Response to RC1 – Submission NHESS-2023-64

Dear Reviewer,

Thank you for taking the time to review our manuscript *"Better prepared but less resilient: the paradoxical impact of frequent flood experience on adaptive behavior and household resilience."* We appreciate your evaluation and insightful comments to improve the quality of our work. In the following section, we address each of your comments and suggestions point by point. The green written text indicates how we would incorporate the proposed adjustment in the final manuscript.

Comment: *Paragraph 145: The sample of the first wave (2020) contains 1833 individuals; the sample from the second wave (2021) contains 1319 individuals, from which 690 are part of both waves. Instead of using first wave, second wave why not use first survey and second survey. Comment: I had to reread the paragraph a second time to understand what you really meant. You could rewrite the sentence as " The sample of the first survey (2020) contains 1833 individuals; the sample from the second survey (2021) contains 1319 individuals, from which 690 are part of both surveys."*

Answer: We agree with your suggestion and will add the word "survey" to the manuscript. We would like to retain the word "wave" as it is a technical term in panel data analysis.

The sample of the first survey wave (2020) contains 1833 individuals; the sample from the second survey wave (2021) contains 1319 individuals, from which 690 are part of both survey waves.

Comment: *Paragraph 145: Therefore, the panel structure applies to 28.03 % (690) of the 2462 respondents. Comment: Instead of panel structure, why not say longitudinal data or panel data. I feel panel structure is a bit confusing.*

Answer: We delete the sentence and include it in the sentence before.

The sample of the first survey wave (2020) contains 1833 individuals; the sample from the second survey wave (2021) contains 1319 individuals, from which 690 (28.03 %) are part of both survey waves.

Comment: *Paragraph 190: The correlation analyses of the relationships between FFE and the outcome variables show that households with more floods experienced have implemented more*

likely adaptive measures in the past. Comment: I think "Floods Experienced" should be flood experience. The sentence should read as .... households with more flood experience have implemented.......

Answer: We agree that, concerning readability, another wording would be beneficial. However, as we already wrote "flood experience" in the subsequent sentence, we prefer another term. We decide to change "floods experienced" into "(…) households that have experienced more flood events have (…)." We will change the wording throughout the text.

The correlation analyses of the relationships between FFE and the outcome variables show that households that have experienced more flood events were also more likely to have implemented adaptive measures in the past.

Comment: *Paragraph 290: To conclude, FFE has a statistically significant negative impact on resilience by lowering self-reported resistance during and recovery from the last flood event. Comment: Contrarily, a previous study concluded that Flooding experience (FE) showed a significant positive correlation with flood risk adaptation, indicating that perceived increase in the severity of flood experience could result in a corresponding increase in flood risk adaptation behaviour. Reference: Chati Jerry Tasantab, Thayaparan Gajendran & Kim Maund (2022). How the past influences the future: flood risk perception in informal settlements, Environmental Hazards, DOI: 10.1080/17477891.2022.2130854*

Answer: In this part (4.2.2) of the manuscript, we only present the regression analysis results that test the influence of frequent flood experience on self-reported resilience. In the discussion part (section 5), we further elaborate on the obtained results and bring into relation the results regarding the impact of frequent flood experience on adaptive behavior and the impact of frequent flood experience on household resilience. As Tasantab et al. (2022), we find that flood experience positively influences adaptive behavior. However, we did not test if the perceived severity of the last flood event influences if people have undertaken protective measures. The reason is that it is not known if people have adapted before or after their last flood event. Therefore, any judgment on the effect direction would not be based on empirical data from our dataset.

Comment: *Paragraph 375: Linking the results of the first and second research questions reveals that, even though individuals indicate that they perceived their first flood event as severe and felt powerless, only the share of people that have adapted the most low-threshold*

behavior of storing essential goods more save changes substantially. Comment: I feel that save in the sentence should be safely. The sentence should read as ....people that have adapted the most low-threshold behavior of storing essential goods more safely changes substantially....

Answer: You are right. We change the spelling throughout the manuscript.

Linking the results of the first and second research questions reveals that, even though individuals indicate that they perceived their first flood event as severe and felt powerless, only the share of people who have adapted the most low-threshold behavior of storing essential goods more safely changes substantially.

