

A flood risk oriented dynamic protection motivation framework to explain risk reduction behaviours

Response to the anonymous reviewer's comments in the interactive discussion: nhess-2019-120

Nbr.	Page/ line	Reviewer 2	Author's response
		The paper presents a method combining two theories to understand better motivation of people to undertake protection measures against floods. The paper is well written and well analyzed and is of interest for the readers of Natural Hazard and Earth System Sciences (NHES). The authors argue that their approach, that splits people groups, according to a classification related to the type of protection measures people are ready to undertake, could help targeting better communication about risk reduction. I believe that the paper could be further improved by providing more details about the context (flood prevention and alert) in the study area. The authors should also discuss how the combination of the two theories (Protection Motivation Theory – PTT) and Trans-Theoretical Model (TTM) and their implementation, mentioned to be different from previous ones, proved to be relevant and the limits they identified in their approach. They should also discuss how their methodology/results could be adapted to other countries/contexts. The conclusions section should also be rewritten, as its	We thank the Reviewer very much for his/her numerous suggestions and comments. We addressed the specific comments in the following. In general, we provide more information about the study area and discussed in more detail the PMT-TTM approach and its limits. We restructured the conclusion and discussed the generalization of our results for different countries.

		present content belongs more to the discussion section than to the conclusion section.	
1	3/14	the authors should precise what they mean by “flood risk”. I guess they are referring to the “static” risk of people being affected in their home, as opposed to dynamic flood risk, when people are exposed during their mobility.	Yes, the Reviewer is correct. We inserted the “i.e. to be affected in their home” to be clear.
2	3/18	when the authors write “motivations to protect themselves”, do they mean to protect their property, not their life?	It’s both. All the measures are meant to protect the property, but at the same time they can also save lives (e.g. having an emergency plan or an adapted use of the basement). That is why we kept a general terminology.
3	4/28	I do not understand the last sentence. Consequential – do you mean sequential?	Yes, we mean sequential.
4	5/1	“In these three studies..” to which studies does “these” refer to?	They refer to the three studies that were done in the context of natural hazards. Therefore, we inserted “and more recently applied by researchers (<i>Bočkarjova et al., 2009; Gebrehiwot and Veen, 2015; Martin et al., 2007</i>) in the natural hazard context” prior to the sentence.
5	5/30	“ of the public to undertake.”	Done.
6	6/14-16	could the authors provide more information about the flood risk maps. Are they built to map areas at risk of floods of different return periods? How is the information about flood risk communicated to people? This could be an important element for the interpretation of the results of the study and I believe it is important to communicate this information for people from countries where flood risk information could be different. In addition, how do you explain that some people had taken risk	Flood hazard maps are available for the main river system (the Adige) from the Distretto Idrografico Alpi Orientali (the former Water Authority). However, the resolution of these maps is not fine enough to capture flood hazards and risks generated by small river basins such as the Novare basin (2 km ²). These risks will be considered by novel maps (included in the Piano Comunale delle Acque), which are still in the making. Given the lack of a flood risk map at the required resolution, flood risk communication is poor and flood risk awareness is mainly based on historical evidences corresponding to floods which occurred in the last 80 years (the first flood

		reduction measures before the flood if the area was not declared at risk?	for which local data is available dates back to May 17 1935. This can be explained by the flood risk awareness mentioned above. Of course, the level of awareness and its potential to take risk reduction measures depends very much on personal experiences (either direct or indirect) and education. We inserted this information in the manuscript: “This is due to the coarse resolution of these maps that are not fine enough to capture flood hazards and risks generated by small river basins such as the Novare basin (2 km²). These risks will be considered by novel maps, which are still in the making. Thus, flood risk communication is poor and flood risk awareness is mainly based on historical evidences corresponding to floods which occurred in the last 80 years. Nevertheless, some people have taken risk reduction measures in the past as the level of flood risk awareness and the readiness to take these measures depends, for instance, on personal experiences (either direct or indirect) and education.”
7	6/26-27	Is there any warning to people when heavy precipitation is expected in a region? How were the losses compensated if few people subscribe to a insurance policy?	A flood warning system is active in the Veneto Region. The system generates flood hazards for specific targets in the region, whereas it provides generic warning for wide areas based on rainfall thresholds. For a <i>frazioni</i> like Arbizzano, only rainfall thresholds are available. Owing to the limited extent (in space and in time) of the 2018.09.01 flash flood generating storm, warnings were not issued. At the time of the survey, losses were not compensated yet (see comment 17). However, major losses can be compensated directly by the Veneto Region given formal documentation of flood damages. We inserted the following information: “Owing to the limited extent (in space and time) of the event, no (generic) flood warnings were issued, even though a threshold based warning system is in place. Thus, no preventive measures were deployed.”

