manuscript is written in bold.

RC: The paper aims to present an approach for quantifying and communicating climate change-related uncertainties and outputs of models to stakeholders as part of a participatory climate change adaptation process. The paper provides information about the context and the participatory process used in this study, the variables used, and how results are communicated and perceived by the audience, and it discusses issues around communicating uncertainty.

The topic of the manuscript is helpful for scientists who want to identify ways to better communicate uncertainty to stakeholders, such as the uncertainty relating to climate change. The adopted approach and the study's outcomes provide insights into how communication can shape stakeholders' understanding and subsequently influence decision-making on adaptation strategies. In addition, the study provides valuable information on aspects that should be considered when designing content to visualise uncertainty.

AC: Thank you for the positive feedback.

RC: However, the manuscript should be improved to bring out the valuable points it discusses in a more structured manner, increasing the impact of the study and broadening the readership.

First, as a general comment, the paper would benefit from some serious editing; the text is too long, and the story gets easily lost. Providing the information more concisely will make it a more valuable contribution. Specific suggestions on how the manuscript can be improved are included below.

AC: Later, we will show concrete ideas where and how we will make the text more concise.

RC: Specific comments

The paper's objective relates to two distinct tasks: (a) how to assess climate change hazards with their uncertainties from multi-model outputs and (b) how to communicate this information in a climate adaptation-focused participatory process. However, considering how the information is presented in the paper sections, it is unclear how these tasks are addressed and what the key messages are. It might help readers to follow the study more effectively if the structure of the paper was slightly re-organised. As a suggestion, the authors could distinguish the two tasks and provide details on the approach and results for each. For example, in chapter 3, where the adopted approach is presented, there could be two different clearly labelled sections, one for each objective, providing details on the methodology used to address these. Similarly, in chapter 5, the discussion could address the two distinct tasks more explicitly.

AC: As proposed, we will restructure our paper with the two foci (a) and (b) to highlight the main objectives of the paper. This is how we will structure the paper in the revised version:

1 Introduction
2 Quantifying and communicating the uncertainty of the climate change-induced hydrological hazards
2.1 Quantification of hydrological hazard indicators

2.1.1 Study area
2.1.2 Processing of multi-model ensemble output
2.2 Communication of climate change hazards
2.2.1 Participatory process
2.2.2 Communication of the quantification
The heading of former 3.3.1 will be dropped; the text will be directly under the body text
2.2.2.1 Communication of potential changes of 30-year mean values by percentile boxes
2.2.2.2 Communication of potential changes in interannual variability
2.2.2.3 Summarizing hazards for the stakeholder discussion
2.2.2.4 Alternative communication of potential changes of 30-year mean values by tables
3 Results
3.1 Interpretation of communicated hazard indicators by the stakeholders (last paragraph of formerly 3.3.4)
3.2 Evaluation of communication format by the stakeholders of the KlimaRhön participatory process
3.3 Comparison of our communication format with a more common communication format by the audiences of two presentations of the project results
4 Discussion
4.1 Why and how should the uncertainty of hydrological changes due to climate change be quantified with a multi-model ensemble of global models?
4.2 How can the uncertainty of hydrological changes due to climate change be best communicated?
4.3 Evaluations in participatory processes
4.4 Using the uncertain information about future climate change hazards for the development of adaptation measures
5 Conclusions

RC: The paper includes an abstract and a plain-language summary; however, there is no significant difference between these two sections. From a typical reader's perspective and if the authors consider the need for a plain language summary, I suggest focusing on the problem this study tries to solve and why this study is important and reference the adopted approach and results using simple language to allow an average reader to understand. In addition, making reference to the usability of such an approach in a different context would also add value. In the case of the abstract, and aiming to help the readers identify the essence of the study and remember the key points, the authors could consider adding details to clarify the study's objectives and overall contribution.

AC: In the revised version, we will highlight that our approach can be applied anywhere around the world due to the global coverage of the freely available data of potential future hydrological changes and also in other contexts. Moreover, we will structure it more clearly after the two main objectives (a) and (b). In the Plain Language Summary, we aimed to have the (almost) same content as in the Abstract but in easier words, i.e. outlining what the paper is about. We would not write about another focus, because this might set other expectations of the reader.

