Response to reviewer 2

This manuscript presents a case study of a modeling framework that could be applied globally to investigate the impact of compound flood risk, at least for initial investigation. The manuscript is for the most part very well written and has a very clear structure.

We would like to thank the reviewer for the review and comments, which we believe will improve the clarity of the manuscript. We are pleased to read that the reviewer considers the manuscript to be mostly well written and clearly structured.

Despite this, there are a small number of comments that need to be addressed. These are listed in page order below but the more important ones are highlighted by *.

Section 2.2.3 Rainfall. Lines 152-153: Design rainfall events with a 24- hour duration were created. Why was this duration chosen? How is this related to catchment response for the chosen area?

The rainfall design events are applied within the SFINCS model domain where the response time of the small tributaries is indeed expected to be in the order of one day. Furthermore, a 24-hour duration is commonly used in flood risk analysis, e.g. in the Soil Conservation Service (SCS) approach (US SCS, 1965). Furthermore, the SCS Curve Number method for infiltration in SFINCS is not applicable to long rainfall events. However, with local rainfall observations (which are not available for this case) an analysis could be done to estimate the typical duration of extreme rainfall events. We have clarified the choice in the methods section and discuss how this boundary condition can be improved in the discussion section.

Line 160: How was the plus/minus ten days determined?

This range is only chosen to calculate the cross-correlation between the drivers. We find a maximum correlation for a lag time of -3 and 1 day. This confirms that the peak in cross correlation is found within the 10-day range. As expected, the cross correlation decreases as expected towards the boundaries of the range, see Figure 1 below. Any range between plus/minus 4 to 10 would result in the same relative lag times and larger time ranges would at some point pick up on cross correlation related to seasonal rather than event-based correlations. We have clarified this in the methods section.

