Summary of changes and comments regarding observations and recommendations from referee #1

We thank the referee #1 for his feedback and suggestions for improving our manuscript. Below we provide our replies to the general comments of this referee, using the following structure: the referee's comment is highlighted in bold font, whereas the answer of the authors is included in normal font.

- **It (the article) is too much fragmentated in subsections that it is almost impossible to read and understand by readers who are not expert of their calculation model. As it currently appears, the manuscript is more like a technical report than a scientific manuscript.**

Answer of the authors:

- The whole article has been restructured to accommodate a more standard structure in scientific communications.
- A new, more detailed description of the model has been provided.
- **The description of the model and the workflow are too synthetic, they need to be enlarged and supported by a workflow.**

Answer of the authors:

- The model description is now part of a larger section "Method". This section starts with an overview in which we include a new workflow for our paper.
- The model description has been rewritten to offer a more insightful description using a less fragmented structure. A new model workflow has been included as well as a new section on the calculation of impacts. This last section is completed with a mathematical annex at the end of the article
- **[...] section 3, 4 and 5 should be completely restructured and better described.**

Answer of the authors:

- Sections 3 and 4 have been integrated in the new section "Method". Both of them have been restructured.
- Section 5 has been included in a larger section "Results" along with section 6 and a new section "Baseline". After careful consideration, we have decided to keep the structure of the section 5 as it was since we do not understand what should be restructured.
- **The figures should be better described in the text and it would be better to add the labels of the x-y axes and the unit of**

measurement, also specify which axis the various curves refer to.

Answer of the authors:

- Figures were modified following the recommendation of the referee #1. However the result made the resulting figure more confusing and busy. Thus, we opted for keeping them as they were, providing the information on axes, units, etc at the bottom of each figure.
- **Please give an extended explanation of what the farm coping tactics are since they are important in the model results.**

Answer of the authors:

- The new model description includes a more detailed explanation of the coping tactics and its effects.
- **The referee recommends the author improving the discussion, explaining their results in the light of past flooding events and making practical cases of the different interactions occurred between and within the damaged elements to better understand how the different damage (to buildings or to plots) had negatively impacted the CWS.**

Answer of the authors:

- The new version of the article includes a new section "Discussion" and a new section "Conclusion". Unfortunately, available information on past flood events is, at best, fragmented and rarely available in public form with the level of detail that this comparison would need. In particular, very few farms are insured and the sinistrality data are unusable for discussion. Consequently, although the authors agree with the referee's recommendation, such an comparison exercise is not possible with the data publicly available and we have not been able to include it.
- The authors have targeted past events and used different elicitation methods available to them (GIS, field interviews, professional expertise, census and statistical data as well as analysis of technical reports and scientific literature) to overcome those problems in the development of the COOPER model. The amount of data collected allowed the authors to reconstruct the way a real French CWS works and reacts to a flood event. Then, over this meta-model, authors were able to build the COOPER model for flood impact simulation. This approach enables us to overcome the challenges provoked by the data quality and availability in the model design but also to allows us to validate our model. Indeed, insofar as the data to validate the model COOPER is limited, we opted for the so-called conceptual validation (Rykiel Jr., 1996). This kind of validation relies on the theoretical plausibility, accuracy and justifiability of the relations cause-effect built in the model.

- **It would also be important to understand how this ex ante analysis can help the economy of the wine sector.**

Answer of the authors:

- The authors thank the referee #1 for the recommendation. Nonetheless, the goal of the article is not to study the wine sector per se but rather, using a specific case study taken from the wine sector, to illustrate how important could be to consider interactions for flood damage assessment at microeconomic, local levels. From this point of view, we discuss the relevance of our work for the analysis of any local organization or supply chain that works in a similar way as the cooperative winemaking system. For this reason, we have provided an statement on how this kind of ex-ante analysis can help local communities and concerning actors and stakeholders, but we consider best not to focus specifically on wine sector. Indeed, as stated in Meyer et al., 2013, "most stakeholders are interested in assessing the indirect impact of various types of events, both large and small, at micro (cities) or meso (catchment) scale, with or without risk mitigation measures. However, most of the methods discussed can only assess the impacts of an extreme event on the national or sometimes regional scale". Our work benefits from the potential of Agent-based models to become computational laboratories in which to evaluate the response of a system to an external perturbation of variable magnitude. Indeed, the goal of the COOPER model is to evaluate the potential disruption caused by different floods over a system bounded to a local, very specific, highly detailed, monosectoral and spatially-explicit supply chain. Furthermore, impacts and disruptions in the COOPER model can be studied either at the level of one individual or groups of individuals. Therefore the model has a very clear microeconomic orientation. The goal of the present article is to present how current practices in damage assessment at local level can benefit from more thorough and spatially-explicit representations of local networks.