"Abstract. Participatory processes for identifying local climate change adaptation measures have to be performed all around the globe. **As these processes require information about context-specific climate change hazards, knowledge about how to quantify climate change hazards and how to best communicate the potential hazards with their uncertainties is essential.** In a participatory process on water-related adaptation in a biosphere reserve in Germany, we used the freely available output of a multi-model ensemble **provided by the ISIMIP initiative, which provides global coverage,** to quantify the wide range of potential future changes in (ground)water resources. **Our approach for quantifying the range of potential climate change hazards can be applied worldwide even for local study areas, and also for adaptation in agriculture, forestry, fisheries, and biodiversity**. To support participatory climate change adaptation processes, we propose to **communicate** uncertain local climate change hazards with percentile boxes rather than with boxplots or simple average **with the** model agreement on the sign of change. This **supports the** stakeholders in identifying the future changes they wish to adapt to depending on the problem (e.g., resource scarcity vs. resource excess) and their risk aversion. Using or adapting our quantification and communication

approach, flexible climate change risk management strategies can and should be developed worldwide in a participatory and transdisciplinary manner involving stakeholders and scientists."

RC: The introduction section seems too long and makes it difficult for the average reader to understand the background, context, and problem this study aims to solve. Also, how it is written makes it difficult for the reader to identify the gap in the literature this paper addresses. The suggestions below can improve the contextualisation of the study and will help the reader follow the next sections better:

- **RC:** Provide information on existing approaches; this could be a table presenting advantages and disadvantages and highlighting challenges when communicating uncertainties. The proposed table will allow the reader to understand the existing approaches, what is missing, and what this paper seeks to address.
  AC: In the discussion (new section 4.2), we will introduce Table X explaining the advantages and disadvantages of uncertainty visualization to communicate uncertainty to stakeholders. Moreover, we will explain why we selected our visualization method, which is a modified visualization of the GERICS bar chart.

  Table X: Advantages and disadvantages of some uncertainty visualization to communicate uncertainty to stakeholders.

Uncertainty visualization	Advantages	Disadvantages
Boxplot	Shows three quartiles showing the change values that are not exceeded by a certain percentage of the ensemble members; defines outliers; common visualization	Potentially reduced readability as it shows minimum and maximum; non-unique definition of and difficult to interpret "whiskers" and, thus, outliers; does not show the distribution of values
GERICS bar chart	Shows five percentiles P0, P20, P50, P80, and P100 showing the change values that are not exceeded by a certain percentage of the ensemble members	Potentially reduced readability as it shows minimum and maximum; does not show the distribution of values
Violin plot	Very precisely visualizes uncertainty by displaying the distribution of values within the whole range by the width of the box	Potentially reduced readability as it shows minimum and maximum; only shows the percentiles minimum, maximum, and median; smoothing of the shape leads to only an approximate representation of the distribution; the high information content due to the high uncertainty precision might be overwhelming for the end user
Letter Value plot	Shows several percentiles showing the change values that are not exceeded by a certain percentage of the ensemble members	Potentially reduced readability as it shows minimum and maximum; area of the Boxes does not correspond to the number of values contained in the boxes; pseudo- (i.e. misleading) visualization of the distribution of values; depending on the visualization, it has too many percentiles
Percentile box	Shows five percentiles showing the change	Does not show the distribution of values

	values that are not exceeded by a certain percentage of the ensemble members; percentiles can be selected depending on the problem and the risk aversion; minimum and maximum can be avoided preventing the misinterpretation that these are the most extreme values possible	

- **RC:** There is information in other sections of the manuscript that can be used in the Introduction section to improve the contextualisation of the study. For example, in section 5 (§5.1.1 and 5.1.2), information around uncertainty and available models and visualisation formats could be used to set the background, preparing the reader about what is coming up and what this study is trying to achieve. Similarly, information included in section 6 around the theoretical background (1st paragraph on page 29 - lines 741-752) could be used to shape the contextualisation of the study.
  AC: We will structure the introduction in a way, which highlights the main objectives (a) and (b) more. For this, we will introduce one sentence, which outlines the structure of the introduction in line 51 after the second paragraph "**This is why (a) future changes should be assessed with their uncertainty and (b) a suitable visualization should be found with which the future changes with their uncertainty can be communicated.**"
  In line 102, we will add "**To communicate the processed potential changes with their uncertainties visually, a suitable visualization format is needed** and should not be a translation into median or mean changes only, […].".Then, in the following paragraph, we will include information from the former 5.1.1 and 5.1.2. For this, we will move lines 553-558 in the Introduction. Moreover, as in the answer to the previous comment, we will move the paragraph in lines 579-587 to the methods section.
  In line 118, after the sentence, we will introduce:
  "**Similarly, the letter value plot shows several percentiles with bars, but with reduced bar width the more distant it is to the median (Figure 10). To show the distribution of values, violin plots can be used, which also show the minimum, median, and maximum values (Figure 10).**"
  As we have not embraced the Cultural Theory in the communication of the uncertainties in the participatory process, we will not move the 1st paragraph on page 29 (lines 741-752) from the conclusion to the introduction but leave it in the conclusion as a recommendation.
- **RC:** To reduce the length of this section and improve its readability, I suggest making the presented information more concise and reducing repetition. Removing the 2nd paragraph on page 3 (lines 76-89) and adding the content as supplementary material would help reduce the length and allow the typical reader to focus on the context of the study.
  AC: We find the paragraph on ISIMIP very valuable for persons who seek to analyze data as we did for another sector to motivate that our approach is also possible with other than hydrological data. But, in the revised version, we will shorten the 2nd paragraph on page 3 as shown:

