

# Response Letter 2

Manuscript: “Identifying the drivers of private flood precautionary measures in Ho Chi Minh City, Vietnam” by Thulasi Vishwanath Harish, Nivedita Sairam, Liang Emlyn Yang, Matthias Garschagen, and Heidi Kreibich

## **Our Response R: *In Italics***

*We would like to thank the reviewer for taking the time and effort to provide comprehensive feedback on our manuscript.*

### **General comments**

The drivers of individual choices in the context of flood protection and flood risk mitigation are not clear. This study takes an interesting and new approach into understanding such drivers, and it selects a very interesting local case for this scope, Ho Chi Minh City, in Vietnam, a city plagued by frequent flooding and with still lackluster government solutions on flood protection. The methodology is statistically advanced, and the size of the survey is impressive. The presentation of results is correct, and useful lessons can be drawn from the analysis. The study grapples with theoretical frameworks from the social and psychological sciences, and I commend the authors for explaining the key concepts and methods with sufficient care that someone without that background – like me – is still able to follow adequately. Terminology throughout the text is consistent. The article is quite concise, with the exception of some lengthy parts of the Introduction. The text is well written and generally clear, though I recommend that the authors revise it again to improve simplicity of some sentences and correct minor mistakes. The paper could be published in this special issue, pending careful revision on a number of aspects, both general and specific, as explained below.

*R: Thank you very much for the positive feedback on our manuscript. We have considered all the comments to improve our manuscript and implemented the recommended changes. We have also provided relevant explanations in the response letter. Sentences from the manuscript are given in quotes.*

The reference to the literature in the Introduction is largely inadequate. I include below specific comments on this issue, limited to the first lines of the introduction. It is necessary that the authors verify every statement and its supporting references carefully throughout the manuscript.

*R: Thank you! We have corrected the references and also, restructured the introduction (also, in respect to comments from Reviewer 1).*

**The Transtheoretical Model as implemented in the study distinguishes between households at two ‘risk reducing stages’: proactive and reactive. It is not clear to me, especially after seeing how this differentiation is carried out in the survey (lines 141-on), whether it is possible to determine whether the moment when the interviewee responds to the survey is before or after ‘the flood’. In a context where floods occur with remarkable frequency, are attitudes and behaviors influenced by thoughts of past floods or rather by expectations of future floods? And is it even possible to tell them apart? Can the authors clarify how they deal with this ambiguity, and how sensitive are the results with respect to this dubious point?**

*R: Thanks for the comment. We agree that the categorization of households in HCMC (given high flood frequencies) into proactive and reactive groups is challenging. The objective is to understand if experiencing a serious flood event (i.e., high level of damage) influenced a household to adopt precautionary measures, we categorize households that implemented a precaution measure before experiencing a serious event as proactive. And the others as reactive, after excluding the households that have not implemented a precautionary measure. Hence, we determined which risk reducing stage of a household based on whether they implemented the measure before/after the most serious flood in the last 10 years.*

*The results indicate that households are influenced by both – past floods and anticipated future floods. Past floods positively influence them to adapt precautionary measures due to the high level of damages already sustained. But surprisingly, anticipating more severe floods in the future demotivates the households to uptake precautionary measures.*

*And is it even possible to tell them apart? The questionnaire survey is specific about the temporal precedence of the implementation of measure with respect to the flood event. In order to obtain valid responses, we ensured that the respondents understood the temporal precedence.*

**The key choice of aggregating responses according to whether the measure is structural or non-structural is not motivated. Even after reading the discussion of the results, I am not convinced that this is one of the two most relevant ways to discriminate among households or measures. I understand that the research is broadly framed in the context of a need for non-structural measures to also be implemented, next to structural ones, so that ‘integrated flood risk management’ is achieved. But it is not clear to me that this implies that structural vs non-structural is a key dimension along which the results of this behavioral survey should be analysed. I think that there is no clear a priori reason to assume that the type of measure matters heavily for the behavior of flood-prone actors, whereas it would seem more reasonable that factors like price (an hypothesis in fact disproven by this study) or familiarity with the measure should matter more, a priori. Please motivate this choice, or alternatively analyse and present**