V. Meyer, N. Becker, V. Markantonis, R. Schwarze, J. C. J. M. van den Bergh, L. M. Bouwer, P. Bubeck, P. Ciavola, E. Genovese, C. Green, S. Hallegatte, H. Kreibich, Q. Lequeux, I. Logar, E. Papyrakis, C. Pfurtscheller, J. Poussin, V. Przyluski, A. H. Thieken, and C. Viavattene. Review article: Assessing the costs of natural hazards - state of the art and knowledge gaps. Natural Hazards and Earth System Sciences, 13(5):1351–1373, 2013.

E. Rykiel Jr., Testing ecological models: the meaning of validation, Ecological Modelling 90 (1996) 229 – 244. doi:http://dx.doi.org/10.1016/0304-3800(95)00152-2.

Summary of changes and comments regarding observations and recommendations from referee #2

We thank the referee #2 for his feedback and insights to improve the quality of our manuscript. Below we provide our replies to both the general comments and to the specific points made by the referee, using the following structure: the referee's comment is highlighted in bold font, whereas the answer of the authors is included in normal font.

Referee's general comments

- **Interesting paper on a relevant topic. It is clearly written but it is challenging to work through and I think it would benefit from some signposting that reminds the reader where (and why) we are up to in the argument.**

Answer of the authors:

- We article has been restructured and new content has been added to improve the readability of the paper.
- **I think more could be made of the actual financial/costs data obtained, and presented to show absolute costs: % changes can be difficulty to interpret: % of what? What do the uplift factors in the table of results actually mean to the baseline cost estimate used in a flood impact assessment or CBA ?**

Answer of the authors:

- The new version of the article includes a new section that presents the estimation of impacts for the baseline in absolute terms.
- Nonetheless, for the visualization of the differences between this baseline and the rest of the simulations proposed in our experiments, the authors have kept the representation in terms of percentage (%). We consider that percentages (%) of variation compared to a baseline are more generic (less case-oriented), illustrative and easily comparable than absolute values of monetary assessments. Thus they transmit the message more directly and efficiently.
- These percentages represent the variation of the monetary value of the flood impact in the cooperative winemaking system of a given modality of interaction or configuration with respect to the baseline for the period simulated.
- **I also think the configurations could be grounded in what is observed: what is the dominant case, and what are the main variations for the industry, perhaps with other configurations showing how estimates vary around a core /central estimate.**

Answer of the authors:

- The authors agree with the observation of the referee #2. However the information that could conduct us to be able to establish a dominant case of network configuration (hence exposure profiles for farmers) in the cooperative winemaking system are neither publicly available nor willingly divulged by the stakeholders.
- At the same time the exercise suggested by the referee is a version of what we do in our article: setting the flood damage configuration of links named no interaction as a baseline (current practice in CBA) to calculate, then, the difference in the monetary value of the flood damage between the baseline and a given scenario.
- **I think more explanation about the seasonal variation in the estimates, and importantly, the magnitude of the difference makes to the overall estimate (once seasonality and other issues are taken into account) relative to a 'careful' consideration of impacts on vine production and processing considered separately.**

Answer of the authors:

- The authors thanks the referee for this proposition. One of the challenges was, indeed, to take into account the seasonality of the processes of the different entities of the model. All the processes modeled and presented in section 3 take seasonality into account and are nested. The interest of the model used is to allow the analysis of the effects of the simultaneous consideration of seasonality for the different entities in comparison with scenarios where these interactions are not considered.
- The authors have provided a more explicit description of the entanglement of seasonal processes in the new model description.

Referee's specific points

- **Agree there is often confusion and an arbitrariness about the definition and classification of costs. Perhaps the paragraph could begin by making this point. The use of the term 'flood damage' doesn't help either; this implies a focus on damage to physical assets (stocks) and not to flows (incomes and expenditures). It might be better to consider 'flood costs'. It also point to the needs for a cost algorithm function to show what is in and what isn't (see below).**

Line 42: so which definition are the authors using here?

The definitions are not independent of the purpose of the assessment: whether financial or economic, and whether concerned with costs: benefit or economic impact assessment.