  "**The Inter-Sectoral Impact Model Intercomparison Project (ISIMIP, www.isimip.org) provides freely available multi-model ensembles of many impact variables in several impact sectors (water, lakes, biomes, regional forests, permafrost, agriculture (crop modelling), energy, health, coastal systems, fisheries and marine ecosystems, and**

terrestrial biodiversity; ISIMIP, 2019). For each impact variable, ISIMIP2b provides a time series for historic and future periods, which were computed by multiple global impact models (Frieler et al., 2017), with which the uncertainties of future changes in impacted variables can be characterized."

and integrate it more with the explanation of multi-model ensembles. The rest of the paragraph will be moved to the Appendix in the revised version.

We will move the explanation of models in lines 52-59 to the Appendix and integrate the last sentence of the paragraph somewhere else in the revised version.

RC: Section 2 provides information about the case study and the participatory process. The authors could consider if this section could be incorporated into the methodology and results chapters. For example, the case study part §2.1 presents the study area and, therefore, could be part of section 4, which presents the study results. Also, the participatory process part §2.2 discusses the approach adopted in this study and links to the methodological aspects. As a suggestion, this part can be included in Section 3, which discusses the overall methodology. In this way, the information will be presented in a more structured way, allowing an average reader to follow the paper better.

AC: In the revised version, we will move both Sections in the former Chapter 3 as outlined above.

RC: Section 3 presents the approach adopted in the study. This section seems too long and makes it difficult for an average reader to understand the approach and reasoning behind it. I suggest the following changes that will improve the way the information is captured and will enable the reader to understand easily the adopted process, broadening the readership of the manuscript:

- **RC:** The authors could explain the methodology used per objectives (a and b) as mentioned previously; there could be two different clearly labelled sections, one for each objective, providing details on the methodology used to address these. Also, to allow readers to follow the logic of the methodology more closely, the authors could consider including a graphical abstract of the main steps of their approach per objective.
  AC: As shown previously, we will change the structure of this Section in the revised version. A graphical abstract (Figure X) will be included as Figure 2 at the beginning of the former Section 3 "Quantifying and communicating the uncertainty of the climate change-induced hydrological hazards" (Section 2 in the new structure).

