

We are very thankful for the thorough reviewer comments that helped us to improve our manuscript. In particular, we changed the structure of the manuscript and added a Figure with a schematic of the presented approach and a table that presents the diverse methods for visualizing and thus communicating uncertain future climate change hazards. We modified figures and thoroughly revised the abstract, the plain language summary and the conclusions.

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. The given lines refer to the revised manuscript unless otherwise indicated.

Reply on comment of Referee #1 Usha Harris

RC1: Let me say at the outset that I can only comment on the participatory approach and how it may be improved, as the scientific data and models discussed in this manuscript are beyond the scope of my area of expertise.

It would be useful to have a clear definition of what the authors mean by the participatory process. Participatory processes enable ordinary people to collectively identify problems, gather information, analyse, design and identify solutions which has value to them and their network. As such an authentic participatory process includes stakeholders in all phases of the research - identification of the problem, design and dissemination of the research.

AC: We agree with your definition of a participatory process but do not think it is necessary to define the widely and broadly used term in our manuscript due to the following. The primary objective of the manuscript is not to provide guidance on how to conduct a complete participatory process but to concentrate on just one (important) component. We wish to offer advice on how (natural) scientists can inform stakeholders participating in a participatory process for the identification of climate change adaptation strategies about potential changes of environmental characteristics due to future climate change. This is expressed by the title of the manuscript and also the formulation of the objective in the introduction which now reads

“The objective of this paper is to show how to **quantify** climate change hazards with their uncertainties for any region around the globe from publically available ISIMIP multi-model output, and how this information can be communicated in a participatory process as a starting point for identifying local climate change adaptation strategies.”

This includes guidance on how to 1) obtain quantitative information on local changes from freely available model output and 2) effectively communicate these potential changes within a participatory process. This is why we only provide the context of the communication of the climate change hazards by shortly describing the overall participatory process (formerly Section 2). In our opinion, it is sufficient to know that it was done in the first workshop, and who the participants/audience were. In addition, in Section 2.2.2.3 we described how the stakeholders further processed the provided climate change information in a World Café format. The specific knowledge generation and communication we describe may fit into different types of participatory processes.

RC1: A better definition for this project would be one developed by Harris (2019) specifically for environmental communication: “Participatory Environmental Communication integrates

interdisciplinary knowledge, inspires collaboration and dialogue, and utilises information networks to catalyse the agency of ordinary people towards collective action.”

AC: Our intention was not to conduct participatory environmental communication but rather to communicate environmental data within a participatory context to empower stakeholders to make informed decisions. The participatory process extended beyond the dissemination of knowledge and continued after we communicated the knowledge presented in this article.

RC1: A participatory process that engages stakeholders in all aspects of the research would be difficult to fully enact in scientific research such as this which requires a high level of expertise and scientific knowledge in the field of hydrology as stated by the researchers in the following quotes: *Scientists or experts have to decide on what and how to produce climate change risk information before they communicate it to local stakeholders.*, “*An interdisciplinary team of two sociologists and us, two hydrologists, designed and conducted the participatory process.*” ... “*The aim of all workshops was that stakeholders jointly develop climate change adaptation strategies, learn about other perspectives and network.*” It is evident that the participatory process was limited to the dissemination of knowledge - “*to what effect is communicated*”— *to raise awareness about uncertainties and enable stakeholders to make more informed decisions in their respective roles and engage better discussions during the subsequent workshops in the participatory process of the project KlimaRhön.*

I suggest that the authors clarify:

1. How did the participants contribute (or not) to the design of the research i.e choice of study area, method, or other input into the research design?
2. What was the contribution of the sociologists in the interdisciplinary team?
3. How did the process benefit the stakeholders to make informed decisions in their respective roles?
4. Did the stakeholders jointly develop climate change adaptation strategies, learn about other perspectives and network.”?

Some of these questions can be answered by conducting a focus group or distributing a qualitative research questionnaire in which the stakeholders are asked how the process benefited them *to make informed decisions in their respective roles and develop climate change adaptation strategies and learn about other perspectives and network.*”

Their comments can then be included in the manuscript. The voices of the participants would increase the credibility of the participatory process.