Answer of the authors:

- The authors appreciate the terminology suggestion since the debates on the best terminology have been present from day one.
- The authors would like to point out that the goal of this paragraph is not to inform the reader of the definitions used in the paper, but to show the diversity of definitions of indirect damage that coexist in the literature. Inasmuch as the COOPER model is spatialized and dynamic, its design grants each potential user the flexibility necessary to fit his/her definitions of indirect impacts, as the ones given by, e.g. Cochrane, 2004; Meyer et al., 2013; or Penning-Rowsell or Greene, 2000.

In other words, the COOPER model simulates an encapsulated system (the CWS) where each entity performs different roles, creating a flow of inputs and outputs between them. When a flood hits the system both performance and flows can be compromised. By comparing a simulation with no floods with a simulation with a flood we can determine the impact that the flood has had on the system, regardless any classification of damages/impacts. Given that the study that we are presenting is done at a system level, we do not need to classify specific damages in direct and indirect. That being said, if we were to descend to the level of the entity, e.g. the farm, we agree with the referee #2 that we would need to ascribe to one specific classification to designate which damage is direct or indirect from the point of view of the farm. The same applies if we were studying the impact at the system level looking at interactions with other systems. Therefore, taking into account that we study the impacts of a flood within the boundaries of our system, and that we do it at a system level because the goal of the paper does not demand damage disaggregation, the authors do not consider pertinent to ascribe to one or another set of definitions. - The authors have made this point more explicit in the new model description (current section 3.2.2).

- **What kind of values for example: the range in estimates of indirect (as defined here?) and direct can be considerable: 3 % to 30% or more depending on impact sector, and guide on this**

The use of static ratios or % of direct damage depends on the definition and estimate of direct costs in the first place: and this may vary? % of what?

Likely that ratio of direct and indirect will vary by impact sector /category, eg types of industry/ economic activity, transport, agriculture. As the authors know In the agric case, damage to physical assets is relatively small: the biggest cost component is usually damage to cropswork in progress and evident in income loss and additional operating costs. (insurable asset losses are relatively small as a proportion.) So how are we defining direct ?

[...] perhaps should mention how this translates into GVA estimates and multipliers, with various assumptions about additionality/displacement

Answer of the authors:

- The authors would like to point out that the statements regarding computational general equilibrium models and input-output models (CGE/I-O hereafter) do not pursue to discuss in-depth CGE/I-O, insofar as these models are out of the scope of the work presented in the article. The article's scope is microeconomic, monosectoral and local as opposed to macroeconomic, multisectoral and regional/national. As noted by Green et al., 2011, and Meyer et al., 2013, CGE/I-O have been indeed successfully implemented at national and/or regional levels, though their potential to provide useful information to decision-makers when the economic disruptions of floods might vanish before reaching the aforementioned levels is debatable. Agent-based models (ABMs hereafter) have the potential to fill the gap left by CGE/I-O, and become useful tools to evaluate flood impacts in local communities, thoroughly representing the complexities faced at this local level. In that sense, ABMs represent complementary tools to CGE/I-O in the flood damage assessment.
- The COOPER model does not use fixed coefficients of direct damage to assess the indirect damage. Rather it rests over a vector of four key variables: i) production; ii) revenues; iii) costs; and iv) investments and reinvestments. This last variable serves us to group all reparations to be done in the system after a flood, reinvestments in plants and materials and planned investments independent of the flood. The impacts are then calculated by differences between two kinds of scenarios, as explained above: the business as usual scenario (simulation of n years without floods) and the simulated flood scenario (simulation of n years with a flood), as it is described in section 3.6.9.
- Consequently, the authors considered superfluos (and potentially misguiding) a review of literature that goes too deep into the details of the CGE/I-O models.
- The new version of the paper includes an extended and more detailed model description that addresses this and some other remarks made by the referee #2. The new description includes workflow diagrams, a better characterization of the coping tactics, impacts calculations and cost distributions (section 3.2 and annex A).
- **Suggest you say who the paper is aimed at.**

Answer of the authors:

- The authors appreciate the suggestion of the referee #2. The paper is aimed at the whole community of researchers in economic impacts of natural catastrophes and economics of natural disasters.
- **Is this costs to agriculture as a share of total event cost?**

Answer of the authors:

- The interpretation of the referee #2 is correct.
- **Perhaps clarify that flood costs here include asset damage as well as income/expenditure impacts (an important aspects of agricultural flooding) Perhaps make it clearer that these two impact categories, farm production and off-farm commodity processing would potentially be treated as separate impact categories in flood assessment. This is said later but emphasize more here, I think.**

Answer of the authors:

- The new version of model description included in the paper makes more explicit the presence of commodity damage and expenditure/income impacts and their origins (section 3.2 and annex A).
- **Given actual cost data were collected it would be good to include absolute flood event cost estimates, and their make up/distribution between cost components.**

A critical point is that that the quantitative results are given as a % of baseline: but what are the base line costs. The use of coefficients and weights to assess 'indirect' costs depend heavily on what the baseline estimate is > And assume that the baseline here is the sum of the two impact categories considered separately. I note that the estimates are by flood extent, but what are the costs per ha of vine flooded, or per unit capacity of wintery ?

