

Process-based flood damage modelling relying on expert knowledge: a methodological contribution applied to agricultural sector

Point by point answer of the authors to referees comments for minor revision

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1 Summary of changes regarding observations and recommendations from referee 1

We thank again the referee 1 for his second review. We are pleased to have been able to respond to its main criticisms.

Suggestion 1: The Authors have specified (L145 and 235) that the model “validation” has been carried out with the same experts who were interviewed in the development phase of the model. I am still convinced that this process cannot be called “validation”, given that, to be so, it would require (at least) different experts involved in the two different phases. The approach followed by the Authors may be fine (as I am aware that it could be difficult to find many experts available to be interviewed), but I would rather define this process as “sanity check of the model” or just “check of the model”.

- Referee 1’s suggestion shows us that we had not insisted enough on the double interest of validation workshops with experts. Indeed, on the one hand, the coherence between the elements collected in the individual interviews and the implementation of the model is ensured (what referee 1 calls check of the model). Beyond that, the interest of these workshops is to allow the experts to readjust their assumptions according to the collective discussion, but above all to allow them to readjust their assumptions by presenting them with the entire modelling chain (loss of plant material, yield, associated behaviours)
- The section on validation was reworded as follows : “The aim of these workshops is multiple. They allow the coherence of the information collected in individual interviews to be verified and discussed collectively. Above all, they allow the results of the overall modelling chain (loss of plant material, yield, associated behaviours) to be presented to the experts who were interviewed separately on the different components of the model and to allow them to readjust their assumptions if necessary.”
- We agree that involving external experts would consolidate the validation and we reworded the section discussion on validation as follows: “Two avenues are usually identified: first, the comparison of model results with each other; second, the comparison with claims data (Molinari, 2019c). A third avenue is to consider the geographical transfer of models as an opportunity to capitalise on expert knowledge by involving new experts and being able to clearly present the modelling assumptions to them.”

Suggestion 2: Always regarding Axis 2 (“Validation” in Table 2), points V3 and V4 pertain to model “usability”; then, I would suggest renaming the title for this Axis as “Validation and usability”. Here the term “validation” is ok, as it is used in a more general context (including traditional validation against observed data).

- We agree that part of the validation presented in axis 2 is related to the operational aspects of the usability of the model. However, we believe that changing the title of the section could lead to confusion

and we propose the following change in the section framework / validation: “The third modality is a validation related to the operationality and use of the model.”

Suggestion 3: I suggest the Authors to rephrase and better explain the following sentence “In this paper, we argue that process-based models are not doomed to be context specific as far as the modelling process is rigorous”, both in the abstract and in the conclusion section. In my opinion, as it is now, it could be misleading, given that process-based models are always general in their methodological framework, while it is only their “application” that it is context-specific (as it also emerges from Authors’ paper). I suggest here a possible amendment for the mentioned sentence: “In this paper, we argue that process-based models, based on a rigorous modelling process, can be suitable to be applied in different contexts.

- We thank the referee 1 for his suggestion of amendment. We reworded the sentence as suggested.

Description of damage to equipment: I guess Equation 16 implicitly implies some damage ratio (or vulnerability function) or are you assuming that equipment is always fully damaged whenever there is a flood? Please clarify this point.

Minor comments

- L2: “because they may have greater exposure and are complex economic systems”: in my opinion, it would be better to say: “because they are complex economic systems particularly exposed to floods”.
 - the proposition has been accepted in the text
- L14-15: not so clear sentence; please consider rephrasing (perhaps by shortening it).
 - We have reworded it as follows : “We show in this paper that the proposed methodological framework allows an explicit description of the modelling assumptions and data used, which is necessary to consider a reuse in time or a transfer to another geographical area. In this sense, this methodological framework constitutes a solid basis for considering the validation, transfer, comparison and capitalisation of data collected around models based on processes relying on expert knowledge.”
- L68: it seems there is a missing word after “insurance”, probably “penetration” or “coverage”.
 - this has been corrected
- L82: replace “it” after “(ii)” with “damage” to be more clear.
 - We changed “it” by “the loss of yield”
- L102-105: delete this paragraph, since it is just mentioned a few lines above (L93-94).
 - ok
- Please check figures and tables numbering: for example, I noted that Figure 3 is cited in the text before Figure 2 (the same applies to Tables 9 and 6).
 - This has been corrected.
- I would suggest merging Figures 3 and 8 into just one figure.
 - As the modelling process and its steps is quite complex, I am afraid that putting the modelling steps and the transfer steps on the same figure will lead to confusion. I prefer to keep the current form.
- L205-206: unclear sentence; please consider rephrasing.
 - We reworded as follows: “floodam.agri includes generic parts and can produce damage functions at different scales, depending on the calibration. We illustrate in this article the use of floodam.agri to produce damage functions at the national scale”
- L273: “materiel” -> “material”.
 - ok
- Table 2: this information could be directly provided in the text (e.g. at L280), without using a table.
 - done
- L305: sub-questions are actually two and not three.
 - ok
- L319: insert a comma after “material” and “mortality”.
 - ok
- Parameter beta (as in Table 7): I guess there are different thresholds for beta (which drives the farmer’s

strategy) for different types of plants, or, based on expert knowledge, are they fixed values? Please specify this point.