Comment: *The same applies to paragraph 390: The empirical analyses show that undertaking property-level adaptation and storing essential goods more* **save** *(replace with* **safely***) have a statistically negative impact on feeling helpless.*

Answer: You are right, we change the spelling.

The empirical analyses show that undertaking property-level adaptation and storing essential goods more safely was negatively associated with feeling helpless.

Comment: *Paragraph 395: The feeling of helplessness might be rather influenced by the fear of losing personal belongings. Comment: A previous study confirmed that those who experience severe flooding or lost property and valuables during previous flooding events believe that future flooding and its impacts could be worse due to the fear or dread from that experience. Reference: Chati Jerry Tasantab, Thayaparan Gajendran & Kim Maund (2022). How the past influences the future: flood risk perception in informal settlements, Environmental Hazards, DOI: 10.1080/17477891.2022.2130854*

Answer: In this paragraph, we discuss the results regarding the influence of adaptive behavior in the past (undertaking building-level adaptation, storing important goods more safely, and taking out insurance) on felt helplessness regarding future flood events. The sentence "The feeling of helplessness might be rather influenced by the fear of losing personal belongings" discusses the outcome of our study that people who have taken out insurance in the past feel statistically significant more helpless compared to people who have not taken out insurance, ceteris paribus. However, your comment does not refer to the influence of past behavior on perceived future resilience but puts into relation coping experience during a flood in the past to

individuals' assumptions about the severity of future floods. Whereas the influence of coping experience during past flood events on assumptions about future performance during floods and their severity is an interesting and important field to study, it is not what we intend to measure with our study and not what we discuss in the paragraph. Therefore, we would not support your suggestion of adding the cited paper to this paragraph. However, the cited paper is already discussed in the literature part of the manuscript (line 99), as we also think the paper contributes valuable outcomes that should be presented in our paper.

Thank you again for your valuable input and critical assessment of our manuscript. Your comments and constructive feedback are valuable for further improving our manuscript.

Sincerely,

Lisa on behalf of the co-authors

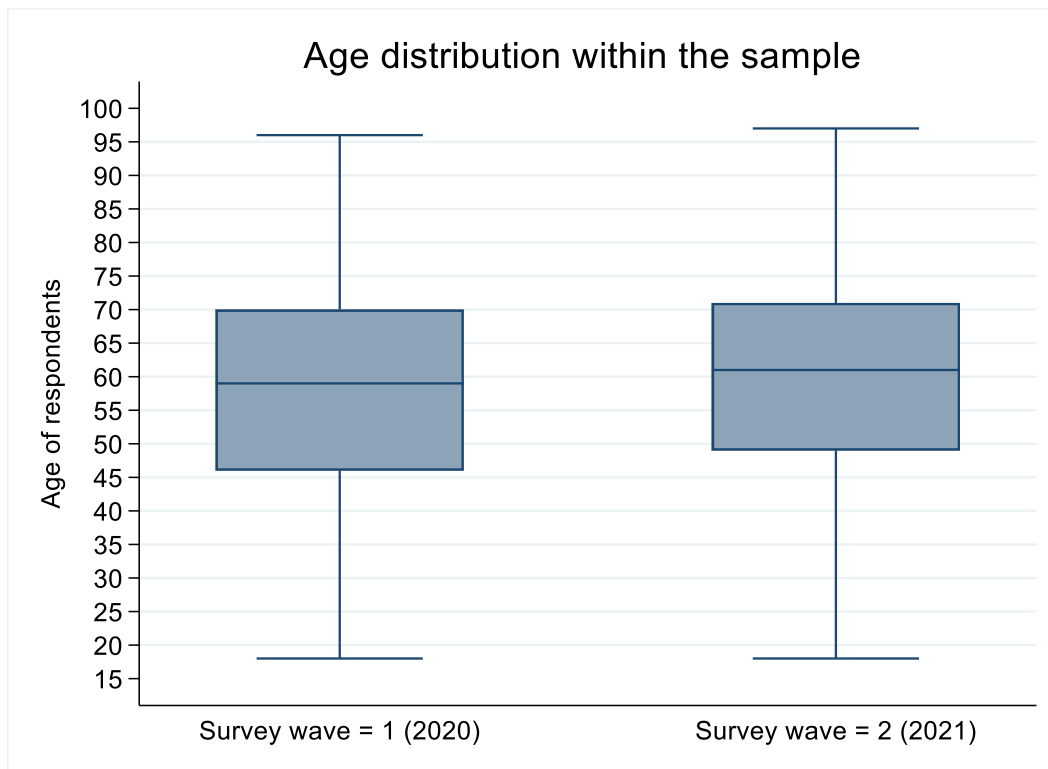
Response to RC2 – Submission NHESS-2023-64