Would be good to have some cost estimates, as suggested above, and this would help show the scale of the differences in the estimates with an without the connections

Answer of the authors:

- The new version of the model description includes an extended description of impacts calculations in order to avoid confusions regarding how the COOPER model estimates impacts. As well, we have added a new section with the absolute cost estimates in the baseline scenarios.
- **Rather complicated to follow: rest on estimates of damage to assets plus impact on revenues and costs, including work in progress?**

Answer of the authors:

- The new version of model description included in the paper makes more explicit the presence of commodity damage and expenditure/income impacts and their origins. It also includes an extended description of the calculations of impacts (section 3.2 and annex A).
- **Seems to largely rest on the assumptions regarding the impact on the winery. Estimates of flooding on the wine production areas**

can be based on ex 'farm gate' effects. The variation depends then mainly on the effects on the winery: so either the winery incurs 'direct' damage, because it is flooded or it indirect damage because, been though not flood, the quality or quality of supply is affected: so what are the impacts on these two elements in the supply/value chain? I think you are saying the underestimation is where the winery is safe from flooding, but takes a hit from not having grapes. But if it does flood, the impacts are assessed as a loss of contents and process. Hence why there is a big lift in your figures 4 and 4. You might make this (more) clear.

Answer of the authors:

- The new description of the model COOPER addresses this the point in section 3.2.2 and annex A.3
- **Figure 2: what's the top dotted blue line.**

Answer of the authors:

- The accumulated number of plots at a given position.
- **The assumptions and configurations are challenging to follow, How representative are these configurations of what is observed in practice: is the size exposure configuration that gives the highest cost increase common ? or has the industry already adapted to flood risk?**

Answer of the authors:

- The information that could conduct us to be able to establish a representative configuration for the cooperative winemaking system are neither publicly available nor willingly divulged by the stakeholders. Thus we cannot establish a "standard" in relation to configurations and spatial locations.
- Furthermore, it is likely that "real life" configurations are very different from each other and sometimes overexposed small to mid size farms whereas other times big farms stocked riverine lands. That is why we think that the exercise done has interest: between the extremes, we have all potential "real life" situations. Nonetheless, the work we are presenting here is not an analysis of a particular system, during a particular flood. Rather, it is a plausible system based in "real world" systems facing a multitude of different floods, that shows us the misestimations in which we incur when we choose to ignore the links among entities in a local productive chain.
- These misestimations are all the more important when flood impacts assessments are utilized to design and calculate the mechanisms of monetary compensations to be implemented in rural communities that are used to protect urban and industrial areas from floods.

- The section 4 has been integrated in a new section "Method" (now, it is is section 3.3) and has been entirely restructured to make the section flow better.
- **It would be useful to produce a cost function that summarizes the type of costs, even better it would be good to produce estimates of costs showing the make up of the cost estimates for the different scenarios /configurations. There appears to be 'damage' to asset 'stocks' as well as to income/expenditure flows: what's the proportions of these. Not quite sure what is meant by material damage. Is there an underlying flood evet cost algorithm?.**

Answer of the authors:

- The new description of the model COOPER addresses this point (section 3.2.2 and annex A).
- **Concrete' flood, suggest rephrase.**

Answer of the authors:

- Rephrased as "given flood".
- **The results suggest, as far as I can see, that the main differences (either in costs by configuration or in costs relative to the baseline) are due to autumn and winter flooding. What is the underlying seasonal distribution of flood costs ? More explanation of what to look for in the figures would be good, especially on observed variation (or lack of it)**

Answer of the authors:

- The new description of the model COOPER addresses this point (sections 3.2.1, 3.2.2 and annex A).
- **I think some of the points in the conclusions, might better go to reinforce the discussions: perhaps there should be a section on discussion of results and what they mean, in their and particularly, in practice, linked to the points made in the introductory sections.**

Answer of the authors:

- The new version of the article includes a section "Discussion" and a section "Conclusion"
- **It seems as though the cost estimates depend on seasonality as it determines where the grapes are in ex–vine storage and processing system, so the assessment of costs (relative to the baseline) largely depends on damage to stocks and flows of grapes in the system, which is seasonally defined. So I am asking why**

would not a seasonally based estimate of damage accommodate this for the production (on the farm) and for the vinery, reflecting the dominant configuration. (A coping strategy might also be to important grapes from elsewhere to keep the process going, at a cost)