AC: Given the objective of the manuscript, we think that it is neither appropriate nor necessary to describe how the participants contributed to the research design or to describe the contribution of the sociologists as they did not contribute to how to quantify and communicate the potential changes. The quantification and communication of the potential changes was not participatory but disciplinary, but the communication was embedded in the very beginning of a participatory process. Equally, the scope of the manuscript does not encompass how the problem fields and the solutions were identified with the stakeholders and whether the stakeholders learned about other perspectives and networked in the participatory process. Consequently, we do not make assumptions about how the 30-minute communication of potential changes at the beginning of the first workshop contributed to the goals achieved in the four subsequent workshops.

However, it seems that we did not fully clarify the scope of the manuscript. In the revised version, we therefore highlighted that it involves only the quantification of the potential hydrological changes and its communication, which was set up disciplinarily – neither interdisciplinarily nor participatorily. For this, we introduced “at the very beginning of the participatory process” in line 140. And we added in lines 271-274:

“The quantification of the potential hydrological changes and its communication method was setup disciplinarily by us, the hydrologists in the team, before the participatory process. The communication was only part of the first out of five workshops in the participatory process, which had the character of a kick-off meeting. 31 stakeholders participated to learn about potential future changes in renewable groundwater resources and total renewable water resources by a presentation and to identify a problem in the form of one or two specific adaptation field(s) in a World Café.”

RC1: As a communication scholar with no expertise in this area, I found it difficult to navigate the data-laden research results and terminology despite the authors’ attempts to simplify the terminology and research results. Since the manuscript will be published in EGU sphere, the comprehensive engagement with data is valid. However, I would recommend less reliance on technical explanations, if they were to publish this for wider public consumption.

AC: In the revised version, the former Sections 3.1 and 3.2 are merged and very technical details in the newly created Section 2.1.2 are moved to the Appendix.

RC1: Note: This reviewer has proposed a model for participatory environmental communication which the authors may like to consult for future projects. See

Harris, U. S. (2019). Participatory media in environmental communication: engaging communities in the periphery. (Routledge studies in environmental communication and media). London; New York: Routledge, Taylor and Francis Group.

AC: We sincerely appreciate your suggestions on evaluating the entire participatory process. These recommendations will be valuable when planning future articles that delve into the methodologies employed in our participatory process.

Reply on comment of anonymous Referee #2

RC2: General comments

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.

RC2: 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: In the response to the specific comments, we will show where and how we made the text more concise and structured.

RC2: 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: We restructured our paper with the two foci (a) and (b) to highlight the main objectives of the paper. This is the new structure of the revised paper:

- 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 was dropped; the text is 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 (this was the last paragraph of former 3.3.4)
 - 3.2 Evaluation of the 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

Because of these changes, we also changed the short explanation of the outline of the manuscript in lines 144-146.

RC2: 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 of the abstract, we provided some more specific information and highlighted 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 (lines 10-14). Moreover, we structured it more clearly after the two main objectives (a) and (b) (lines 8-9; use of the term "communicate" in line 14). We have thoroughly revised the Plain Language Summary to make it more accessible to non-experts.

"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 for local to regional 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 averages **with the** model agreement on the sign of change. This **helps 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."

"Plain Language Summary. **All around the world, it is necessary to adapt to climate change, and people need to work together in local participatory processes to be able to identify the best local adaptation measures. Any development of adaptation measures requires information about the changes that may occur in the future, for example changes in water resources or crop yield. As the future cannot be reliably predicted, a range of possible future changes should be considered. These can be quantified with free data of global coverage from multiple computer models, which is available for many sectors like water, agriculture, forestry, fisheries, and biodiversity.** To **optimize communication**, we propose using "percentile boxes" instead of boxplots or simple averages **with the** model agreement on whether there will be an increase or a decrease in water resources. This way, people can better understand **what may happen in the future** and decide what possible future they want to adapt to, **for example** to much less or to somewhat less water than today, depending on how much risk they are willing to take. Our **quantification** and communication approach can support climate change adaptation processes worldwide, where stakeholders and scientists collaborate to develop flexible strategies for reducing climate change risks.