**results with the only differentiation of preventative vs reactive households, or other relevant differentiations.**

*R: Thank you for the comment. Precautionary measures are classified into structural and non-structural measures based on whether their implementation requires making structural changes to the building. The*

*We classified households based on structural and non-structural measures in order to control for the bias around provides insight into how the permanence component of a precautionary measure influences the household's decision. Because structural measures will require permanent structural changes to the building which are not portable while non-structural measures are portable. Hence, the type of measure does heavily influence the behaviour of flood-prone actors. Most of the households interviewed were the owners themselves and their behaviour (i.e., highest implementation- building elevation) is justified by the results. In a different scenario, if a person is renting a house, they would not be willing (or permitted) to make permanent structural changes to the house. Using other factors such a price or familiarity would introduce uncertainty since they cannot be as distinctly classified as structural and non structural.*

**In the Methods, there is no presentation of the explanatory variables that are taken into consideration in the survey and for the regressions. Nor is it stated whether households are surveyed about the cost of the measures, of whether costs are taken from other sources.**

*R: All the explanatory variables are presented in Appendix A while only the important explanatory variables are described in Table 3 under 'Results and Discussion'. We have added the source of implementation cost in the revised version – cost was obtained from the survey.*

### **Specific comments**

**In the abstract we read that two seemingly contrasting beliefs both promote proactive implementation of private measures: “degree of belief that the government will implement effective flood protection measures and degree of belief that one has to deal with the consequences of flooding by themselves”. How is this possible?**

*R: The first belief is an assurance that the government is enacting to prevent flooding by implementing on a large scale (at city level) measures which motivates a household to do their bit to complement the measures of the government. This is directed towards the preparatory phase of flood risk management. On the other hand, if flooding occurs despite all the precautionary/ preparatory efforts from the government, then if the household believes they have to deal with the consequences of flooding*

*themselves. Understanding the lack of adequate measures in the recovery phase of flood risk management also plays a role in motivating the households.*

**L 24: whereas Botzen et al 2019a is a fine review of the trends and drivers of economic impacts of floods in the past and future, it doesn't seem to support a statement specifically on the physical aspect of floods and climate change. There are several papers that can be picked for that, e.g., Winsemius et al. 2015 (10.1038/nclimate28930) for river flooding, or those referenced in the following sentence.**

*R: We agree the review by Botzen et al 2019a, does not support the statement regarding climate change and hence have retracted the statement in the revised manuscript but the other two statements supported by this reference are not directed towards the physical aspects of flood but rather Indicate the economic consequence of floods in a developing country and the disaster risk reduction measures required at all levels, international; national; and local.*

*“Developing countries are more severely impacted by flooding due to their limited capacity to lessen the effects of disaster (Hagedoorn et al., 2021) and the hindrance posed to their economic growth due to the consequences of large flood events (Botzen, et al., 2019(a)).”*

*“Therefore, integrated flood risk management strategies are explored as conventional large-scale flood protection structures fail due to changing flood hazards level (Botzen, et al., 2019(a); Nguyen et al., 2021(a)).”*

**27: Whereas sea level rise obviously increases coastal flooding, it is not clear that it will bring more frequent or intense storm surges. E.g., Muis et al. 2020**  
<https://doi.org/10.3389/fmars.2020.00263>

*R: The statement has been removed in the revised manuscript. However, we agree that it was a poorly formulated sentence but the intention was to convey the existence of a relationship between sea-level rise and storm surges which is also supported by the reference paper in your comments.*

**L 30: Mendoza et al. does not seem an appropriate study to support that Vietnam is the country most vulnerable to climate change. Further, Dasgupta et al is a dated study. This is a bold statement that requires credible support.**

*R: It is also mentioned in the IPCC AR5. Vietnam is not directly mentioned but Ho Chi Minh City, our area of interest is mentioned.*

[https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap24\\_FINAL.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap24_FINAL.pdf)

