

Authors' responses to the comments of Reviewer #2

We appreciate your review and comments on our manuscript, “**The Pluvial Flood Index (PFI): a new instrument for evaluating flash flood hazards and facilitating real-time warning**”. Your feedback is valuable to us, and we made the recommended revisions accordingly. We provide detailed responses to each of your comments below.

This manuscript proposes the Pluvial Flood Index (PFI) as a tool to assess and communicate pluvial flood hazard based on hydrological–hydrodynamic simulations. The approach consists of (i) defining pluvial flood hazard areas (PFHA) using thresholds of water depth, flow velocity, and specific discharge, and (ii) aggregating these hazard areas using a moving circular buffer to derive a dimensionless index (PFI), which is then classified into hazard levels. The manuscript addresses an important topic, as pluvial flooding remains challenging to assess and communicate, particularly at larger spatial scales and in the context of real-time warning. The idea of simplifying complex model outputs into a communicable index has clear practical relevance. This manuscript has already undergone one round of review, with one reviewer generally supportive and another raising substantial conceptual concerns. In my view, the manuscript has improved in clarity and better explains the intended purpose of the PFI as a large-scale, communication-oriented indicator.

However, some conceptual issues remain partially resolved, particularly regarding (i) the novelty and scientific contribution of the PFI, (ii) the physical interpretation of the index, and (iii) the justification of key methodological choices (spatial aggregation and thresholds). Therefore, I recommend minor revision.

We agree that parts of the manuscript still can be improved. Based on your valuable comments we changed and refined our manuscript in order to address the three key issues you raised. We hope that this becomes now more clear. Please find our detailed response below.

One issue raised by both previous reviewers concerns the novelty of the PFI. The authors acknowledge that the PFI can be interpreted as a post-processing step applied to standard hydrological and hydraulic model outputs. While they argue that the combination of hazard thresholds (PFHA) and spatial aggregation constitutes a contribution, the manuscript still does not clearly establish what is fundamentally new from a scientific perspective. At present, the PFI appears to be a threshold-based classification of model outputs, and a spatial smoothing (aggregation) of binary hazard fields. This does not invalidate the usefulness of the approach, but it raises the question of whether the contribution is primarily methodological or rather operational/communicative. Therefore, the authors should more explicitly position the PFI as either a practical/operational tool, or a scientifically novel index, and adjust claims accordingly. Overstating the conceptual novelty should be avoided.

We tried to make this clearer now in the form that the PFI itself is mainly a practical/operational tool designed for the easy communication of pluvial flood hazards to potential users on the regional scale. However, the underlying PFHA (which forms the local basis to calculate the PFI) is a new scientifically based approach that is built on scientifically-sound empirical data. We tried to consistently make this

clear in the different parts of the manuscript – PFHA as a detailed local hazard mapping approach, PFI as a subsequent user oriented information on the larger, regional scale – both necessary for the PFI concept presented here.

Reviewer #2 raised an important concern that the PFI may be interpreted as a physically meaningful indicator of hazard, while in reality it largely reflects spatial smoothing of hazard patterns. The authors now clarify that the PFI is intended for regional-scale assessment and communication, not for local physical interpretation. This clarification is helpful. However, the manuscript still risks implying that the PFI represents a physically grounded hazard metric. In particular, the use of a moving circular buffer means that areas may receive elevated PFI values due to nearby hazards, even if local conditions are not hazardous. This raises the possibility of misinterpretation, especially by non-expert users. The authors could either clearly and consistently state that the PFI is a derived, scale-dependent indicator, not a direct physical measure of hazard or explicitly discuss the implications of spatial smoothing. Please consider adding a short subsection discussing limitations and interpretation guidelines for users.

We followed the suggestion of reviewer 2 and added a small section at the end of the PFI definition where we again made clear, for what purpose PFI (identifying potential hazard regions) and PFHA (local scale hazard information) estimates are intended for.

The choice of a moving circular buffer (~2 km²) remains insufficiently justified. The authors indicate that this choice is based on experience and stakeholder discussions, but this remains largely qualitative. Given that the PFI is highly sensitive to the choice of buffer size, and weighting scheme, this is a critical methodological component. The thresholds used to define PFHA (depth, velocity, specific discharge) and the classification thresholds for PFI remain only partially justified. While the authors state that thresholds are based on safety considerations and experience, the workflow for defining them is still not transparent. Given that these thresholds directly determine the resulting hazard maps, this is a key issue. It is necessary to discuss uncertainty and transferability of the thresholds to other regions.

We agree that the threshold we used for different applications might be a partly subjective and might need a bit more clarification.

With respect to the size of the circular buffer zone on the PFI, we calculated the PFI maps for the mesoscale SW Baden-Württemberg region with different buffer area sizes (new Figure S3). Due to the fact that we suggest to use a weighted buffer, we find that the general PFI patterns are rather similar in all three cases, hence the actual buffer size is of less importance.

We agree that the link between areal PFHA fraction and PFI might sound a bit arbitrary, however, it is based on the application of the PFHA/PFI concept on a series of past events and is in our opinion and given the data available as good as it can be. But as this more defines the color and hence a possible warning level, it can be adapted in future if necessary.

The thresholds to define PFHA areas, however, are clearly defined based on recent field and laboratory experiments documented in the presented literature.