Dear Reviewer,

Thank you for taking the time to review our manuscript *"Better prepared but less resilient: the paradoxical impact of frequent flood experience on adaptive behavior and household resilience."* We appreciate your evaluation and insightful comments to improve the quality of the manuscript. In the following section, we address each of your comments and suggestions point by point.

Comment: *What is currently missing, and what I would highly recommend adding, is a description of the sample. It is shown how the sampling was done but there is no information about the composition of the sample e.g. in terms of gender and age groups. Do the respondents represent a balanced relationship between different age groups? This information is important in the description of the method, but the information could also be important for the interpretation of the results and the discussion section (especially if not all age groups are equally represented in the sample). It would be also interesting to know if the analysis showed any differences among different age group and gender.*

Answer: The manuscript has a separate sample description for each survey wave (line 175). The described characteristics are demographic background (age, gender, tenure), the type of building people live in (share of people that live in single/semidetached/ apartment/ double houses), frequency of flood experience (share of people that have experienced none/one/two/ at least three floods), past adaptation (share of people that has undertaken building-level adaptation in the past), and the share of people that have been surveyed before/ after the flood event in western Germany in July 2021. However, what becomes not clear from the table is the age distribution within the sample. Therefore, we would add the following graph to the manuscript (section 3.2.2):

Age distribution within the sample

For the other characteristics, the distributions should become clear from the table. It can be seen that the sample covers a wide range of ages, with most people being between 45 and 70 years, but also includes people who are 18 years old or above 95 years.

Regarding the second part of your comment, it would be interesting to see if the relationship between FFE and behavior/resilience varies depending on the age group or gender. Same counts exemplarily for different educational backgrounds. However, this is not the scope of our paper. This study's research objective is to obtain a clearer picture of the influence of FFE on protective behavior and self-reported resilience. It would be worth another study to dive deeper into this relationship and see if other factors, such as age, gender, education, or economic background, influence it. This study would also demand an in-depth theoretical grounding to define factors that are assumed to influence the relationship and to draw conclusions on possible reasons. However, this would exceed the scope of this study but would be an interesting future project.

Comment: *I would suggest to better elaborate on the concept of household resilience and individual resilience. It is not always clear in the manuscript whether the focus is on individual or household resilience. From the title and what stated in line 40, RQ2, it seems that the unit of study is households, while elsewhere it is individual resilience (e.g. line 43/44). In the description of the methodology authors state that the questionnaires were addressed to individuals within specific households so it seams that the research unit is the individual level*

or did the questionnaire also cover the household level with specific questions? Since the paper claims to investigate the impact of multiple flood experience on household resilience, I would expect that household data (composition, presence of young children, persons with disabilities, etc.) would also have been collected and taken into account in the data analysis and discussion of the results.

Answer: Our paper aims to measure the influence of frequent flood experience on self-reported resilience. Here we asked, "How powerless did you feel during the last flood event?" "How helpless do you feel with regard to future flood events?" "How severe was the last flood event for you?" to measure the respondents perceived resistance during the last flood events and their expected capacity to resist future floods. The question "How much does the last flood experience still weigh on you today?" measures their perceived recovery. The underlying assumption for using the term household resilience instead of individual resilience was that an individual's resilience is possibly closely connected to a household's resilience and that protective measures are subject to household action rather than one individual alone. Additionally, the main interest of our study, the number of experienced flood events, is also affecting the household as a whole rather than one member individually. For example, a respondent would not say they recovered quickly if their household members or building had not done so. However, when rethinking our terminology to answer your comment, it becomes clearer that this assumption is pretty strong and that the individual perception can also be disentangled from the household members' perceptions and actual damage to the building. Therefore, we refrain from using the term "household" and replace it with "individual." However, to what extent the household's resilience influences the self-reported resilience of its members delivers a new interesting research question that could be worth investigating for a future project and could deliver insightful outcomes regarding the influencing factors on individuals' resilience. We also appreciate the idea of including household-level data in a model to measure household-level resilience.

