Response to Reviewer 2

We would like to thank the reviewer for the very detailed and insightful comments to the first draft of the paper, which have helped to greatly improve it. We agree that many details needed further clarification. We hope that this improved version is easier to understand and makes the key points in a clearer fashion.

Comments from Reviewer 2	**Response**
This paper presents a framework that combines modelling with data collected through a citizen observatory running in northern Italy. The idea that citizen science could successfully be used to reduce the risk of catchments to the effects of flooding is interesting and timely. Having said that, I find several shortcomings in this paper that need to be fixed before it can be considered for publication in HESS. These shortcomings are: 1. The core message of the paper for me should be that citizen science and modelling are effective in reducing risk. However, the paper describes extensively the modelling approach whereas the citizen science part is very vaguely described. The two together don't make a convincing story.	We have strengthened the core message of the paper, i.e., that citizen science and modelling are effective in reducing risk. In particular, we have added a section describing the citizen observatory in more detail. This should hopefully provide the necessary context for making this story more convincing.
2. The concept of risk used in this paper is a known one. The paper uses quite some space in the methods section to go through the component of risk but it does it in a very confusing way. For example, one would expect that Fig 1 is used through the methods to arrive to the risk estimates, but it isn't, and therefore the presentation of the method is muddled. I would suggest re-writing the risk section, shortening and focusing it on the application to flooding risk, using a comprehensive figure to guide the reader.	The introductory section on risk has been removed and flood risk has been discussed in the introduction as per your more specific comment below. A new Figure 1 has been added and better aligned to the description of the methodology.
3. The modelling approach uses many coefficients that lead to the estimation of risk. These coefficients presented in several figures, were taken apparently from a number of sources (not always disclosed) and are not subject to a thorough sensitivity analysis. The results of the modelling are heavily determined by the coefficients adopted so it is critically to explain these very well. I don't recommend this additional explanation is included in the methods section, but it has to be properly documented in Supplementary material. Without this, it will be extremely hard to test and to apply this method elsewhere.	We have now specified the source of all of the coefficients, weights and value functions used in the methodology. They are based on existing literature, expert consultation and the guidelines on flood risk estimation published by ISPRA (2012). Some of these values are based on years of experience (e.g., exposure by land use type) and have been internally validated.

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4. The description of the Citizen Observatory is the most disappointing. It doesn't inform the reader in terms of data collected, how did the work, how it was implemented, etc. This should be lot more prominent in this paper. I do not recommend the publication of this paper because it requires significant re-writing.	We have thoroughly revised the description of the citizen observatory, moving this to a separate section 2.
Specific comments. The **abstract** is not informative, and it should reflect the key innovation of this study. Presumably, the successful linking of risk modelling and citizen science should be the key message in the abstract.	The abstract has been rewritten to reflect the main message, i.e., potential reduction in risk possible when linking citizen science with modelling.
For the case study, the findings seem misleading because the study does not cost a infra-structure adaptive intervention, only the roughly estimated costs of the potential damage.	In the results section, the cost of constructing a retention basin in the municipalities of Sandrigo and Breganze is provided.
Introduction L20-30 This section is irrelevant for the story of the paper, and not well written. I suggest to delete it, and add instead a clear definition of risk specific to flooding that introduce the paper.	These lines have been removed and the introduction rewritten to include a clear definition of risk specific to flooding.
L37-39 References required for the statement 'exponential growth' in citizen science.	This statement was modified from exponential growth to the rise in citizen science and crowdsourcing, and references were added.
L40 unclear why references were added after . . ."Among the various form of citizen science". Instead of references I would expect a list of the different forms. This whole sentence needs re-writing.	We agree with the reviewer that this was confusing. We have removed this and replaced it with a simpler statement and a reference.
L61-63 and L65-68	There were no comments provided with these line numbers. Please clarify if there are specific comments to address.
L70 section 2.1 needs to be more carefully described. Details needed to interpret results.	More details have been added on the input data including a table.
L74 section 2.2 See general comment. This section up to 2.4 is so poorly written that it is hard to keep track of the method used, sources of information and assumptions made. In addition, the calculation of risk must be done from the beginning with a focus on flooding risk, the aim of this study.	We have modified these sections and also shifted some material to the Supplementary Materials.
Fig. 1 is not self-explanatory and it is not connected properly to the text that follows in 2.2 and 2.3.	Figure 1 has been modified and better connected to the text.