- We reworded the paragraph concerning plant material to make it more explicit. beta is not fixed as presented in the diagrams of the table 3. It is a function of water depths, flood duration, and velocity. I specified also that the thresholds given in the ex table 7 (now table 6) are the assumptions made for the application at national scale.
- L467 and 469: “data” instead of “date”
 - ok

2 Summary of changes regarding observations and recommendations from referee 2

We thank again referee 2 for his second review. We appreciate his encouragement to publish this article and are pleased to have been able to respond to his recommendations and questions in the first round.

Suggestion 1 : On validation L409-416. you recommend (Axis V1) to compare estimation with sinistrality data, by comparing the output (as you say line 137). I guess by output you mean the final damage in monetary terms. But output is only one element of the comparison. The difference in the assessment method is another element. As you say L 413-416, your model uses more type of expenses after flooding than the compensation systems. So, why are sinistrality data considered as a reference data to compare your model with? Sinistrality data are also subject to assumptions, limitations. This issue is crucial for Cost-Benefit analysis because depending on the model used, a project can be approved or rejected. But both methods are valid as long as the assumptions are accepted by society (V3 on stakeholder expectations).

- We fully agree with referee 2 concerning this aspect. To make this more explicit we have added the following sentence to the section framework / validation : “In addition, sinistrality data should be considered with caution as it may only represent part of the damage that one wishes to compare. The insurance coverage of the different types of damage, in particular in agriculture, is not complete.”

Suggestion 2: On transferability. Can we think that your model could be used by a system of flood damage compensation where damage are not collected (because it is too costly for example) but estimated with your model? I think this would deserve to be discussed at some point in the paper or you should define the limit of transferability.

- We thank the referee 2 for this suggestion. This raises an issue that we had not discussed so far in the article, which is to use the model for post-flood damage estimation from partial data. To take into account this interesting suggestions, we reworded the section discussion/consolidate validation as follows: “The proposed framework allows for a clear improvement in the validation methodology with experts involved in the modelling process. However, we are aware of the need to consolidate this aspect. Two avenues are usually identified: first, the comparison of model results with each other; second, the comparison with claims data (MolinariD2019c). A third avenue is to consider the geographical transfer of models as an opportunity to capitalise on expert knowledge by involving new experts and being able to clearly present the modelling assumptions to them. We consider that the clarification of the assumptions is a prerequisite for both avenues and the framework presented here is a step towards the possibility of comparing models with each other. We have made a first proposal in the table C1 based on existing literature. This should not be considered as a result but as a discussion support to allow exchanges on methods with a view to capitalization. Concerning the collection of ex post damage data, in particular for the agricultural sector, this is a real challenge that requires a long-term effort. Some interesting initiatives are to be highlighted, as for example, the validation carried out by (ChauVN2015) or (ShresthaBB2021a). The modelling effort we have carried out to develop floodam.agri has highlighted the importance of acquiring knowledge both on biophysical and human processes in order to be able to assess damage in economic terms. This implies that the data to be collected post-flood in order to validate a model such as floodam.agri must be of different natures, ranging from biophysical impacts (yield loss, mortality of plant material, soil erosion...) to monetary damage, including the chain of

behaviours of recovery and continuation of crop management sequence. But this type of post-flood data collection is very time consuming. Most of the time, on large-scale events, the primary objective will be to obtain an overall damage assessment fairly quickly and not to carry out a detailed characterisation of the damage formation processes. In this case, it could be used to estimate damage in monetary terms from hazard parameters. It could also be used to estimate damage in monetary terms from partial post-flood data collection such as yield losses, which corresponds to the practice of the insurance system in France. This type of use would provide a more complete picture of the damage on the basis of the current modelling assumptions, but would not or only partially validate the estimated values. On the contrary, such a characterisation makes sense for small-scale events for which, however, various levels of impact can be encountered on an individual scale. In this case, the collection of data allows for validation. For this, the implementation of observatories is an interesting approach.”

Technical corrections/clarification

The following corrections have been done.

- Line 182: What do you mean by local communities? Do you mean municipalities?
 - communities has been changed by local flood risk managers
- Line 373: delete “are”
- Line 483: “the” week.