



EGUsphere, author comment AC2
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Reply on RC2

Paul D. Bates et al.

Author comment on "A climate-conditioned catastrophe risk model for UK flooding" by Paul D. Bates et al., EGU Sphere, <https://doi.org/10.5194/egusphere-2022-829-AC2>, 2022

We are very grateful to the reviewer for their supportive comments and the suggestions for improvement.

First of all, we'd like to reassure the reviewer that we are indeed "walking the talk" by making the data fully available for non-commercial research use under a standard academic licence. This is already mentioned in the "Data availability" section on lines 523-525 of the main text but we will see if this could be made clearer.

General comments

In terms of the ABI data and whether this is an under-estimate or not, it is worth noting that the ABI data have already been substantially adjusted to deal with many of their limitations. For this we follow the approach given in Penning-Rowsell (2021). This method corrects the data (as far as can reasonably be accomplished at present) for inflation, territorial basis, betterment, taxation, missing pluvial flood losses, underinsurance, ABI market share, missing non-residential losses and changing GDP over time. There is a long section on this in the SI on lines 170-225 and the approach is summarised in the main text on lines 153-163 and 332-337. Of course, this is not to claim that the corrected ABI data are therefore 'truth' or that the correction factors determined by Penning-Rowsell are exact, but it does mean that it is not at all clear that the corrected ABI Expected Annual Damage value is an under-estimate. Post-correction, the ABI EAD is just as likely to be too high as too low. The ABI data will of course have error and we do already note in the conclusions on line 488 that "the ABI data need careful handling and adjustment because of the way they have been collected". However, the referee is correct that we could have said more about their likely uncertainty and will add this discussion to a revised version of the paper.

We agree that including socio-economic as well as climate scenarios would be interesting, however understanding changes in risk due to climate alone is extremely useful in its own right. Moreover, only by controlling for socio-economic change can the impact of particular climate emission policy responses be clearly identified. Demarcating the impact on flood risk of the COP26 commitments and 'net zero' ambitions is major outcome of the paper and should have wide impact. The reviewer is however correct that the next step is to look at the interplay between climate and development in modulating future risk, although this is not trivial because of the granularity of socio-economic projections that are required. The IPCC Shared Socio-economic Pathways (SSPs) are at country level and downscaling of these to 1km (i.e., still much coarser than the ~20-25m resolution

inundation model) has only just been completed for the UK (see <https://uk-scape.ceh.ac.uk/our-science/projects/SPEED/shared-socioeconomic-pathways>). These downscaled SSP data will need careful evaluation prior to their use in a flood risk study and some careful methodological development will be needed to bridge the remaining resolution gap. This will be a substantial task and one that realistically will need to be described in a stand-alone paper. Including socio-economic projections in the present (rather overlong) manuscript is probably too much. Instead, we do already include statements about the likely impact of including socio-economic change on lines 390-393 and indicate that this should be looked at in future work.

Specific comments:

P7 L194ff: One main advantage of the local modelling approach used by the Environment Agency is that they have a good understanding of local flood defences and other protection infrastructure. Can you say something about how your approach compares to that? I have not checked Wing et al. 2019, but in case you have any information on the accuracy of your approach compared to data on local spatial flood defences that would be great.

Primarily, we use the exactly same government flood defence database as the UK environmental agencies, namely AIMS (<https://www.data.gov.uk/dataset/cc76738e-fc17-49f9-a216-977c61858dda/aims-spatial-flood-defences-inc-standardised-attributes>). A reference to this is already included in the bibliography. Most flood defences in our model are based on this 'official' view and therefore the majority should be exactly the same between local and national studies. It is also worth noting that local models are only employed in the UK to produce estimates of flood hazard, and these hazard maps are not currently used in the production of national risk estimates. Instead, flood risk is determined separately using large scale simplified inundation models built using national data sets including AIMS for the flood defences (e.g., the NaFRA methodology in England). Official national scale risk estimates thus do not benefit from local knowledge either (at least as far as we can tell from the limited information about these methods that is in the public domain).