*Pg 1346. Section Floodplains and coastal areas.*

**31: The study of Nguyen et al. 2021b does not show that floods are the most damaging hazard in Vietnam, as it is concerned with a very different issue.**

*R: We agree and have extracted the statement in the revised manuscript.*

**32: How can Hagedoorn et al. 2021 discriminate between the impacts of floods in developing and in other countries, when they only study flood adaptation behavior in Vietnam?**

*R: We agree and have removed Hagedoorn et al. 2021. Instead Parker, 2006 is cited as a more suitable reference. It highlights the economic consequences of natural disasters in developing countries. The paragraph is also restructured in such a way that this statement appears before addressing Vietnam to keep the flow intact.*

**L 55: whereas Sairam et al 2019 (previously referenced) empirically verify the effectiveness of measures, the studies of Scussolini et al and Du et al are based on modeling, and undertake many assumptions. This has to be made clear in the manuscript, as the empirical and modeling approaches have different value when it comes to show-prove-support-report effectiveness of measures.**

*R: Thank you! The methodology implemented in the reference studies is mentioned in the revised manuscript as suggested.*

**67: “evaluate how these drivers are associated with the willingness of households to adopt private flood precautionary measures”. Isn’t this a tautological sentence? Once the drivers of behavior are known, we also know what makes people willing to adopt the behavior. I might be missing something here.**

*R: It is based on the assumption that all people are not the same. We may obtain the drivers for 1000 households but all the households are not the same. Here willingness helps in creating more specific target groups for risk communication. For example, if quitting smoking is the goal, some are only thinking about quitting, others are in the process while few others have already quit. Similarly, when implementing private flood precautionary measures is the goal, willingness tells us in which stage they are – based on timeline of the implementation of measures. These stages are modified in our study based on flood experience as proactive and reactive groups to especially identify the drivers for reactive groups so that they can be motivated to implement measures.*

**L 68 “we develop an empirical data driven approach complementing theoretical protection motivation theory and transtheoretical model frameworks”. I don’t think the meaning/content of this sentence will be clear to the reader. Further, the following sentence is repetition of previous sentences.**

*R: Thank you! The sentence is rewritten in the revised manuscript*

**Section 2: I think much detail about physical/climatic aspects of HCMC can be shortened, as these are not highly relevant to this study. To any extent, if referring to the drivers of floods, this recent study rigorously looked at the key drivers and their dependencies: Couasnon et al. 2022 <https://doi.org/10.1029/2021WR030002>**

*R: Section 2 'Study Area' is shortened and only the relevant information is included within the 'Introduction' of the revised manuscript.*

**88: "Protection of livelihood from flood events has a high priority and it is leading to high investments in extensive flood defense systems (Kreibich et al., 2015; Weyrich et al., 2020)." This section is about HCMC, so why this statement with references on investments elsewhere?**

*R: In the revised manuscript Cao et al., 2021 is cited as a more suitable reference.*

**Fig. 1. The figure is helpful in sketching the framework. Some questions: if 'dependency on government influences the coping appraisal (and not the threat appraisal), wouldn't it make sense for that block to link with the coping appraisal before its joining to the threat appraisal? Does the same apply to 'household profile' and threat appraisal? It is possible that I am wrong here. Why is 'past flood experience' not linked to the other arrows, and in a dashed-line box?**

*R: Thank you for the comment. 'Protection Motivation Theory' has only two factors at its core – coping appraisal and threat appraisal, it is further extended to add two more independent factors 'Dependency on government' and 'Household profile' which are not connected to the former core factors, they are all independent. The explanatory variables representing 'past flood experience' are only applied to the reactive household groups during regression since proactive groups adapt precautionary measures before experiencing a serious flood event as defined by this study – that is why shown in dashed-line box. We hope this clarifies our approach.*

**109: "Effectiveness of the PMT framework is limited as a household's willingness to adopt protective measures in flood risk areas is not considered." This is surprising, since the paragraphs above seemingly explained how PMT is precisely helpful to conceptualize households behavior towards flood protection measures. Please clarify, because otherwise the need for the transtheoretical model is not motivated.**

