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Reply on RC2

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Author comment on "Process-based flood damage modelling relying on expert knowledge: a methodological contribution applied to the agricultural sector" by Pauline Brémond et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-398-AC2, 2022

We would like to thank referee 2 for the analytical work that was done on our paper. We thank him for his encouragement to publish this work and for all the suggestions and questions that were formulated and that will allow us to improve this paper.

In the following, we have numbered the general comments from 1 to 5. Sometimes comments have been subdivided into sub-sections in order to respond specifically to each suggestion. This is the case for the general comment 3. Then specific comments (SC) are numbered from 1 to 6. One technical comment seemed to us to require a more detailed response and we have added it to the specific comments. This is the SC 6. Referee 2's comment is given in bold and our response follows the comment in plain text. All technical comments will be taken into account without the need for a specific response

General comment 1 : The authors propose a methodological framework to understand under which conditions expert knowledge used to fed process-based models of flood damage assessment are valid. Their framework is based on 4 axes: explication of assumptions, validation, updatability and transferability. an application is proposed in France for the agricultural sector. The focus given to the agricultural sector is well justified by the fact that agricultural lands are often flooded to reduce urban flood risk. Assessing flood damage is thus key to evaluate the efficiency of this measure and the compensation given to farmers. This article is very valuable contribution because it proposes a framework for flood damage assessment which is generalizable and it claims to make explicit the assumptions used in such models. Furthermore, it proposes an open source model for flood damage assessment in agriculture in the form of a R package, to be available soon.

- We thank referee 2 who encourages us to publish this work which seems to us important to go towards a mutualisation and a capitalisation of the modelling effort to better evaluate the impacts of floods.

General comment 2: The model is applied to the agricultural sector. It is restricted to the plant farming. What about livestock? Is this also applicable to this sector of agriculture? It could be discussed

- At present, floodam.agri has not been used to produce damage functions for the

livestock sector. However, floodam.agri can be used to produce damage functions for grasslands. Regarding the impacts on livestock, interviews were conducted with experts. However, these inputs have not yet been modelled. We propose to take this into account at two levels. Firstly, in section 4.1, we propose to add the cattle component to the farm entity and to make it clear that, as things stand, the damage functions produced do not estimate the impacts on animals. Secondly, we propose to add in section 5 (Discussions), a remark on the potential for improvement and future developments envisaged around floodam.agri (integration of herds, coupling with floodam.building for the consideration of buildings).

General Comment 3: on taking into account the farmer's decisions in the model

- **GC 3.1: When I look at your system of decision I cannot see a symmetry between the crop and plant material systems. You include the possibility to change the crop type in equation 8 but not for plant materials. One should also have the case of a farmer who decides to plant another type of trees, similarly to equation 8 for crops.**
  - Concerning adaptation decisions, this is a very pertinent remark which invites us to better explain in the article the consideration of farmers' behaviour in the face of floods. In the current damage functions produced with the floodam.agri model, adaptations such as crop changes are not taken into account. The underlying assumption is that of a continuity of the current type of production. There is no change of crops (annual or perennial) in the strategic sense. Behavioural adaptations are at the level of the rotation, the technical itinerary or replanting decisions. Crop changes as described in equation (8) only concern field crops that are usually grown by farmers in rotation. If a flood occurs in winter and destroys the autumn planted crop, the field crop farmer still has the opportunity to plant a spring crop. It is not a question of switching to market gardening or viticulture, for example. All these hypotheses on the usual adaptation strategies during the production cycle were constructed and validated with the experts. A change in production type, even for annual crops (e.g. field crops to market gardening), implies a broader strategic change at the farm level (equipment, inputs, inclusion in a production chain, training), the determinants of which are still poorly understood. However, we are well aware, and we were able to meet with farmers during our field interviews, that these adaptation strategies can be implemented, especially when farmers are subjected to recurrent events on sensitive crops such as arboriculture. We propose to take this observation into account at several levels.
  - First, in section 4.1, we will clearly explain the assumption of continuation of the current activity and reconstruction used for all components to produce the current damage functions with floodam.agri.
  - Secondly, in the paragraph dedicated to the description of the decisions related to crops, we will make more explicit the behaviors that we have retained on the basis of our interviews with the experts. We propose to make a table summarising the decision rules according to the types of crops. In addition, we will give examples with the apple crop chosen as an example in response to referee 1's comments.
  - Thirdly, based on the example of field crops, we propose to detail more explicitly the strategies for continuing the itinerary, reseeding, sowing a spring crop, abandonment, which were defined on the basis of discussions with the experts.
  - Fourthly, we propose, as in the response to comment 1, to describe the prospects for improvement around floodam.agri and in particular a discussion around the question of adaptation to the meaning of flood risk by changing the crop on a plot (conversion from vineyard or cereals to grassland) and the implication in terms of economic evaluation.
- **GC 3.2: It seems to me that not all the post flood decisions made by farmers should be taken into account in the model otherwise you overestimate the damage. This is particularly the case when farmers decide to do something**

