Reply to the comments by Reviewer #1

Herein, the authors create a set of 25 counterfactual extreme precipitation events to simulate the catastrophic flooding seen in the Ahr Valley, Germany during July of 2021. Their use of downscaled precipitation data and hydrological modelling showed that small shifts in the trajectory of the storm systems could have resulted in even worse flooding events than what was experienced. This type of analysis shows stakeholders and policy makers how best to be prepared for natural disasters and emerging climate risks.

Overall, I found the paper to be of excellent quality. I had one major comment on the precipitation data used and a few minor comments (see attached). After those are addressed, I am confident this paper will be ready for publication.

A: We thank the Reviewer for his/her positive comment on the manuscript and very valuable remarks that we address below.

Nhess-2024-97
It could have been much worse: spatial counterfactuals of the July 2021 flood in the Ahr valley, Germany
Major Comments:

1. The authors use bi-linear interpolation to regrid the E-OBS daily precipitation data to use in the hydrological modelling. I have some concerns regarding this method of regridding. Bi-linear interpolation can smooth out extremes, which seems counterintuitive for the purpose of modelling an extreme event. Precipitation, especially at the extremes, exhibits incredibly high spatial variability, and I worry that bi-linear interpolation loses the fine-scale variations needed to accurately model the flooding. And finally, it is my understanding that bi-linear interpolation is not a conservative method, meaning that the total amount of precipitation in the coarse data may not be the same in the subsequent downscaled data. Could the authors address these concerns, add some justification for this chosen method, and perhaps provide some validation of the interpolated data, either comparing it to a more robust interpolation method or high-resolution observations? I also did not see anything in the discussion on how this choice may have affected the results.

A: Thank you for your thoughtful comment. For this study, we used a quick bilinear interpolation to adjust the resolution from 0.11° to 0.0625°, hence having minimal impact on spatial details. While bilinear interpolation may slightly smooth extremes, the close resolutions (0.11° to 0.0625°) retain key spatial features, as shown in Figure 2 and Table 1. We verified by visual check that total precipitation remained consistent before and after interpolation. Since we carry out analysis of relative changes of precipitation, discharge, volume and inundation in counterfactuals in comparison to the reference scenario, we believe the selection of this method will have little impact on the overall results and conclusions. In the revised manuscript, we shall add a short note on interpolation effects of the used approach.

Minor comments:

Line 130 – Why bring up snowpack and Sweden when the paper is about precipitation and Germany?

A: In our study, we apply a relatively new approach of spatial counterfactuals. This method falls into a category of methods used to construct unprecedented or worst-case scenarios. Introduction gives an overview of these methods including among others „perfect storm" approach. Whereas it is applied in other risk domains, in hydrology, we found only one mentioned example from Sweden. We believe the overview of these methods is important to properly embed the presented work in the context of research on extreme flood scenarios.

Line 195 – First use of "E-OBS" acronym – please define

A: Will be addressed.

Figure 7 – This figure seems to be at a lower resolution than the other figures, recommend replacing with a high res figure

A: This Figure will be replaced.
Figure 8 – If this is the standard then please ignore, but my intuition says you should plot max H (m a.s.l.) along the y-axis, not the x.

