

# ***Interactive comment on “AGRIDE-c, a conceptual model for the estimation of flood damage to crops: development and implementation” by Daniela Molinari et al.***

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Received and published: 31 July 2019

We would like to thank the referee both for appreciation of our work and for carefully reading our manuscript; we greatly appreciate the insightful comments as they may contribute to increase the manuscript robustness and, in general, to improve its quality and readability. In the following, we supply a point by point reply to the general and specific comments raised by the referee (see also attached file).

General comments:

RC1: There is scope to improve the structure of the paper: - by separating the introduc-

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tion of context and rationale, including statement of research objectives, and statement of methods to cover literature search, review of knowledge and construction of the analytical framework. - There should be a critique of the approach. - The case study then becomes results (reordering some results that currently occur in discussion). - Discussion can then follow on both the case and the validity or otherwise of generic framework. Some items currently in the conclusion, particularly on gaps/further development, can go in discussion (they appear to be recommendations). Conclusion on what has gone before can focus whether the objectives (regarding the tool, its application and its prospects) have been met, rather than introducing new elements into discussion.

Answer: We would try to address at our best the suggestions provided by the referee, especially regarding a better re-organisation of the contents of the introduction/literature review/methodological part, and discussion/conclusions. Still we think that the present organisation of the sections is appropriate for the explanation of the conceptual model and its exemplification. Of course, if the editor thinks that a change in the structure of the paper is required to better meet the journal standards, we will re-organise the paper as suggested.

RC2: It probably would be best to be more cautious and modest about the claims made about the comprehensiveness and novelty of the approach, and its suitability to all circumstances and contexts.

Answer: After reading the referee comment, we realised that the “scope of use” of our model was not well specified in the original version of the paper, which could lead to incorrect interpretations of our work. Indeed, without such specifications our claims appear as too wide, and we will be more specific in the revised version of the manuscript. In fact, the conceptual model has been designed to supply an estimation of flood damage: - to annual crops (i.e. not including perennial plants) - by considering one single culture (i.e. by not considering replacement of one culture with another one) - by limiting the time frame of the analysis to one “productive year” (i.e. not considering long

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term damages, e.g. loss of soil productivity in the following years); - for infrequent flooding (i.e. effect of two, or more, consecutive floods is not considered) Nonetheless, as specified at page 9 line 11-19, AGRIDE-c do not consider damage to other components/elements of the farm that may induce additional damage to crops, as, for instance, damage to machineries and equipment (e.g. the irrigation plant) that may prevent cultivation for a while. Only damage to soil is considered from the evidence that, during a flood, damage to soil and plants occurs always at the same time, differently from damage to the other components which can occur or not, independently from the damage to plants; as a consequence, damage to soil and plants is modelled together, while damage to the other components could be modelled as separated factors, not included in the conceptual model. We will specify all these aspects in the new version of the paper, by hopefully clarifying what we mean with “generality” and “transferability” of the approach. We never referred in the paper to “novelty” or “comprehensiveness” of the approach, but we highlighted the fact that we are trying to encapsulate and systematise the available knowledge on damage mechanisms (to annual crops) triggered by inundation phenomena, as well as on their consequences in terms of income for the farmers.

RC3: Further clarity on its potential application, either in cost benefit analysis of (publically funded) investments at the landscape scale in flood risk management, or in guiding individual farm-scale responses would be appropriate. The two applications are different in purpose and detail of approach. There is a difference between, for example, economic and financial appraisals. There is also a difference between ex ante appraisal and ex post evaluation, which is implied. This will support the important point made that insufficient ex post evaluation is undertaken to provide sound ex ante decisions

Answer: The CBA of flood risk mitigation strategies would require a comprehensive estimation of benefits linked to the different strategies, i.e. of the avoided loss to all exposed sectors and at different temporal scales (i.e. direct and indirect/long term

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damages). Present damage modelling capacity prevents comprehensive flood damage assessments, which usually include only direct damage to people and some of the exposed assets (typically residential buildings). In such a context, by allowing the estimation of the expected loss to crops in a specific flood scenario, AGRIDE-c may support more comprehensive CBAs of public risk mitigation strategies. Of course, to meet such an objective, the tool must be critically used, e.g. by considering possible transfers of losses/gains between farmers in an economic perspective, according to the temporal and spatial scales of the analysis. Regarding individual responses, by supplying the expected damage for different types of crops and alleviation strategies (according to the expected yield reduction for different flood intensities and period of occurrence), AGRIDE-c may support individual farmers exposed to flood risk in preventing losses by supporting: the choice of the most appropriate crops to be cultivated, the choice of the best alleviation strategy to be followed once flooded, the evaluation of the opportunity to ask for a flood insurance scheme and the definition of the premium. The model was not designed to be used ex-post. This explanation will be added in the revised version of the manuscript.

RC4: One particular issue requires attention, namely the importance, especially in temperate climates, of agricultural land drainage. The control of water levels in the soil, and particularly the removal of excess water and below surface 'flooding', including during the post flood phase before field return to 'normal' is an important aspect of agricultural flood risk management and assessment. Impacts and land management responses are often driven by seasonal waterlogging and drainage problems as much as they are by surface flooding. This is certainly the case in northern Europe and North America. There should be coverage of this aspect, and the implications of not explicitly allowing for it in this model framework. Many areas of strategic importance are pump drained.