Answer of the authors:

- The authors thank the referee #2 for the remark and the suggestion. As we understand the statement, we would like to point out that our work goes one step further of what the referee is proposing. Sure, we could make the assumption that stocks are either in one place or another -even using a probabilistic distribution behind based on a supposed dominant way of working- and do not take into account the flow of goods from one entity to another according to their schedules. This is somehow the exercise proposed in the case of *interactions within activities*: since information regarding losses of harvest does not flow from farm to winery, in those cases in which a flood impacts the winery, an estimation of the loss should be done and that might lead to problems of double accountability of damages.
- With the COOPER model we go one step further and we can know exactly where the stock is so estimations do not need to take place.
- Concerning the suggestion on the coping tactic, we agree that, in absolute terms, it would be an effective one. However the plausibility of such a tactic is inevitably linked to the reality of the CWS. As it is today, cooperative winemaking systems group farmers that decide to share the property of productive means to process their harvest and create their products employing professional experts for the day-to-day management and commercialization. The possibility that those farmers willingly accept to buy grapes from other producers is unlikely. Furthermore, if those farmers belong to a so-called *Appellation d'origine contrôlée*, they are subject to very strict rules regarding the quality and origin of the product (even the origin of the soil), if they want to keep the label.
- These institutional constraints made us decide to focus on the two more plausible coping tactics evoked by the interviewed farmers.
- **You say the approach is too costly: could estimates be built into the cost algorithm for representative configurations of the industry to allow for these so-called 'indirect' impacts.**

Answer of the authors:

- The idea we wanted to pass to the readers with such a statement is that the approach is too costly if it were to be implemented with the same amount of detail at a different level other than the local one, given the thoroughness with which the system is described and "translated" into a model. The best approach we can foresee is to analyze in depth different

local communities using detailed models, such as the COOPER, that feed regional or national models in some sort of nested structure.
- We have addressed this point in the conclusion of the new version of the paper.

H. C. Cochrane. Indirect losses from natural disasters: Measurement and myth. In Y. Okuyama and S. E. Chang, editors, Modeling Spatial and Economic Impacts of Disasters, Advances in Spatial Science, chapter 3, pages 37–52. Springer Berlin Heidelberg, 2004. doi:10.1007/978-3-540-24787-6_3.

C. Green, C. Viavattene, and P. Thompson. Guidance for assessing flood losses. CONHAZ WP6 Final Report, Flood Hazard Research Center - Middlesex University, Sept. 2011.

V. Meyer, N. Becker, V. Markantonis, R. Schwarze, J. C. J. M. van den Bergh, L. M. Bouwer, P. Bubeck, P. Ciavola, E. Genovese, C. Green, S. Hallegatte, H. Kreibich, Q. Lequeux, I. Logar, E. Papyrakis, C. Pfurtscheller, J. Poussin, V. Przyluski, A. H. Thieken, and C. Viavattene. Review article: Assessing the costs of natural hazards - state of the art and knowledge gaps. Natural Hazards and Earth System Sciences, 13(5):1351–1373, 2013.

E. C. Penning-Rowsell and C. H. Green. New insights into the appraisal of flood-alleviation benefits: (1) flood damage and flood loss information. Water and Environment Journal, 14(5):347–353, 2000. doi:10.1111/j.1747-6593.2000.tb00272.x.

Summary of changes and comments regarding observations and recommendations from editor

We thank the referee #1 for his feedback and suggestions for improving our manuscript. Below we provide our replies:

- **Data gathering: actually, I find the sources but not the type of data that you collected (We collected data from the Aude and Var administrative departments (southern France), both subject to major floods that have impacted the winegrowing sector ....). Could you please describe what kind of data are you talking about?**

Answer of the authors:

- Data sources and applications have been disclosed in a new table, included as “Annex B”.

- **I agree with R2: the subsections should be reduced**

Answer of the authors:

- The whole article has been restructured to accommodate a more standard structure in scientific communications. Subsections have been reduced

- **A clear figure/diagram of the methodology is needed in order to understand the starting point and the way to reach the results. The research approach presented in the paper must be clear enough to be reproduced by other researchers.**

Answer of the authors:

- New section "Method" includes a workflow diagram of the method we propose.
- **Conclusions should be more concise and direct.**

Answer of the authors:

- The conclusions have been rewritten in the new version of the paper. Also a new section "Discussion" has been included.