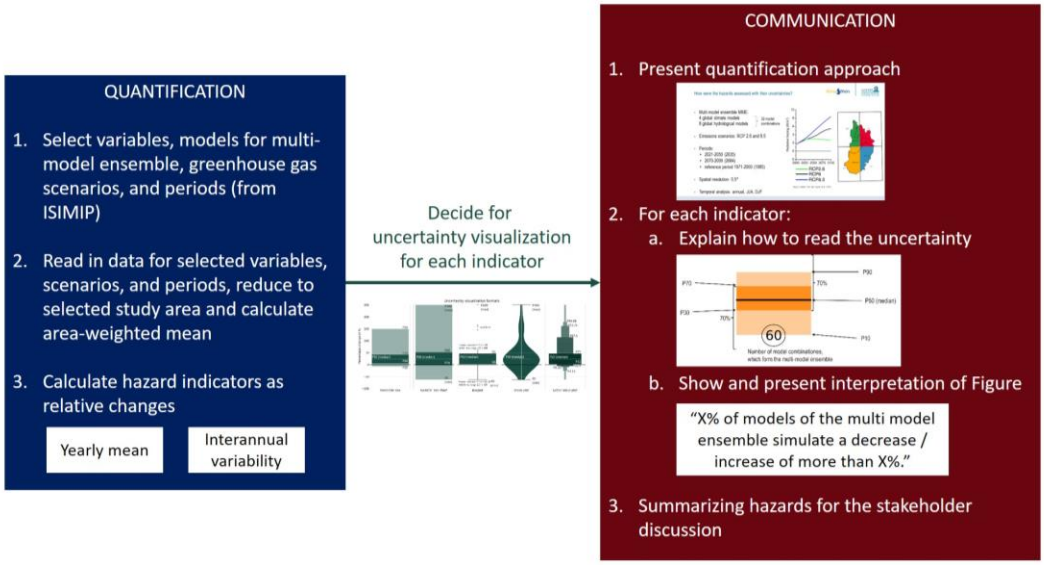


Figure X: Schematic of the presented approach of quantifying and communicating uncertain climate change hazards in participatory climate change adaptation processes. ISIMIP: The Inter-Sectoral Impact Model Intercomparison Project (www.isimip.org/).

- **RC:** Sections 3.1 and 3.2 provide information on the hydrological hazard indicators; although the information is useful, it can distract the reader from understanding the adopted approach. I suggest the authors provide a brief summary in this section and include the information as supplementary material to improve the readability.
  AC: In the revised version, the former sections 3.1 and 3.2 will be merged (see above). The text will not be structured by subsubsections anymore and will be made more concise (very technical details important to applying the approach will be moved to the Appendix). Thus, the first two sentences of the paragraph "Greenhouse gas emissions scenarios" (the former 3.1.2) will stay in the text, the rest will be moved to the Appendix.
- **RC:** Sections 3.1 and 3.2 provide information on the analysis conducted, addressing the objective (a) of the study; what is missing to allow readers to follow the approach more closely is the output of this task, what this analysis provides and how it feeds into the next step (objective b). Currently, this information is captured in section 3.3; for example, the analysis output was the design of graphics used in the participatory process (as mentioned in §3.3.2, line 325).
  AC: To make the connection between the objectives (a) and (b), we will rewrite the first paragraph of the former Chapter 3:
  "**Future changes should be assessed with their uncertainty and then a suitable visualization should be found with which the future changes with their uncertainty can be communicated in participatory processes. For this,** scientists or experts have to decide on what and how to produce climate change risk information before they communicate it to local stakeholders. So, during the first step, the data processing **and the analysis,** they need to decide what indicators of climate change hazard should be quantified, given the problem, the interest of the stakeholders, data availability and quality as well as technical and time constraints. **In the second step,** the scientists, experts or communicators have to decide on what, **with which visualization format** and how to communicate given their audience, the aim and the generally severe time constraints in the participatory process."
- **RC:** Section 3.3 provides information on communicating the hazard indicators, so it mainly addresses the objective (b) of the study. Although the section provides detailed information on the process followed, how the information is presented can be confusing for an average reader. The authors could consider (as mentioned previously) including the participatory process part §2.2 in this section, as it addresses methodological aspects adopted in this study. The overall process and information could be presented in a graph or a table, showing details on the workshops, timeline, participants, objectives, and what has been achieved. Also, the authors could consider adding information to reflect why they chose the specific way of communication to allow the reader to understand the driver behind the specific approach. Furthermore, information relevant to the options provided to stakeholders (mentioned in section 4, page 21) could also be included here. This will improve the paper's readability, allowing the reader to follow the logic of the participatory process more closely.
  AC: As mentioned above and proposed by the referee, we will move the Section about the participatory process to the communication section. Moreover, we will move lines 505-511 and Figure 8 to the former Chapter 3 (see above). Together with the table of the advantages and disadvantages of uncertainty visualizations, we will include two sentences reflecting why we have not chosen existing uncertainty visualizations in the Discussion (in section "4.2 How can the uncertainty of hydrological changes due to climate change be best communicated?"). However, we think that more information on the participatory process will not enhance understanding as the paper only covers the very first workshop in the participatory process.
- **RC:** Section 3.3 is too long and includes details that can confuse the average reader. To improve the readability, I suggest the authors consider including information that is relevant to the approach only and not the results and presenting it more concisely. For example, the last paragraph of the section on page 18 (lines 442-454) presents some of the results that can be included in section 4 (results).
  AC: In the revised version 2.2.2.3 "Summarizing hazards for the stakeholder discussion" (former 3.3.4) will be reduced by the second paragraph, which will be moved to 3.1 "Interpretation of communicated hazard indicators by the stakeholders".

