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Hydrology and Earth System Sciences Discussions

Interactive comment on "A framework for global river flood risk assessments" *by* H. C. Winsemius et al.

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We thank anonymous referee 1 for his/her useful comments on our manuscript. The comments are in our opinion such, that they will considerably improve the manuscript.

Below we reply to all comments brought forward by referee 1.

1. Validation of hazard/inundation modeling

The reviewer suggests that we can improve on the hazard validation by carrying out a comparison on a case study event basis. We have not pursued this option so far. The results of a comparison between observed and simulated inundation maps, given a certain flood volume, will be related to the quality of the DEM and the validity of our

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assumption that the main source of flooding is the major rivers. In Bangladesh, much more local drainage impediment (e.g. due to local rainfall) as well as coastal inundation may also cause flooding. As these processes are not accounted for in our model chain, and uncertainties remain within the model cascade, differences between observed and simulated events will remain, as seen in the validation pursued so far.

If we are to validate on an event basis, as the referee suggests, the simulated flood volume during the event may in addition strongly depend on the quality of the meteorological input dataset in terms of volume and timing, exactly during the event (note that we used the CRU-ERA40 merged dataset). By using a cdf over a long period and focusing on a return period within this cdf, we reduce the impact of the input quality during one single event.

Nonetheless, we feel that the referee is right that we should demonstrate this. We propose to perform the event-based validation with the 1998 flood event. We will perform downscaling over a number of days during the event. Furthermore, we will study the sensitivity of the used elevation model. So far we have used the SRTM HydroSHEDS elevation model, which is slightly conditioned to follow natural hydrography. Therefore, we will test the impact of non-conditioned SRTM on the flood patterns and add this analysis to the paper. The 1998 event will be taken from our latest simulations with the EU-WATCH dataset (Haddeland, 2009), which provides data until 2000.

2. Time period modeled.

So far we have restricted the simulation to a typical climatology period (1961-1990). Indeed we can extend this period. We have done this in the meantime by performing a 100-year simulation based on the EU-WATCH dataset as mentioned above. However, the extension of our time series is beyond the scope of this paper as the paper is meant to outline and demonstrate a framework, rather than perform additional simulations (which will be the scope of future papers). The referee further suggests combining ERA40 and ERA-Interim to produce a longer time series. We feel that this would result in a non-homogeneous time series. Therefore, we propose to stick with the CRU-ERA40 30-year time series within this paper, and only use the EU-WATCH series for the case study validation.

3. Volume to water level.

The referee comments that our description of the downscaling procedure is too limited. In the revised manuscript we will clarify the procedure, including the following points. We will clarify that in each 0.5 degree cell, 1x1 km river cells are identified. Each 1x1 km river cell is given a layer of water, and through the local drainage direction network upstream cells are identified that have a lower elevation than the river cell elevation + the water layer. These cells are assigned a water depth of the river cell elevation + the water layer – the elevation of the cell under consideration. We will use equations to clarify this.

4. Use of the term 'bias'

We agree with the referee that the use of the word 'bias' is not fully correct. We will clarify that our scheme only reduces errors in the mean, not in the full distribution.

5. Consideration of embankments

The referee correctly states that the presence of dikes needs to be accounted for. We have tried to do this in a globally feasible manner by introducing the volumetric threshold. We stress here that this volumetric threshold is a suitable way of dealing with present dikes, as long as a) the dike is not dimensioned for very high safety standards, such that a flood event will only occur with very high return periods, far beyond the simulated time series (see section 4.5); and b) we can reasonably assume that flood risk occurs due to levee overtopping, rather than dike breaches. The risk due to dike breaches is of interest typically if safety standards are very high (e.g. in the Netherlands for the large rivers, a minimum 1250 year return period is maintained). In such cases, a more localized modeling approach is required. We will further clarify this in the discussion.

As for a strategy to include the safety standards across the world and the spatial variability therein: a first step to improve on this is to build up a global database of safety standards. A second step could be to establish a global database of river profiles, including the levees. This would lead to further opportunities to improve global inundation modeling. As yet, such databases do not exist but we will certainly pursue options to establish such databases in future research. We will include some comments on this in the discussion, particularly in Section 4.5.

6. Empirical vs. estimated probabilities

Indeed, estimated probabilities based on extreme value distributions are a feasible option to include in our framework. This has also been shown in the paper by Pappenberger et al. (2012) and we are following this approach in our next contribution from this research. We will also include a comment on this in Section 2.2.3, where the derivation of statistics is described.

7. Conclusion on use of study outputs

We have included a number of end users of such information in the introduction of the paper. We propose to keep this subject in the introduction as it is more a motivation for the study than a conclusion.

We will pay attention to the minor remarks in the updated manuscript.

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