RC2: 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:

- **RC2:** 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 (section 4.2), we introduced Table 1 as Table 1 explaining the advantages and disadvantages of uncertainty visualization to communicate uncertainty to stakeholders. Due to the introduction of Table 1, we deleted some text parts in Section 4.2. Moreover, we explained why we did not use existing uncertainty visualizations but used an own visualization format, which is a modified visualization of the GERICS bar chart (lines 545-554) in the discussion. We presented existing uncertainty visualization formats in the introduction in lines 94-113 and opened the gap that a suitable uncertainty visualization format for climate change adaptation processes needs to be identified (lines 113-114).

Table 1. Advantages and disadvantages of some visualization methods to communicate uncertain changes to stakeholders. All represent the distribution of changes that are simulated by the different members of the multi-model ensemble and indicate the change values that are not exceeded by a certain percentage (percentile) of the ensemble members.

Uncertainty visualization	Advantages	Disadvantages
Boxplot	Shows three percentiles (P25, P50, P75) and possibly outliers and minimum (P0) and maximum (P100) values; common visualization.	Potentially reduced readability if it shows minimum and maximum; non-unique definition of and difficult to interpret “whiskers”; does not show percentiles suitable for strongly risk-averse stakeholders (P10 and P90); does not show the distribution of simulated change values precisely.
GERICS bar chart	Shows five percentiles (P0, P20, P50, P80, and P100).	Potentially reduced readability as it shows minimum and maximum; does not show the distribution of simulated change values precisely.
Violin plot	Precisely visualizes uncertainty by displaying the distribution of simulated change 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 (does not show many percentiles); 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 and difficult to read for the end user.
Letter-value plot	Shows many percentiles and uses the width of the boxes to guide the eye.	Potentially reduced readability as it shows minimum and maximum; area of the boxes does not correspond to the number of simulated change values contained in the boxes; pseudo- (i.e., misleading) visualization of the distribution of simulated change values; depending on the visualization, it has too many percentiles.
Percentile box	Shows five percentiles; percentiles can be selected depending on the problem and the risk aversion; minimum and maximum can be avoided, which increases the readability of the more central values and prevents the misinterpretation that the minimum and maximum values of the ensemble are the most extreme values possible.	Does not show the distribution of simulated change values precisely.

- **RC2:** 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 structured the introduction in a way that better highlights the main objectives (a) and (b). For this, we introduced one sentence, which outlines the structure of the introduction in lines 52-53 **“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 94, we added **“To communicate the quantified 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 included information from the former 5.1.1 and 5.1.2.

For this, we moved a paragraph from the Discussion to lines 69-74 in the Introduction.

In line 111-113, we introduced:

“Similarly, the letter value plot shows several percentiles with bars, but with reduced bar width the more distant it is to the median. To show the distribution of values, violin plots can be used, which also show the minimum, median, and maximum values.”

As we have not embraced the Cultural Theory in the communication of the uncertainties in the participatory process, we did not move lines 709-720 (formerly lines 741-752) from the conclusion to the introduction but leave it in the conclusion as a recommendation.

To highlight the two main objectives, we changed synonyms (e.g. “assess” or “present”) to the two words “communicate / communication” and “quantify / quantification (e.g., line 132, 138).

- **RC2:** 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 shortened the paragraph in lines 75-81 as shown:

“The Inter-Sectoral Impact Model Intercomparison Project (ISIMIP, www.isimip.org) provides freely available multi-model ensembles of many model output variables that are of interest to quantify climate change hazards in several impact sectors (water, lakes, biomes, forests, permafrost, agriculture (crop modelling), energy, health, coastal systems, fisheries and marine ecosystems, and terrestrial biodiversity; ISIMIP, 2019). The available impact model outputs mostly cover all land areas of the globe. For each impact variable, ISIMIP2b provides a time series for historic and future periods and several greenhouse gas emissions scenarios, 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.”

The rest of the paragraph was moved to Appendix A4. Moreover, we moved former lines 144-148 to Section 2 (lines 206-210) and moved the explanation of impact models in former lines 52-59 to Appendix A2 and only shortly introduced the topic in lines 54-55.