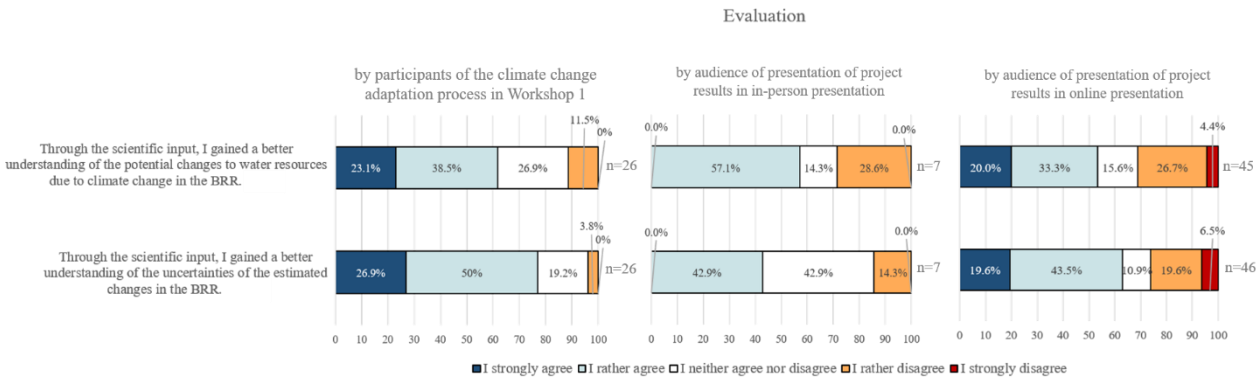
- **RC:** The authors could consider adding a more detailed description in Figure 2 (page 13) to allow the reader to understand why the selected multi-model ensemble represents the currently best estimate of future hydrological hazards.
  AC: Figure 2 shows exactly the slide that we showed and explained to the stakeholders. We wanted to show the reader exactly what we showed the stakeholders, and therefore do not want to add anything to Figure. 2. Later, in (former) Section 5, we discuss the advantages and disadvantages of the chosen multi-model ensemble.
- **RC:** Average readers might be able to follow the graphs presented in Figure 4 (page 15) more clearly if there was a more thorough explanation of the potential change of groundwater recharge in the caption, as mentioned on page 14 (lines 345-352). A similar approach could be adopted for Figure 5).
  AC: It is not the main intention of the article to present our interpretation of the processed potential changes but to show how we communicated the potential changes and how we communicated our interpretation of the potential changes. Therefore, we find it too exhaustive to add the interpretation in the figure caption. But we will refer to lines 345-352 in the caption of Figure 4 and lines 398-404 in the caption of Figure 5 in the revised version.
- **RC:** In section 3.3, pages 14-15, lines 359-368, information more relevant to the analysis rather than the communication aspects is included. The authors could consider whether this information can be moved to section 3.1 (as per the previous comment) to allow readers to follow the logic of the methodology more closely.
  AC: In the mentioned paragraph, the processed data is interpreted (also in the paragraph in lines 405-416), which is neither part of our communication approach nor part of our quantification approach. We will move these two parts in the Appendix and will refer to them in the captions of Figures 4 and 5 respectively, which is not the perfect solution because the interpretation should be close to the visualization of the results for better comprehension.
- **RC:** To reduce the length of this section, terms and concepts (including Table 1) could be included in the introduction or supplementary material.
  AC: In the revised version, we will move Table 1 into the Appendix.

RC: Section 4 presents the results of the study. As mentioned in a previous comment, this section could include information about the case study (currently §2.1) at the beginning and then present the results.

AC: In the revised version, we will move the former §2.1 before §2.1.2 Processing of MME output in the revised structure.

RC: Figures 6 and 7 could be presented on the same page, allowing the average reader to compare the results easily.

AC: To make sure that Figures 6 and 7 will be presented on the same page, we will rearrange them and display them in one Figure (see below).