different from what they were doing before the flood (like in equations 8 and 12, sowing another crop or not replanting). In this case, the variation of revenues is not a damage because the reference has changed. The pre and post yields are not comparable, Y_new is different than Y_u because it is another crop, not because the biophysical conditions have changed in the farm because of the flood. If a farmer decides not to replant trees or crop, for example because he/she stops the activity or because she/he wants to invest in another farming activity or other species for example, then the damage function (eq 8, eq 12) is rather an opportunity cost or possibly a benefit rather than a damage. Counting equation 8 and 12 as a damage creates opportunities for farmers to operate a change in their agroecosystem and ask for money to the damage compensation organism for that change because they have been flooded. But the reason is not the flood, the reason can be economic or another reason. This will also have the perverse effect of making farmers prefer to wait to be flooded to change their agroecosystem to receive more money (in the case where they are compensated based on your damage functions.) This does not mean that the famer cannot anymore change the crop system after a flood, but it means that the compensation based on the damage function should not pay for the change but pay for what has been lost. To pay for the change brings your model to the context of adaption to climate change, not a context of compensation for flood damage. One could imagine a farmer willing change species in order to use species more resilient for floods because floods become more frequent or more devastating. This is possible but this is not what your paper is proposing. Your paper is about compensation, not adaptation. This should be discussed or corrected.

- The answer to the previous question seems to us to partly answer the questions formulated concerning annual crops.
- For perennial crops, I should clarify that in the non-replanting strategy, there is no option not to replant the plot at all. It is a matter of not replanting the missing trees. Beyond a certain number of missing trees, the decision rule is to uproot and replant the whole plot. This will be mentioned more explicitly in the article and as suggested by referee 1 will be illustrated with the case of apple crop in arboriculture.
- For field crops, where there is the option of planting a new crop with a Y_new, in no case can the product be higher than a conventional campaign since the sowing and some costs will already have been incurred. The behaviour summary table should make this more explicit.
- The application of floodam.agri proposed in this article does not aim to propose a method of compensating farmers. The application of floodam.agri presented in the article is an application that aims to develop large-scale damage functions for damage assessment (project CBA). For an application aiming at compensations in the case of overexposure protocols for example, local data should be specified. Furthermore, in this case, it could be considered locally to define crops less sensitive to flooding and to set up compensations to farmers, but this is not the purpose of our article.

General comment 4: Section 4.2 validation: V2 on comparability with other models (uk , Italy, etc). Maybe you can compare the conceptual approaches between UK, Italy and France. This can help you to also highlight the contributions of your model to the literature. By literature I do not mean the case study based literature (filling the gap of having a model for the French agriculture) but the literature on the structure of flood damage assessment models (ie your figure 8). For example, is it usual to integrate decision rules in the calculation of damage or the biophysical processes? This kind of comparison will improve your contributions (in addition to the contribution of making explicit the assumptions) and the value of the paper for an international readership.