*R: Thank you for the question. We have answered this question in the response to L67 regarding the significance of the transtheoretical model.*

**128: It could be useful to know where those districts/wards are in HCMC, maybe via a map, so that an impression can be gathered of how their position relates to flood-prone areas of the city, potentially discriminating different types of flood, which you mention in the following sentence. This is only a suggestion, not a necessity.**

*R: An appropriate map is included in the revised manuscript along with the names of the districts.*

**Fig. 2.** The figure is correct in principle, but I think it would be much clearer to the reader if a matrix format were chosen instead, with one level of classification along the columns and one along the rows. This is a much more common way to conceptualize the intersection of two classes.

*R: We agree and have made the changes.*

**Section 3.3:** I suggest making more explicit the relationship between drivers and explanatory variables, and between ‘decisions’ and response variables. I suspect these coincide, respectively, but I am not sure.

*R: You are correct, they coincide and their relationship has been explicitly stated in the beginning of the section.*

**L 176:** “and when a group of variables have high pairwise correlation, then lasso randomly selects one variable from the group.” It is not clear that groups here consist possibly of more than 2 variables. In this case, there are several pairs of variables that can be correlated, and it is not clear how the variable(s) are selected in case of high pairwise correlations. Also, change to “before the lasso model saturates”.

*R: Thank you for the question. Here “group” just refers to the group of highly correlated explanatory variables. This information is only to provide a general introduction to lasso regression technique and does not apply to this study since no set of variables have a high pairwise correlation in this research work.*

**L 178:** it may be due to my lack of familiarity with these methods of regression, but it is not clear to me how terms L1 and L2 play a role in eq. 2, supposedly via hyperparameters alpha and lambda.

*R: Yes, they play a role via the alpha and lambda hyperparameter. In lasso regression, the lambda term controls the amount of coefficient shrinkage and eliminates explanatory variables that have no influence on the response variable. In elastic net regression, another hyperparameter alpha is added to compute the contribution of L1 and L2 penalty terms. This combination helps in overcoming the drawbacks of lasso regression by shrinking together the coefficients of correlated explanatory variables.*

**198:** What do you mean by “aspects of the PMT-TTM framework”? are these the independent/explanatory variables, or classes of them? Linked to this, I cannot understand the following sentence starting with “Since the predictors...”: what are the predictors, again the explanatory variables?

*R: Thank you for the question. Aspects are components of the PMT-TTM framework which are represented by groups of explanatory variables it is mentioned in L139. Predictors are explanatory variables. The term predictors is replaced by explanatory variables in the revised manuscript.*

*“PMT comprises six aspects: (1) risk perception, (2) severity, (3) self-efficacy, (4) household profile, (5) dependency 140 on government, and (6) past flood experiences (Figure 1). Each of these aspects is determined by a group of explanatory variables, acquired by a relevant question from the questionnaire (Appendix A).”*

**L 206: Please consider whether it is appropriate to report results of the questionnaire as coinciding with information on the actual implementation of the results that respondents state to have implemented. Also, her please explain again what both events are, as the reader can't be expected to memorize all aspects of the Methods.**

*R: Yes, we believe it is appropriate. Both events, i.e, the most recent and most serious event experienced by a household in the last 10 years is mentioned in the caption of Figure 3 which L206 describes.*

**232 and throughout the text: 'dry-proofing' is commonly a structural measure consisting of preventing water from entering the house. I think that what you mean by dry-proofing is what the literature commonly understands as wet-proofing, i.e., placing elements inside the house on higher ground, so that flood waters entering the house will cause less damage. Just one informal, arbitrary reference: <https://www.coastal-management.eu/measure/wet-proofing-sealable-buildings.html>**

*R: Thank you for this clarification. The term Dry-proofing valuables has been changed to Wet- proofing valuables throughout the revised manuscript.*