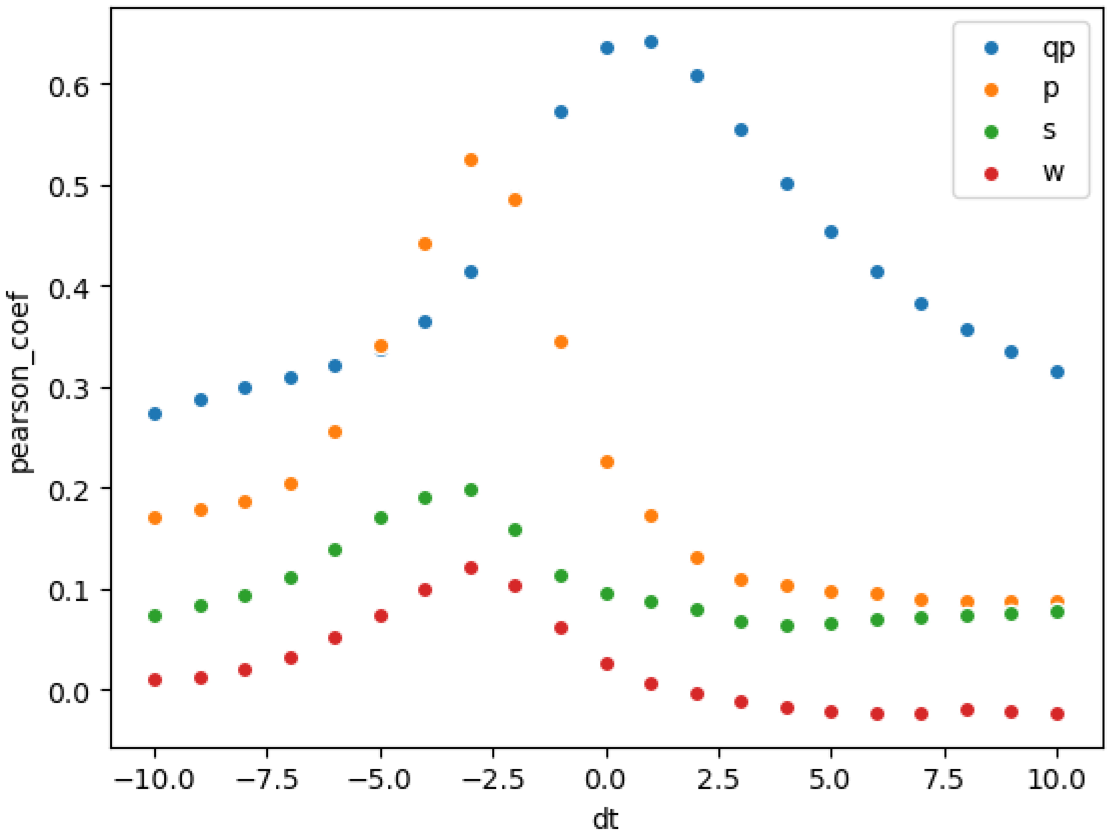

Figure 1: Cross-correlation between the primary flood driver (i.e., discharge at the Buzi river) and other floods drivers (qp: discharge at the Pungwe; p: rainfall; s: surge; w: total water level).

Line 176 and throughout the manuscript. The authors use both Pair Copula Constructions and Vine Copula interchangeable throughout the manuscript.

We have edited the manuscript to use Vine Copula consistently in the manuscript.

***Section 2** and in particular section 3 (3.2). The authors present the results and talk about inaccuracies (Line 243). However, these are never combined . In Section 3.2 there is a lack of quantifying the statements and relating to the relevant inaccuracies in the data. For example, Line 322-323, the authors states interactions decrease flood depth in the estuary but upstream increases flood depth. By how much and how does this relate to the overall errors in the datasets. This is needed to understand if these changes are significant relative to the data errors. Again Line 326, the authors do not quantify the lower volume of coastal water entering the river mouth and if this is a significant amount.

We appreciate the importance of uncertainty analysis to support any statements made about the physical behavior of the system. In this manuscript we have performed a sensitivity analyses for some of the assumptions taken in the risk modeling framework, such as the assumption of a constant relative lag time between flood drivers. The sensitivity of the model to uncertainties in the globally applicable model were assessed in a previous paper (Eilander et al. 2022). Based on a comparison with observed flood extents from remote sensing, we found that the model skill is not very sensitive to the river depth, but most sensitive to the Manning roughness and dynamic forcing. We also investigated the sensitivity of the transition zone (i.e. where hydrodynamic interactions between flood drivers increase water levels) to river and estuarine bathymetry based on two events. We found that with a deeper estuary the transition zone in the Pungwe estuary extends further inland, but this change is relatively small compared to the total extent of the transition zone. With sufficient coverage of (new) remote sensing missions such as ICESAT 2 and SWOT, it will become easier to quantify uncertainties in global datasets for local flood studies and go beyond sensitivity analysis. We have added more discussion about the uncertainties in the used datasets and model layers based on relevant literature in section 3.5.

Section 3.3. (Line 345-348). The authors state that the damage caused by pluvial damage is mostly related to the infiltration capacity. Can this be quantified and what are the other factors that influence this.

There appears to be a misunderstanding. We state that the infiltration capacity and the 15cm flood depth threshold for damage results in no damage for events up to 10 years. We have clarified this in the text.

***Section 3.5** Limitations and way forwards (Line 390 - 395). The authors mentioned the accuracy of the input data should be considered. It would be nice to see this point discussed in more detail. This is similar to the point above.

See reply to comment on Section 2 above.

***Line 436-439.** This statement sums up the entire manuscript excellently. However, it needs to be stated more strongly throughout the manuscript and include in the manuscript (more clearly) the weaknesses in the approach.

We have included a sentence in the conclusions and abstract to reflect on use and limitations of global datasets and possible ways forward

"As the framework is based on global datasets and is largely automated, it can easily be repeated for many other regions for first order assessments of compound flood risk. Furthermore, the framework can readily include higher quality (local) datasets to improve the model. We therefore argue that the framework provides a suitable means to improve large scale compound flood risk estimates."

References

US SCS: National engineering handbook, section 4: hydrology, US Soil Conservation Service, USDA, Washington, DC, 1965.