- We thank referee 2 for this suggestion, which we believe to be very relevant. This table could be a summary of how the axes of the conceptual framework are treated in the following models : FHRC model, AGDAM developped by USACE, Agride-C model and in floodam.agri.

General comment 5: I recommend to have the paper revised by a native English speaker: grammar, use of the article "the" (the figure x , the table x versus Table x, Figure x), etc.

- We are aware that English still needs to be improved. We have tried to make our words as clear as possible in this non-native language. Knowing the publication process of NHESS, we have full confidence that the final review process of English, in which we will be fully involved, will achieve the necessary language standards.

Specific comments

- **SC1: Tables are at the end of the paper (except Table 1) and figures in the main text. Are the tables part of an appendix or to be included in main text? If they have to be part of an appendix, please check the guidelines for authors.**
- The latex format proposed for the submission of the preprint has automatically placed some of the figures and tables at the end of the document. This should not be the case for a final version. We will check this with NHESS technical support.
- **SC2: Plant material or perennial crops? You have related plant material to perennial crops line 318 but you have an equation for perennial crops in the section related to crops and then several equations in a section on plant material. This is confusing.**
- Plant material is attached to perennial crops (e.g. apple trees for apple crop) but crop losses depend on farmers' decisions to replant plant material. Yield loss on plots depends on the proportion of damaged trees and decisions to replant or not. We propose to make this more explicit by adding a diagram and making the summary table of behaviours and associated equations as proposed earlier.
- **SC3: Equation 8: What happens if Y_new > Y_u? It is no more a damage but a benefit. Does this mean that the farmer will revert money to the compensation fund because she/he earns money after the flood? This should be discussed or a constraint should appear in the system of equations**
- As explained earlier, the possibility of sowing a new crop only arises for cereals when the flooding occurs too late for the previous crop to be resown and early enough for a spring crop to be sown. This is not optimal, but it does compensate for some of the costs incurred. We propose to explain this point in the article.
- **SC4: Section Decision related to soil. It seems to me that you should also discuss the case of a variation in soil quality because of the flood (example of chemical pollution, or loss oforganic matter of the first layer of the soil). This affects yield also. Does this correspond to equation 6? Or would this be a case of double counting if you add an equation for that?**
- Soil damage such as pollution, salinisation and loss of organic matter have not been included in floodam.agri for the time being. The main reason for this is that there is no physical model to establish a correlation between flooding and pollution or loss of organic matter. Furthermore, the experts consulted indicated that they were unable to establish correlations between the hazard parameters and these biophysical processes. We thank referee 2 for this remark which will allow us to support the soil part in the physical processes section (EA2).
- **SC5: Figure 8. Following my concern about accounting for decision rules and actions in the modelling of the damage functions. My concern is now visual: depending on the decision/action, the farmers has the possibility to increase the damage if he/she chooses the appropriate action. To maximise the damage and so the future compensation can become a strategy for the**

farmers in this model. This is a perverse strategy in my sense but your model allows it if I understand it well. The damage should be based on past losses not on future losses in case of changing practices. I am Ok with accounting for future losses in case of deterioration of soil quality, or in case of sowing the same crop again

- We hope to have answered this question in the previous answers. The confusion is related to this option of changing crops which is only valid for field crops in rotation.
- **SC6 : Farm building. Is the cadastre a possible source for the data on agricultural buildings? What are the limitations to not use it if it exists?**
- The land register allows to locate buildings but not to know their use (housing, shed, silo…). The BD TOPO could be an improvement. However, it seems to us that it would be important to be able to link the types of crops to farm buildings. Indeed, from our modelling experience (floodam.building and FDF to companies) for economic activities, damage to buildings is largely linked to the equipment and stocks present and therefore to the nature of the activity. We propose to address this comment in the perspectives of improvement of floodam.agri.

Technical corrections

We thank referee 2 for his technical corrections that we will all take into account.