RC2: 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 moved both Sections in Section 2 (as Sections 2.1.1 and 2.2.1).

RC2: 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:

- **RC2:** 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 changed the structure of this Section (Section 2). A schematic of the presented approach was included as Figure 1 at the beginning of Section 2 and now guides the reader early on.

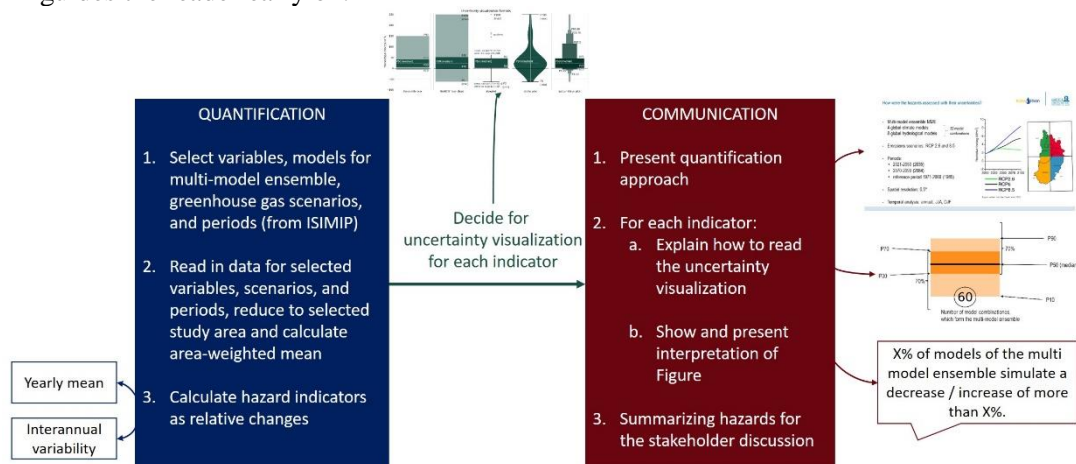


Figure 1. Schematic of the presented approach of quantifying and communicating uncertain climate change hazards in participatory climate change adaptation processes. ISIMIP: The Inter-Sectoral Impact Model Intercomparison Project (www.isimip.org/).

- **RC2:** 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 are merged (see above). The text is not structured by subsections anymore and was made more concise (very technical details important to applying the approach are moved to the Appendix Sections A3, A5, A6, A7, A8, and A9). To make it more concise, we only left the first two sentences of the paragraph “Greenhouse gas emissions scenarios” (the former 3.1.2) in the text, the rest was moved to Appendix A6.
- **RC2:** 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) and due to the inclusion of a

graphical abstract, we added a first sentence and slightly rewrote the first paragraph in Section 2 (formerly Section 3):

“Future changes should be quantified with their uncertainty and then a suitable visualization should be found with which the future changes with their uncertainty can be communicated in participatory climate change adaptation processes; an approach that we applied (Figure 1). At first, scientists or experts have to decide on what and how to produce climate change risk information (Figure 1, left box), and how to visualize the information (Figure 1, arrow between boxes) before they communicate it to local stakeholders (Figure 1, right box). So, during the first step, the quantification, 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.”

Moreover, we included a graphical abstract, in which the two steps quantification and communication are displayed, which are connected by an arrow, which says “decide for uncertainty visualization for each indicator”.

- **RC2:** 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 moved the Section about the participatory process to the communication section (Section 2.2.1). Moreover, we moved lines 399-405 (formerly lines 505-511 in Section 4.2) and Figure 7 (formerly Figure 8) to Section 2.2.2.4. To help the reader understand our communication approach (in vs. outside the participatory process), we included lines 290-297, and made some small changes in the text (e.g. in the caption of Figure 7 or e.g. including the words “participatory process” or “outside of the participatory process” in the text where needed).

To explain why we chose the specific visualization, we included lines 545-554 and the table of the advantages and disadvantages of uncertainty visualizations (Table 1) in the Discussion (Section 4.2). 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.

- **RC2:** 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, we introduced Section 2.2.2.3 for the former 3.3.4 and reduced it by the second paragraph, which we moved to Section 3.1 (i.e. to the results as suggested).