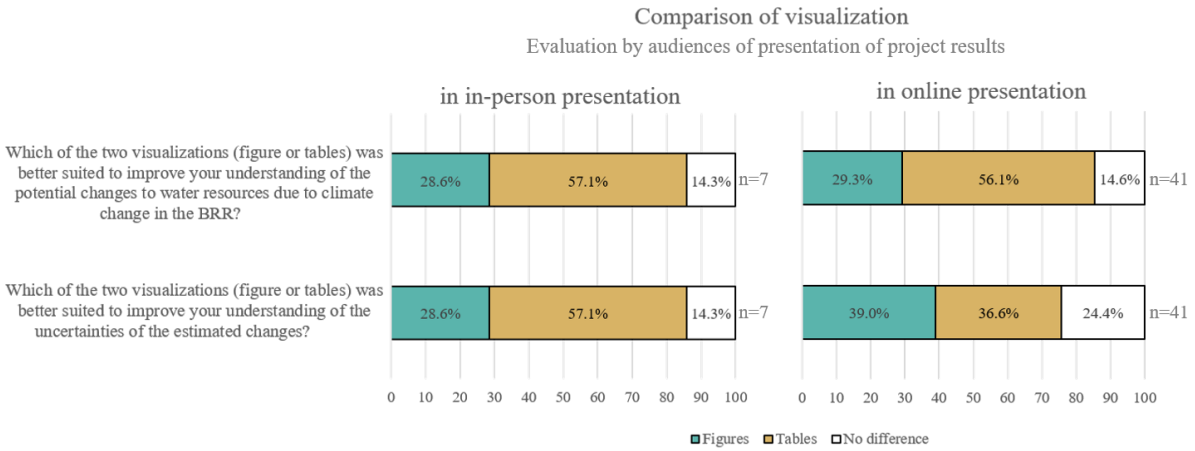
RC: The authors could consider adding information on the importance of the results and how these are dependent on the number of participants in the workshops. For example, based on the online participation, the results seem more significant than those from the in-person presentation. There is no information to determine whether the type of participants in the in-person workshop adds value to the results. Also, no information is included regarding the conducted statistical analysis of the results.

AC: The results of the evaluation by the stakeholders in the participatory processes is more important than those of the in-person presentations as we wanted to study methods for participatory processes on climate change adaptation. This has already been expressed in lines 650-652, 687-689 and in section 5.2 (of the preprint) in general. As we wanted to address all types of persons with our uncertainty communication, we did not make differences between the types of participants. We only discuss later in Section 5 that the information needs and the intention of listening to the uncertainty communication (interest in the presentation of project results vs. participation in a workshop to develop adaptation measures) is important for the suitability of uncertainty communication. Due to the low number of respondents, no further statistical analysis is deemed to be necessary.

RC: Finally, the authors could consider a different type of format for Figure 9 (perhaps combining the two visualisations in one) to avoid confusion with the graphs used in the participatory process and help the reader interpret the results. In addition, and as per the GC guidelines, the authors should use in the figures a colour combination that would allow readers with colour vision deficiencies to interpret the findings correctly.

AC: To avoid confusion, we will extend the figure captions of Figs. 7 and 9 to clarify that these evaluations refer to two presentations of the project results to persons that have not been involved in the participatory process. We will also add as titles in Figure 9 and the combined Figure of Figures 6 and 7: “Evaluation by audience of presentation of project results” and to the combined Figure also: “Evaluation by participants of the climate change adaptation process” (see Figures below and above).

In the revised version, we will also change the color combination for better visual readability (see Figure below). The color combination is colorblind safe and print friendly concerning https://colorbrewer2.org/.



RC: The discussion chapter (Section 5) could be further improved by adding more detail on interpreting the results in the context of the objective of this study rather than referencing the results, which is already done in Section 4. For example, considering the outcome of the workshops, did the authors further explore the stakeholders' views on the communication format that would make more sense to them?

AC: Within the scope of this paper, we did not explore stakeholders’ views in addition to the evaluations that we presented in this paper. The aim of the whole participatory process (in which this

presented study just represented an aspect in the first of five workshops) was to identify adaptation measures in water management for the study area. We aimed to ensure that stakeholders did not perceive themselves as experimental subjects and recognized that their identification of measures was taken seriously, not merely as an observation of communication methods.

RC: How did the authors interpret the results considering the overall context of the study?

AC: In the revised version, we will include in 5.3 that the specific results of the multi-model ensemble were not used quantitatively (only qualitatively) in the discussion of adaptation measures because no technical measures were discussed or monetary cost-benefit analyses were performed.

RC: What are the key messages?

AC: We will include the following information in the conclusion of the revised version (see below):

Concerning objective (a):
To assess uncertainties with multi-model ensembles it is more robust using changes (not absolute values). Moreover, our approach is preferable to use even for local study areas except when another (local) multi-model ensemble is available, which is very rarely the case. The important changes of interannual variability were hard to grasp for non-scientists, thus, for their communication, another communication format is needed.

Concerning objective (b):
Based on our experience and the results, we believe that for stakeholders who need to identify climate change adaptation measures hazard communication by percentile boxes is preferable to communication by simple tables. For the presentation of climate change hazards to the general public, a simple table with the mean changes and an indication of the agreement of the models on the sign of change is preferable.