**233: “Highest number of respondents have elevated their houses only after experiencing serious and recent flood events (Figure 3) because the flooding is getting worse in HCMC (Paulo and Rivai, 2021).” The causality in this sentence doesn't seem clear. Also, if possible I would use a source different from a journalistic article to support the higher frequency of flooding in HCMC.**

*R: We agree and have removed the causality from the statement in the revised version.*

**237: it is not clear what the contradiction is, here. Similarly, in the following sentence, the other contradiction needs to be made more explicit. Further, in the following sentence, a vast generalization is proposed about differences between developed and developing countries, on the bases on only three data points: HCMC, Denmark and Germany: this does not seem warranted, or should be played down. Lastly, note that 'rapidly growing economy' does not stand in contrast with 'developed economy'.**

*R: Thanks for the comment. Yes, we agree to the comment. We have removed the socio-economic comparisons in this context. The statements have been restructured to make the contradictions explicit and we have played down the generalization as suggested.*

*“Highest number of respondents have structurally elevated their houses only after experiencing serious and recent flood events (Figure 3) despite the high cost of implementation because of its effectiveness in preventing the floodwater from reaching the living area. However, a study by Koerth et al. (2013) states structural measures as the least preferred flood precautionary measure by the households in Denmark and Germany due to their high costs. Similar study conducted by Bubeck et al. (2018) in Germany and France, reports the requirement of policies to encourage structural flood-proofing.”*

**251: what are house impacts, in contrast to house damage? Here the shortcoming of not having explained these variables becomes evident. Similarly, one is left to wonder about the meaning of other variables too, like ‘people’. Only later is the reader informed that there is an annex that supports this.**

*R: ‘House Damage’ variable represents the damage already experienced by a household from past flood experience. ‘House Impact’ variables depicts the level of damage to the house anticipated by the household due to future flood events. All the important variables are described in Table 3 which is moved to the beginning of the ‘Results and discussion’ section in the revised version So that the reader is acquainted with these terms before reading them in the text.*

**258: this counterintuitive effect is very interesting: could you try to explain the mechanism behind it briefly, also on the basis of the other studies that report it elsewhere?**

*R: According to Protection Motivation Theory, protective measure is adopted only when coping appraisal reaches a certain threshold. With respect to the ‘House impact’ variable (i.e., belief that one’s house will be more severely impacted from floods in the future), an increase in this perception increases the threat appraisal of the household and decreases their coping appraisal as they feel it is beyond their capacity to adapt to the future events. This discourages them from adopting structural flood protective measures (Babcicky and Seebauer, 2019; Gebrehiwot and van der Veen, 2015; Grothmann and Reusswig, 2006).*

**300. You offer an explanation for the lack of results for this group of households. But it is not clear to me how the methods simply fails to produce any importance level above zero with this dataset: could you also offer an explanation of what happens here methodologically? Also, maybe I missed it, but how come for the non-structural proactive group the lasso and net-elastic models yield precisely the same results?**

*R: Methodologically, there is a lack of variability among the structural proactive group of households, only 264 out of 1000 households have proactively implemented a structural measure while there are 30*

explanatory variables. Therefore, each explanatory variable is supported by less than 10 households with lower frequency outcome. That is why the method fails for this group of households.

**How come for the non-structural proactive group the lasso and net-elastic models yield precisely the same results?** Net elastic regression is a combination of L1 lasso penalty term and L2 ridge penalty term which is controlled by the hyper parameter, alpha. When alpha = 1, the L2 penalty ridge penalty term becomes zero (Eq.2) and hence only the L1 lasso penalty term is followed. Hence, net elastic regression behaves like lasso regression. For non-structural proactive household group alpha =1. These are now included in the manuscript.

**312: it doesn't seem that ground elevation and precautionary savings (a concept that requires clarification) belong to dry- or wet-proofing.**

*R: We agree and have rewritten the statement to clarify that ground elevation and precautionary savings do not belong in dry- or wet- proofing*

**326: I don't think you can state that "costs do not restrict the implementation of precautionary measures in HCMC". This is an exceptional claim that needs stronger evidence than the lack of correlation between the cost of measure and their rate of implementation.**

*R: We agree and the statement has been removed.*

## Technical corrections

I have a number of suggestions regarding readability of the article.