- **RC2:** 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 3 (formerly Figure 2). Later, in Section 4, we discuss the advantages and disadvantages of the chosen multi-model ensemble (lines 494-508; 521-527).

- **RC2:** 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 now refer to lines 324-331 in the caption of Figure 5 and lines 364-370 in the caption of Figure 6 in the revised version.

- **RC2:** 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 the former lines 405-416), which is neither part of our communication approach nor part of our quantification approach. We moved these two parts in the Appendix Sections A10 and A11 and refer to them in the captions of Figures 5 and 6 respectively, which is not the perfect solution because the interpretation should be close to the visualization of the results for better comprehension.

- **RC2:** To reduce the length of this section, terms and concepts (including Table 1) could be included in the introduction or supplementary material.

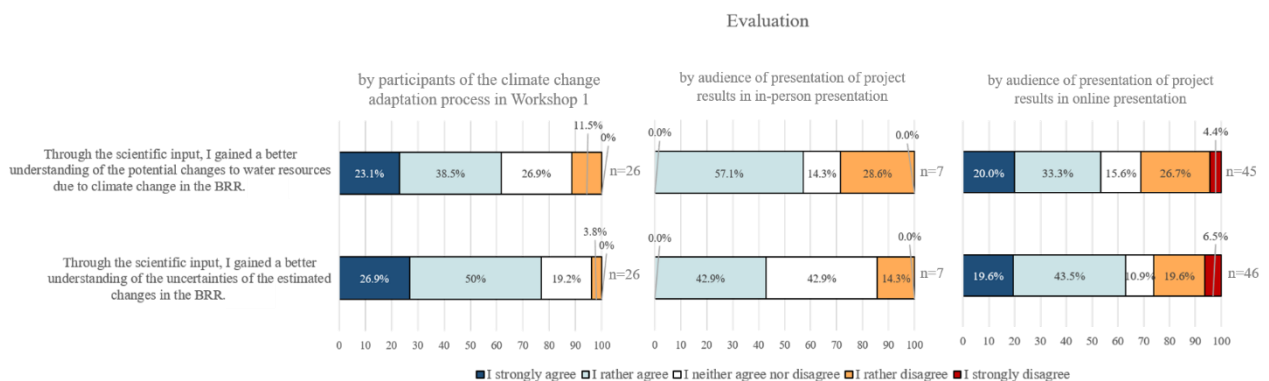
AC: In the revised version, we moved the former Table 1 into the Appendix A1 as Table A1.

RC2: 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 moved the former Section 2.1 before Section 2.1.2.

RC2: 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 former Figures 6 and 7 are presented on the same page, we rearranged them and displayed them in one figure, Figure 8 (see below). Because of this change, we had to make some changes in the text in lines 438-440 and in the caption of Figure 8.



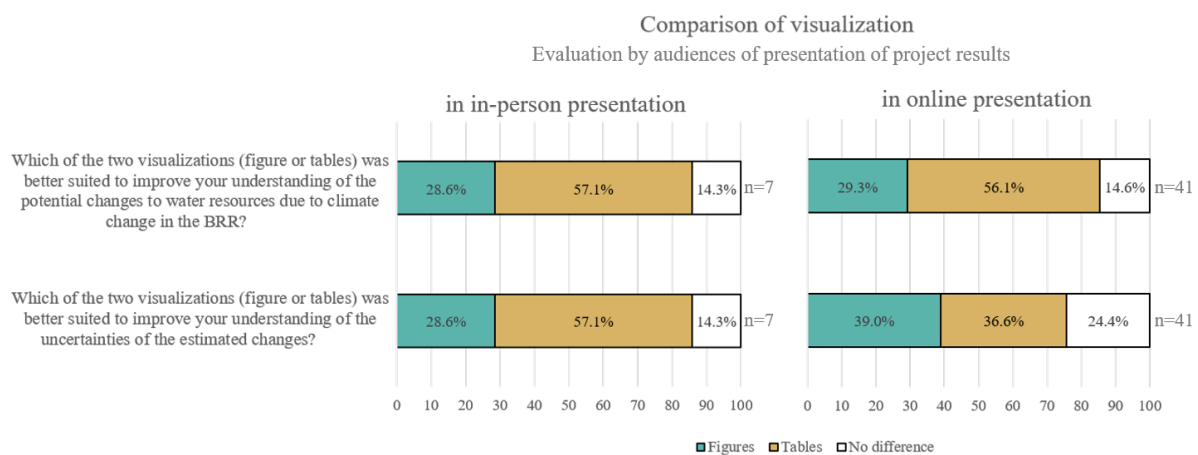
RC2: The authors could consider adding information on the importance of the results and how these are dependent on the number of participants in the workshops. For example, based on the online participation, the results seem more significant than those from the in-person presentation. There is no information 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 is expressed in lines 610-611, 648-650 and in Section 4.3 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 discuss in Section 4 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.