RC: What is the novelty of the approach, what are the advantages and disadvantages, and why was this specific approach chosen? What are the limitations?

AC: The novelty of our approach is that we highlighted that multi-model ensembles exist and that their results are globally available. We show how to make use of a global multi-model ensemble analysis for a small study area in very detail (processing can be done with basic knowledge in any programming language such as R, Python, or MatLab) so that it can also be done worldwide. This is especially useful for locations where no local multi-model ensemble is available. Moreover, in the paper, we show in very detail how uncertainty can be communicated with various uncertainty visualization formats in a real participatory process. We will combine these novelty aspects with the key messages and rewrite the Conclusions with the information (see below).

In the revised version of the Discussion, we will include in lines 595-596:

"The percentile box shows five (P10, P30, P50, P70, and P90) percentiles**, thus transparently visualizing uncertainty to stakeholders, enabling communication of more thresholds than other visualization formats and an advantage is that the percentiles can be chosen individually depending on the risk aversion and the problem. However, the boxplot only shows** three percentiles (P25, P50, and P75) **and includes** the difficult-to-interpret boxplot "whiskers" (Fig. 10)."

To stress the disadvantages, we will include in line 619:

"**However, the communication, i.e. the explanation of the approach and the interpretation, takes a lot of time in a workshop and asks the stakeholders for a long concentration span.**"

Moreover, in lines 579-624, we showed the advantages and disadvantages of our approach (the percentile box and the continuous percentile box) compared to other uncertainty visualization formats.

At the end of the first paragraph (line 552), we will include a technical limitation:

"**However, it needs an expert with basic technical knowledge in any programming language to assess the potential changes.**"

Before the second paragraph of the former §5.1.2, we will explain why we chose our approach:

"**We came up with our approach because we wanted to communicate more percentiles and did not want to communicate minimum and maximum values. We left out the minimum and maximum 1) to not give too much room to possible outliers and 2) to not give the impression that minimum and maximum values could not be exceeded in reality. We wanted to have several percentiles to have the possibility to say how many percent of models simulated a stronger or weaker change than a certain change value, which supports communication that does not include a specific prediction.**"

RC: Also, a typical reader might not understand how the specific approach adopted in this study tackled some of the issues mentioned in the chapter. For example, how did it address the transparency?

AC: In the last paragraph of (the former) 5.1 (lines 658-666), we will include that we showed the stakeholders the uncertainty of the models through multi-model ensemble and showed them the approach of our quantification to address the uncertainty routine "transparency".

"**By showing the stakeholders the uncertainty of the models through multi-model ensembles and showing them the approach of our quantification,** we address one of the uncertainty routines of stakeholders called "transparency", in which the stakeholder **considers** the limits of knowledge (Höllermann and Evers, 2019)."

RC: How did it help the stakeholders in decision-making? Explicitly exploring and answering these questions would lead to a much stronger paper with a more broadly applicable impact and will allow for broadening the readership of the manuscript beyond subject area experts.

AC: We cannot make reliable statements about how our approach helped the stakeholders in decision-making because we guess (and hope) that the whole participatory process influenced their decision-making and because we did not evaluate how their decision-making changed. We will integrate in the Discussion that we hope to have highlighted uncertainty enough so that they will more carefully look at uncertainties in their decision-making in the future. In line 703, we will include:

"**Due to highlighting the uncertainty of future changes, we hope that the stakeholders will more carefully embrace uncertainty in their decision-making in the future.** Next to the uncertainty of…"

RC: The conclusions section (Section 6) would benefit from a synthesis of the main points of the study, highlighting the advantages of the adopted approach and the importance of the paper more briefly. This would help the reader understand why the study should matter to them after having finished reading the paper.

AC: We will rewrite the Conclusions in the revised version integrating the key messages, novelty aspects, and advantages formulated above and structuring after the objectives (a) and (b).