The referee is correct however that that EA, SEPA, NRW and DfI local flood hazard modelling studies may possibly supplement the AIMS data with knowledge that is not systematically recorded in an open-source form. Large scale studies, as conducted here, need to work with available published data and their results may diverge from local modelling where this such information has a significant impact. To address some of these limitations we use the method of Wing et al. (2019) to automatically identify flood defences in high resolution terrain data and apply this everywhere such data exists. The Wing et al (2019) paper showed that this method could added important information to official flood defence records and for a test reach of the River Po led to improved model predictions. Importantly, the method can identify structures which impact flood propagation on floodplains, such as causewayed roads and railway embankments, which are not officially classified as flood defences. It is difficult to generalize the River Po findings, but in general we would expect this automatic detection approach to miss some flood defences that local knowledge would pick up, but at the same time it may identify relevant terrain features that might otherwise be overlooked. NaFRA does not include a similar methodology to supplement AIMS flood defence information (as far as we can tell).

We will add some further comments to the paper to discuss this.

P8 L199: How where the 10 different return periods selected? Olsen et al. (2015) (<https://doi.org/10.3390/w7010255>) show that the selection of return periods for the loss exceedance probability curve has a large effect on the EAD. Have you done any sensitivity analysis on how the selection of return periods is influencing your EAD estimates?

Actually, each loss-exceedance probability curve comes from the catastrophe model part of the workflow so is based on 10,000 years of synthetic flood events with realistic spatial footprints. The return period maps are used to turn each of these spatially variable event intensity footprints into a composite flood depth map for which we can calculate a loss. This gives a distribution of losses with which to form a loss exceedance curve. The Expected Annual Damage is therefore just the integral of the loss exceedance curves. This approach differs significantly from the simpler method of calculating loss for a series of 'constant in space' return period maps and using these to compute an EAD as Olsen et al have done which. This is already discussed in the SI on lines 377-382. The choice of return periods in our method will somewhat influence the granularity with which footprints can be generated but the results are not expected to be significantly sensitive to this choice. Accordingly, the return periods were simply chosen to form a spread across the range of typical loss creating flood events and we will add some text to better explain this.

P9 L249: You mention the "Fathom model" for the first time in the manuscript. I am assuming this is the name of the model you are presenting in the paper, but would be good to formally introduce the name to avoid confusion.

"Fathom" was included in error, and we will remove this. The model was produced by Fathom (www.fathom.global) but as this is an academic work we did not want to be accused of advertising.

P9 L257: If possible, it would be great to have the equations for each metric in the text as it makes it easier for the reader to understand how those metrics are calculated.

Of course. We will add these.

Figure 2: Would be nice to have an inset showing the location of each flood layer on a GB/UK map

We will try to do this. The tension here is that the plot is already a whole page figure so where to add an inset without reducing the size of each sub-panel (and hence losing detail) could be a problem. We will experiment with some potential solutions.

Figure 2 caption: flood hazard maps on the right are shown in red not green

Thanks! This is a mistake and will be corrected.

Table 2: Table 2 is an example, but comment is more general: it is sometimes not perfectly clear if values are for England, GB or the UK. As far as I am aware, the NaFRAs are conducted by each of the devolved nations individually. Is the number shown in Table 2, the sum of all NaFRAs or are these values for England only?

NaFRA is the name of the flood risk mapping programme in England only (although it did also cover Wales pre-2013). Wales, Scotland and Northern Ireland have their own programmes with different methodologies and only report number of properties exposed and not financial losses. To create a GB loss we therefore scale the NaFRA result for England using the ratios reported in Penning-Rowsell (2021). These were taken from the emulation methodology used in the 2017 UK Climate Change Risk Assessment (Sayers, 2017). This suggested that England accounts for 79% of flood losses, Scotland 12%, Wales 6% and Northern Ireland 2%.

You are right however that this is not very clear in the main text, and we will correct this.

References

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