Answer: We thank the referee for highlighting these important aspects for flood risk/damage assessment and management (that were erroneously not included in the

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original version of the paper), and for supplying some of the related literature. In the new version of the manuscript, the conceptual model will be modified in order to take into account of the effect of waterlogging and prolonged soil saturation on both the yield and the soil, as well as on the corresponding effect on the revenue and costs for the farmer, and then on the final flood damage. Still, these aspects will not be considered in the application of the model to the Po Valley because, according to experts' opinion, phenomena like waterlogging and prolonged soil saturation after floods are not common in the area.

RC5: Saline flooding, a major issue in coastal and tidal areas, should be referred to with implications for costs, especially regarding remediation and subsequent year impacts

Answer: The conceptual model was not conceived to cover coastal floods but we have decided to extend the context of applicability of the model in the revised version. However, the model will still be focused on “one” productive year. We will discuss limitations of this hypothesis in the discussion section.

RC6: Surprising the authors do not mention climate change as a driver of concern or a factor affecting damage costs and responses. This seems an omission given the topic.

Answer: Given that the model is focused on “one” productive year, long term effects of climate change are not considered in the model. Anyway, we will add a sentence in the introduction on the importance of climate change in exacerbating future flood damage to agriculture.

RC7: Further clarity is required regarding the definition of measurements of damage. A more detailed listing, upfront, of the revenue and cost related parameters would help: these emerge in the case application later on.

Answer: A comprehensive list of all revenue and cost related parameters cannot be compiled in the framework of the conceptual model, as most of them, especially those related to costs, are context-specific. Still, we will add examples of such parameters in

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the description of the conceptual model

RC8: A table would be good to summarise the main elements of cost estimation processes /assumptions/ algorithms and where they come from. In the main, the methods draws on published data from SubâĂŃsector models of crop damage or additional costs, such as Agenias et al. What other ones are used to transfers changes in yield, revenue and cost responses?

Answer: a table will be added summarising the main elements and sources of revenue and cost estimation processes

RC9: Further clarity would help regarding the use of the terms ‘turnover’ and ‘gross profit’, ie exactly what is in these terms? They are not universally applied in farm business accounting, where the terms gross output (or gross revenue), gross margin and net margin are often used. (Turnover can for example include sales from previous production periods – just to be clear). And the definition of gross profit may or may not include elements of farm level fixed costs, such as machinery and buildings costs (again to be clear, so that the methods can be generally applied). The use of ‘relative’ Gross profit measured at negative % values is difficult to interpret and doesn’t mean a lot.

Answer: we really thank the referee for the suggestion. According to the literature suggested, we will change the terms “gross profit” and “turnover” in “net margin” and “gross output”, respectively, by also specifying what is included in production costs.

RC10: On flood scenarios, the treatment presumably here is for oneâĂŃoff relatively infrequent flooding on a land use that is not hitherto constrained by flood exposure. An increase in flood frequency, associated with climate change for example, or withdrawal of flood defences, could lead to increased flooding with a range of outcomes, permanent abandonment, repeat annual losses or a switch to more flood tolerant land use. How are these to be handled by the model?

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Answer: As explained before (RC2) the model considers damage to one productive year for infrequent floods. Limits of these assumptions will be discussed in the new version of the paper.

RC11: The paper refers to spreadsheets and supplementary data containing both data and estimation methods. I had difficulty locating these and understanding them when I did. This is probably my fault. It would be good to explain what is in them and how they can be reliably accessed.

Answer: We will ask the NHESS editorial support office whether the spreadsheet can be added as supplement material; otherwise, we will upload it in a repository with an easier access We will also develop a user manual for it.

RC12: There is a need to strengthen the treatment of inherent variation and uncertainty in the estimates.

Answer: We will include a deeper discussion on model uncertainty in the discussion section.

RC13: there is a need to provide a more systematic critique of the model and the resultant damage estimates, and implications for use and improvements

Answer: see answer to RC2, RC3 and RC12

RC14: The authors report that their work draws on systematic review of multiple sources, including expert judgement. This aspect, especially the latter, is under reported. Did the research approach follow a particular methodology that can be supported by literature, especially engaging experts?

Answer: Experts were involved with two main objectives. The first one is to support the definition, and validate the quality, of the conceptual model. The second one is to give suggestions/information on the implementation of the model in the Po Valley, above all regarding expected physical damage and costs. With respect to the first objective, an iterative process was followed. First, a semi-structured interview was conducted,

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by asking experts about the main damage mechanisms/phenomena in case of flood, possible interconnections among them, important explicative variables. In this phase, results from the literature review were proposed to experts for their judgment. In the following step, experts were asked to evaluate a draft version of the conceptual model we draw according to the literature review and results from first interviews. Then, there was an iterative revision process of improved versions of the model until an agreement on its final structure was reached. With respect to the second objective, several individual meetings were organised with the aim of asking experts about context-specific information on: crops calendars, yields and prices, type, timing and costs of cultivation practices. In this phase, the transferability of the model by Agenais et al. was also discussed. Three kinds of experts were involved. One representative of the Regional Authority responsible for agricultural damage management and compensation, with more than 20 years of expertise in the management and compensation of flood damage to farms in the Lombardy Region. Two agronomists of the local association of farmers (Coldiretti Lodi), with specific knowledge on the investigated context and with direct experience in managing floods in the last 20 years. During the work, the two agronomists asked for data/information also to individual local farmers that were flooded in the past years, including also their viewpoint in the process. Finally, an academic economist, with specific expertise in agriculture, has been involved in validating the final model. A new sub-section will be added to the revised version of the paper explaining the whole process of experts' involvement.

Specific comments (see attached file)

Please also note the supplement to this comment:

<https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2019-61/nhess-2019-61-AC2-supplement.pdf>

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2019-61>, 2019.