Here is how we want to revise the Conclusions:

"With ongoing climate change, adaptation to climate change has to happen everywhere around the globe at local to regional scales. Adaptation measures should be identified in participatory processes involving local stakeholders and professionals with a scientific background, by embracing the multiple uncertainties that affect the future success of adaptation measures. In this paper, we present a readily applicable approach for quantifying and communicating climate change hazards and their uncertainties **with multi-model ensembles** that **is** applicable in many climate change adaptation processes worldwide. It **is not restricted to hydrological hazards but can also be used in climate change adaptation processes in the fields of agriculture, forestry, fisheries, and biodiversity.**

The presented method for producing quantitative estimates of future climate change hazards, which benefits from the freely available output of global multi-model ensembles (provided by the ISIMIP initiative), can be replicated by anybody with basic knowledge in any programming language such as R, Python, or MatLab. Due to the high uncertainty of the translation of climatic changes into hydrological changes, utilization of the multi-model ensemble output is preferable even for local study areas unless multiple local hydrological models are available; with only one hydrological model, the uncertainty of future changes would be underestimated. We recommend quantifying hazards as relative changes as these can be estimated more robustly by multi-model ensembles than absolute values or changes of absolute values.

Based on our experience, we recommend using our propose to use different uncertainty visualization formats to communicate the range of potential future changes to either stakeholders in a climate change adaptation process or the general public. Stakeholders who need to identify adaptation measures based on uncertain futures hazards are best informed about the hazards by percentile boxes that show which relative change of a variable is exceeded according to which percent of all ensemble members. Distinguishing five percentiles in an easy-to-grasp visualization with an appropriate degree of complexity, percentile boxes enable the stakeholder to select to which future changes they plan to adapt depending on their risk aversion. For the presentation of climate change hazards to the general public, a simple table with the mean changes and an indication of the agreement of the models on the sign of change is preferable. Communicators should always reflect and decide what information should be the focus of a visualization. When presenting the results, we propose to communicate what share of the multi-model ensemble simulates a change instead of stating this share of the multi-model ensemble as a probability. This communication approach avoids the uncertain relation of ensemble percentiles to probabilities and moves the multi-model ensemble from a shallow to a **shallow medium** uncertainty level. **We suggest that an improved visualization and communication format for the important changes in interannual variability is investigated in the future.**

However, as legitimacy, credibility, and salience are perceived differently by individual stakeholders, no perfect, standard method to communicate information can be identified; "our worldviews, values and social norms dictate how we receive information and apply it" (Corner et al., 2018, p. 3). A potential remedy is to implement the Cultural Theory into the communication strategy, which categorizes people into four cultural world views when dealing with risks: hierarchists prefer expert opinions and regulations, egalitarians value societal contribution for risk reduction, individualists prefer market-based solutions and fatalists are apathetic viewing risks as unpredictable and random (Verweij et al., 2006; Czymai, 2023). These cultural worldviews could be integrated into the communication strategy to convince a heterogeneous audience to embrace uncertainty in their decision-making and the impact should be evaluated. To address hierarchists, it could be communicated that practitioners and scientists view uncertainty information as relevant (Höllermann and Evers, 2017). For egalitarians, it could be communicated that embracing uncertainty promotes fairness and prevents exposing only a few individuals to hazards due to collective inaction. Individualists could be approached by elucidating that embracing uncertainty could maintain their capacity to act and foster innovation.

Despite the coarse model resolution and wide uncertainty ranges, the multi-model ensemble results and their suitable communication helped the stakeholders in the participatory KlimaRhön process to

understand uncertainty and to develop robust and flexible adaptation options. With our approach to **quantifying** and communicating multi-model ensemble results as a basis, flexible climate change risk management strategies can be developed jointly by stakeholders and scientists in a participatory and transdisciplinary manner."

RC: Finally, as a suggestion and according to the GC guidance, the ethical statement should be more comprehensive, and a description of the process should be included in the methodology section of the paper.

AC: We will add the following in line 791 to make the ethical statement more comprehensive:

"**For this, the stakeholders were asked to evaluate (among others) the communication format in an online evaluation at the end of the digital workshop 1 and they were informed before that when they filled out the evaluation, the evaluation results could be published anonymously. In the in-person presentation outside of the participatory process, we collected consent documents from each participant regarding their voluntary participation and their agreement to publish the evaluation results anonymously. In the online presentation, also outside of the participatory process, the audience was asked to evaluate the communication formats in an online evaluation and they were informed that when they filled out the evaluation, the evaluation results could be published anonymously.**"

AC: In the revised manuscript, we will adjust the reference list according to the Copernicus standards. Moreover, we will publish the script to produce Figure 10 so that scientists/experts assessing potential changes can try out the discussed uncertainty visualization formats. We will also add another uncertainty visualization format, the letter value plot, and will discuss it in comparison to the other visualization formats (see previous comments, e.g. for the methods' section introducing Table X) and make suggestions in the Discussion on how to improve the visualization formats to reduce the identified shortcomings.