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Table 1 could be sent to supplementary material. It is not critical to the results.	We have moved this to the Supplementary Material.
L100-110. A description and testing of the hydrological model are needed because the reference included is not a peer-reviewed source and can't be accessed by the reader. This could be added to supplementary material	We have added a description of the hydrological hydraulic model to the Supplementary Material.
Table 2, Table 3 and Table 4. It should be clear what the sources for these coefficients are and why these are accepted to be reasonable without performing a sensitivity analysis.	The weights in Table 2 have been developed through stakeholder consultation and guided by flood risk assessment in ISPRA (2012). The weights in Table 3 have been developed over decades of experiences with exposure by the province of Trento (with the reference added). The weights in Table 4 are from a UK DEFRA study and are cited in the guidance on flood risk provided by ISPRA (2012). These sources have been added to the paper.
L174 why is the use of 'value functions' the preferred approach, and what is the uncertainty associated with them? I don't see an uncertainty analysis conducted here.	We have added more information about what and why this approach is used and removed the text regarding the method being the preferred approach. The value functions have been derived through extensive expert and stakeholder consultation. An uncertainty analysis has not been conducted but we mention this in the discussion section of the paper.
Fig. 3 I wonder why this figure is presented in addition to Fig 1, and using slightly different terms and approach?	Figure 1 has now been updated to better align with the text in the paper and to be more consistent with Figure 3.
Fig. 4, 5, 6, 7 and 8. What is the uncertainty associated with this coefficients?	The coefficients in Figures 4 to 6 (now Figures S1 to S3 in the Supplementary Material) have been determined through expert consultation (at the provincial level) and stakeholders at AAWA. Therefore, they represent a consensus view. In fact, the reason for using expert consultation is because of uncertainty. We have added a paragraph to the Discussion and Conclusions section to discuss this aspect of the paper. The coefficients for Figures 7 and 8 (now placed in the Supplementary Materials) are based on laboratory experiments and sources are provided in the text. Although we agree that there will be uncertainties around these figures, the final vulnerability coefficients have been further agreed upon through expert consultation at AAWA and represent conservative estimates.

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L214 Are forecasting systems the same as 'early warning systems' of Fig. 3? This is confusing.	We now use early warning system to be consistent.
Fig. 9 It is very hard to understand this figure. The caption is not self-explanatory.	We have corrected water depth to water height to be consistent with the graphs. For each land use type, there are two vulnerability values. Figure 9a for vineyards indicates that at a water height of less than 0.5m and a flow velocity of less than 0.25 m/s, the vulnerability is 0.5. Values greater than 0.5 m and 0.25 m/s have a vulnerability of 1.0.
L284. The component of the equation should be explained. This equation should be introduced after Fig 1 when the concepts are explained.	The individual components of the equation are now explained but these rely on explanations that are contained in the hazard, exposure and vulnerability sections so the equation has been kept in the same location.
L295. This section on C/B analysis is not clear at all. I would have expected that the costs would be the cost of remedial and/or preventive actions, which are not clearly explained here. What are the units of ISRR? I would guess hectares of km2. And of CBA?	The ISRR is a unitless index. If positive, it means that there has been an overall reduction in the risk due to the implementation of the CO. If negative, then the risk has increased. In this example, the ISRR is 2.5 so the overall risk has been reduced. The CBA equation has been removed as the damage compared to the avoided damage provides a monetary assessment of the benefits.
Table 7. I would expect large variability in these values. No uncertainty analysis performed.	These figures come from a study by Huizinga (2007) from the Joint Research Center (JRC) in Italy. In 2017, Huizinga et al. published a report on global flood depth damage functions, comparing the results in 2017 with those in 2007. The overall patterns matched the 2017 values but showed overestimates in Europe, which were corrected by assuming a 40% inalterable portion for European buildings. The numbers then matched well. Hence some uncertainty analysis has been performed by the original authors of the figures. We would also assume they are conservative, having been published in 2007.
L348 section 2.4. This should be one of the key section of the paper, but it is unfortunately very vague and doesn't provide the reader much information on how the citizen observatory worked, data collected, for how long etc.	We agree with the reviewer. As the paper has now been revised substantially, we hope there is more clarity.
Results. In view of all the methodological questions, it seems pointless to go through the results. From the paragraph included in L426-432, it seems that the paper should have explained the simulations of risk and damage, and	We have added a section explaining the citizen observatory and changed the headings to more clearly show that the risk calculations have been undertaken with and without the implementation of the citizen observatory.

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what the citizen observatory programme did and achieved, which here remains as a black box.	