8	6	in the presentation of the case study, could you also indicate the types of houses that were affected by the flood: are they located in old or new parts of the town? Do the house have several floors (it seems to be the case as basement is mentioned p. 9 line 11)?	Both new and old parts of the town were impacted by the flood. Palazzina d'Arbizzano, which is the area with the largest damages, is located in the oldest part of the town. Most of the damaged houses have several (up to five) floors. We added the following text: "Both new and old parts of the town were impacted by the flood. Palazzina d'Arbizzano, which is the area with the largest damages, is located in the oldest part of the town. Most of the damaged houses have several (up to five) floors."
9	7/16-17	did some people mention other protection measures than the ones that are included in Table 1?	No, people did not mention other measures. There wasn't an open question to ask about other protection measures. However we prepared the list based on interviews and discussion with local authorities and residents.
10	7/24-28	it could be easier for the reader to present the percentages in terms of increasing of decreasing level of education. Furthermore, the authors use "compulsory school" and "middle school": it is the same thing.	We realized that the information in the brackets was confusing and not relevant or necessary for the understanding of the information. Therefore, we deleted the text in brackets.
11	8/1-14	If you are able to affect the different interviewees in the three categories, it means that they are aware that there is a risk and are ready to protect themselves. Are you sure of that? Apparently not as you mention p. 9 line 14 that the majority of people are not ready to implement any protection measure.	Yes, we believe, that people are at least to some degree aware of the flood risk. The sentence at p.9 line 14 is incorrect, or at least the sentence structure is wrong. What we initially meant to say is that the majority of respondents only adopted a few of the ten measures (or plan to do so in the near future), while they would not implement any of the other measures. Thus, it was also possible to classify most of the people (124 of 146) into one of the three groups as they adopted at least one or two measures (see next paragraph). Therefore, we changed the sentence into "Overall, it is important to highlight that the majority of people indicated to have implemented just a few measures."
12	8/20	when you ask people if they consider their house to be at risk of flooding,	We are referring to the perception of the flood risk. Interviewees made that clear when asking the questions (in Italian). We

		are you referring to their perception of the risk or to objective information like maps of flood prone areas?	exchanged “considered” with “perceived” to be clearer.
13	8/31	You mention the use of regression analysis: does it mean that all the variables were transformed to quantitative values? How did you perform that for “benefits”?	As we indicated a couple of sentences above, we measured benefits with two statements that referred to an extrinsic and an intrinsic reward. It was measured on a 5-point Likert scale from completely disagree to completely agree.
14	9/14	you mention that the majority of people has not or did not plan to perform protective measures. How did you classify these people in one of the three categories?	See comment 11.
15	11/2	Have you any idea of the results of the survey if it has been conducted before the flood?	No, not really. However, one could speculate that the influence of PMT variables in each group may not have changed as experience was not found to be significant.
16	11/22	“more important influence than threat”	Done.
17	11/26-27	when you performed the survey, had people already recovered from the flood? Did some people were affected on the long term? Did they receive any compensation for the damages? Which type of communication would be required so that people remain aware of the risk of flash flooding?	We did not explicitly ask these questions, but from the interviews, it seemed that almost all people recovered completely from the flood. The majority had economic damages, but no one had to permanently leave their home. For instance, some people had 3 meters of water in their basement, but we do not know whether the basement was again completely functional at the time of the survey or not (e.g., due to mould). One interviewee was getting flood protection barriers installed by workers. Regarding the psychological impact, that’s hard to say. It was a severe event, but people did not die or were severely injured. No, people did not receive any compensation for damages at the time of the survey. We added some sentences: “Furthermore, the flood may not have been severe enough, as the damage was mostly economic, but no respondents had to be relocated. As people

			were not compensated for the damages, they may have spent their money for recovery instead of investing in future flood preparedness. Also, (fortunately) no people died or got severely injured, which may further limit the psychological impact, and thus the likelihood to engage in risk reduction behaviours.” We describe the types of communication in more detail in the second last paragraph.
18	12/17-18	the last sentence is not clear.	We understand that the explanation is not clear, and as it is only our speculation, we decided to delete the sentence.
19		Discussion: could you add some elements in the discussion explaining how general/particular are the results of your case study? You should also discuss the relevance of your methodology as you mentioned that you applied the PTT-TTM models differently than others	Based on the Reviewer’s suggestion we added a paragraph on the generalization at the end of the discussion: “Finally, the research was designed to analyse flood risk awareness in Italy, and could therefore provide insights that are relevant for promoting the adoption of risk reduction behaviours in small municipalities in the Italian Alps. However, several case and hazard-specific characteristics may hinder result generalization. For instance, hazards can be slower-onset, spatially diffuse (such as droughts) or rapid-onset, spatially localised (such as flash floods). This clearly has relevant implications for preparedness, including e.g. time availability to adopt risk reduction behaviors. Furthermore, preparedness is not only impacted by the hazard characteristics, but also by social, legal, cultural, institutional and political aspects that can strongly differ from one region/case to another. Thus, further research would be needed to explore these aspects, e.g. by applying the same PMT-TTM model for different hazards and in different countries.” In the first paragraph of the discussion, we compare the general findings with the other studies that applied PMT-TTM. We added a couple of sentences. “Our findings add to other studies in the natural hazard field (Bočkarjova et al., 2009; Gebrehiwot

			and Veen, 2015; Martin et al., 2007), in which people were grouped based on total amount of their risk reduction behaviours. However, we decided to classify people based on the quality of these behaviours and distinguished between structural, avoidance, and emergency measures. Interviews with local authorities confirmed our belief that people who have an emergency plan for their household may be motivated by different factors than people who keep expensive appliances above the expected flood levels. The motivation is again different for people who installed anti-backflow valves in their houses. Therefore, we can only compare the overall results of the few studies that applied the PMT-TTM models in the natural hazard context, and not the specific findings for each group.” Furthermore, we discuss the relevance of the model by emphasizing specific implications for risk communication strategies for different people depending on their readiness (see second last paragraph of discussion).
20	12-13	what is presently in the conclusions, should appear in the discussion and the conclusions should include the main findings of the study, not possible outcome of the study.	As suggested by the Reviewer, we moved the part with the implications to the discussion (see second last paragraph of discussion). We summarized the key findings in the conclusion. We end with the limits of our approach.