Thank you again for your valuable input and critical assessment of our manuscript. Your comments and constructive feedback are valuable for further improving our manuscript.

Sincerely,

Lisa on behalf of the co-authors

Response to CC1 – Submission NHESS-2023-64

Dear Alexandre Pereira Santos,

Thank you for your thoughtful evaluation of our manuscript and for initiating a discussion regarding the application of theories and the multidisciplinary nature of resilience and its development. We acknowledge your viewpoints and recognize the many opportunities for further research of the research community to enhance our understanding of the driving factors of protective behavior and resilience in the context of natural hazards.

Nonetheless, we disagree with the suggestion to incorporate these considerations into our current manuscript for the following justifications:

First, you claim that the literature part could be improved by including more scholars and discussing more contextual factors that are assumed to influence resilience. We agree that many more factors influence resilience than those we discussed in the literature part of our manuscript and that, if one would like to draw a more comprehensive picture of the development of resilience, a more in-depth discussion on these factors should be included. However, we would like to emphasize that the primary research aim of our study is not the general development of resilience, although we recognize its significance as a research area warranting further exploration. Instead, our research objective is explicitly centered on examining frequent flood experiences' influence on protective behavior and self-reported resilience. Consequently, we believe that incorporating the literature and theories you mentioned may not enhance the manuscript's value in terms of alignment with our research objective and could potentially reduce its clarity in linking our research objective to theory and existing knowledge.

Second, you mention the well-established Protection Motivation Theory (PMT) and claim that its factors are not fully included in our empirical model. Whereas we agree that establishing stronger links between theory and empirical outcomes, we also want to highlight that the research strategy of our study follows an inductive reasoning approach, as we want to get a better idea of how the number of experienced flood events influences protective behavior and self-reported resilience. Therefore, we do not intend to test an existing theory as the PMT, as we would if we followed a deductive approach.

Third, you criticize the absence of the role of social capital in our study. We agree with you that social capital is an important factor in the context of protective behavior and resilience. It is important to note that many factors play a crucial role in this domain (for a review, Kuhlicke et al., 2023; Bamberg et al., 2017), as also highlighted in our manuscript. However, due to

constraints such as lack of data, or the Principle of Parsimony in empirical modeling, we will never be able to include all the factors that may influence the outcome variable in a regression model. Accordingly, it requires precision in selecting the independent variables to ensure the development of a robust and well-fitted model aligned with our research aim. With our study, we want to measure the influence of frequent flood experience on protective behavior in the past and self-reported resilience. Furthermore, we are interested in the existence of nonlinear relationships. To follow this specific research aim, we follow an exploratory research design, including the number of experienced flood events in the model as the primary variable of interest and other variables, referring to the demographic background and building characteristics, as control variables. Consequently, whereas social capital is an interesting research field, it does not belong to the key elements we want to analyze with our study.

Given these considerations, we appreciate the valuable insights and perspectives you shared. We believe your comments will contribute to the ongoing discourse and advancement in the field.

Sincerely,

Lisa on behalf of the co-authors

Cited literature:

Bamberg, S., Masson, T., Brewitt, K., and Nemetschek, N.: Threat, coping and flood prevention – A meta-analysis, J. Environ. Psychol., 54, 116–126, https://doi.org/10.1016/j.jenvp.2017.08.001, 2017.

Kuhlicke, C., Madruga de Brito, M., Bartkowski, B., Botzen, W., Doğulu, C., Han, S., Hudson, P., Nuray Karanci, A., Klassert, C. J., Otto, D., Scolobig, A., Moreno Soares, T., and Rufat, S.: Spinning in circles? A systematic review on the role of theory in social vulnerability, resilience and adaptation research, Glob. Environ. Chang., 80, https://doi.org/10.1016/j.gloenvcha.2023.102672, 2023.