RC2: 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 extended the figure captions of Figures 8 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 also added in the titles of Figure 9 and the combined Figure of Figures 6 and 7: “Evaluation by audiences 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 also changed the color combination for better visual readability (Figure 9, which is the figure below). The color combination is colorblind safe and print friendly concerning <https://colorbrewer2.org/>.



RC2: 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.

RC2: How did the authors interpret the results considering the overall context of the study?

AC: In the revised version, we included in lines 656-659 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.

RC2: What are the key messages?

AC: We included the following information in the conclusion (Section 5):

Concerning objective (a):

- To assess uncertainties with multi-model ensembles it is more robust using changes (not absolute values) (lines 693-694).
- 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 (lines 688-693).
- The important changes of interannual variability were hard to grasp for non-scientists, thus, for their communication, another communication format is needed (lines 707-708).

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 (lines 695-700).
- 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 (lines 701-703).

RC2: 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 (e.g. line 139). 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 combined these novelty aspects with the key messages and revised the Discussion and the Conclusions with the information (see previous answer and below).

In the revised version of the Discussion, we included in Table 1 (last row, second column):

“Shows five percentiles; percentiles can be selected depending on the problem and the risk aversion; minimum and maximum can be avoided, which increases the readability of the more central values and prevents the misinterpretation that the minimum and maximum values of the ensemble are the most extreme values possible.”

To stress the disadvantages, we included in lines 577-578:

“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 529-554, lines 570-584 and in Table 1, we showed the advantages and disadvantages of our uncertainty visualization formats compared to other uncertainty visualization

formats. And in lines 555-565, we included ideas how other uncertainty visualization formats could be improved for the communication in participatory climate change adaptation processes.

At the end of the first paragraph (line 507-508), we included a technical limitation:

“However, it needs an expert with basic technical knowledge in any programming language to quantify the potential changes.”

In lines 545-551, we explained 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. Another advantage is that the percentiles can be chosen individually depending on the risk aversion and the problem (Table 1).”

In lines 688-690, we included:

“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.”

RC2: 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 lines 619-621, we included 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).”

RC2: 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 666-667, we included:

“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...”

RC2: 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 completely rewrote the Conclusions in the revised version integrating the key messages, novelty aspects, and advantages formulated above and structuring after the objectives (a) and (b).

RC2: 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 added following sentences in lines 841-847 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 the evaluation results may be published anonymously. In the in-person presentation outside of the participatory process, consent documents were collected from each participant regarding their voluntary participation and their agreement to publish the evaluation results anonymously. In the online presentation outside of the participatory process, the audience was asked to evaluate the communication formats in an online evaluation and they were informed that the evaluation results may be published anonymously.”

Other changes

AC: In the revised manuscript, we adjusted the reference list according to the Copernicus standards and according to the changes made in the revised manuscript.

We published the script to produce Figure 10 so that scientists/experts assessing potential changes can try out the discussed uncertainty visualization formats (see <https://zenodo.org/records/10400312>). We added this information in lines 542-543, and 825-826.

We added another uncertainty visualization format, the letter value plot, discussed it in comparison to the other visualization formats (see previous comments, e.g. in introduction of Table 1), and made suggestions in the Discussion (Section 4) on how to improve the visualization formats to reduce the identified shortcomings (lines 556-565).

We moved the text in the former lines 312-314 to lines 249-251 to enhance understanding.

We did some spelling corrections.