**L.13-on: This sentence is huge. It contains both methods and results, whereas methods were exposed already in the previous sentence. Also, for readability, I suggest reversing the sentence, like "Analysis reveals the factors that positively influence the proactive ... : education; degree of ...".**

*R: The sentence is modified in the revised abstract.*

**L 16: "Households that experienced increasing... were more likely to implement measures reactively" or something similar seems more easy to understand.**

*R: The sentence is modified in the revised abstract*

**L 18: I would leave to the reader to decide what is 'important'.**

*R: Thank you! The sentence is modified in the revised abstract.*

**25: “long-duration precipitation events”**

*R: The statement was removed in the revised introduction.*

**59 “often not willing to take the responsibility and fail to implement”. Please revise for ambiguity**

*R: The statement has been revised*

**75: I am not sure, but I reckon HCMC is less than 80 km away from the sea. Please check.**

*R: Thank you! It is correct, it is only 50km away from the sea. The statement has been extracted in the revised introduction.*

**76: ‘even faster’: it’s not clear what the reader should compare the faster future rate or growth to.**

*R: ‘even’ is removed from the revised manuscript to make the statement clear.*

**129: “households which suffered”**

*R: Corrected in the revised manuscript*

**Fig. 3: Building elevation and Elevate are the same measure? Please stick rigorously to the same terminology to prevent ambiguity. Also, is there no respondent that did not answer any question?**

*R: Thank you for the comment! In the revised manuscript Elevate has been used consistently. Since, the survey was conducted in-person, the respondents answered all the questions. If they didn’t know the answer, the response was excluded from the analysis.*

**211: sentence incomplete.**

*R: statement rephrased*

**230: “lack of support to increase responsibility among households to implement other private measures”. It is not clear what this means. Also, if elevation is largely implemented, it is hard to argue that there is a general lack of responsibility regarding implementing measures privately.**

*R: We have made small changes to the sentence. The full statement including the proceeding two sentences read:*

*“Majority of the respondents in this study have exclusively only elevated their house. Buildings are often built elevated or are elevated during renovations. Other measures such as installation of flood protection*

*systems and usage of water-resistant materials, though found effective in other regions, are not common in HCMC. This might be due to lack of knowledge or lack of support to implement other precautionary measures.” In this context, we attempt to provide potential reasons for the lack of implementation of other precautionary measures apart from elevation.*

**232: eliminate ‘yet’.**

*R: Done!*

**Section 4.2: title is unclear: why not just “Drivers of...’**

*R: The title is changed as suggested.*

**L 248: I suggest “except for the group of households that proactively undertook structural measures”. In general, throughout the text, you can turn around many sentences in this way, using verbs and active clauses instead of substantives, improving clarity.**

*R: Thank you! Yes, we have turned around the passive sentences to active.*

**249: again, I don’t think ‘importance’ is clear in this context. Also, there is probably no need to pre-emptively present what the manuscript section does, here.**

*R: An additional statement has been included to define importance in this context and we would prefer to introduce the section in the beginning.*

*“... a description of the important variables which is determined by the weighted median of lasso and elastic net regression coefficients.”*

**325: change to “there is no correlation between the costs of a [type of] measure and its rate of implementation”**

*R: The statement revised as suggested.*

**328: I would skip “identified a set of important aspects that motivates the implementation of precautionary measures” and straight away recap the key drivers of behavior. In the following sentence, ‘pragmatic’ does not seem the right word. Perhaps ‘activating communication’ or similar.**

*R: Thank you! The changes are implemented in the revised manuscript.*

**331: as for other sentences, this should also be turned around for clarity: “The analysis further shows that factor that positively influence the decision of proactive groups are...”. The same**

**goes for the following sentence: “Therefore, to motivate proactive behavior of households ...”.  
Last, I would skip the last sentence, as it doesn’t add anything meaningful.**

*R: Thanks for the suggestions. The changes are now implemented*