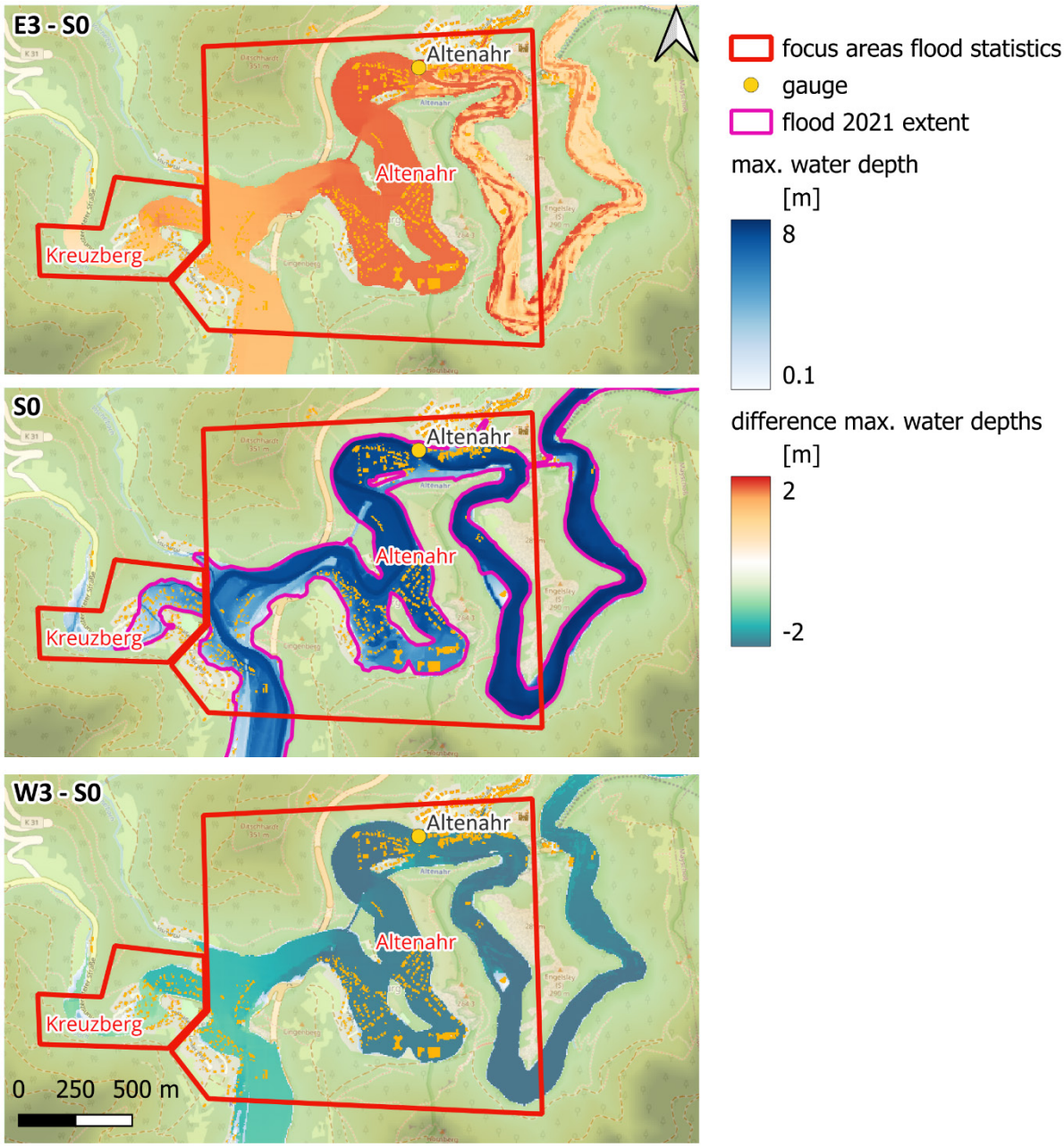
A: We shall exchange the axes.

Line 515 – loosing -> losing

A: Thanks. It will be corrected.

Inundation figures (ex. Fig 9) – I like what these figures are showing, but I think they would benefit from two changes. First, I think the colorbar should be larger. Second, instead of a single column, I think they would be better represented as three columns in a single row, with scenario W3 on the left, S0 in the center, and E3 on the right. Or perhaps best would be to show the difference in the scenarios, so E3-S0 to better visualize the inundation difference between the scenarios.

A: We agree with the reviewer that showing the difference in water depth between E3/W3 and S0 scenarios would be more informative. We will address this and adjust the legend size. Below we show an example, how e.g. new Figure 9 would look like. We think however that aligning the panels horizontally instead of vertically would lead to significantly reduced size of the images and will impair readability. Especially for Figure 11, which follows the same logic as Figure 9, this would lead to very small figure panels. We therefore prefer to keep the original alignment.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