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# How awareness and confidence affect flood-risk precautionary behavior of Greek citizens: the role of perceptual and emotional mechanisms

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**Abstract**. This study examines the mechanisms of flood-risk precautionary behavior among Greek citizens. To that end, it specifies a comprehensive model in which risk perception and worry mediate the effects of awareness-raising factors and confidence attitudes on individuals' flood preparedness. Both the current preparedness and preparedness intention are assessed. Raw data were obtained via an online survey that received 1,855 responses. Findings from SEM (structural equation modeling) analysis indicate that worry mediates the effects of awareness and confidence on preparedness; risk perception is limited to the activation of preparedness intention. The results also suggest that past risk perceptions might have affected prior preparedness motivations associated with current preparedness. Interestingly, citizens who had already undertaken preparedness measures in the past appear to be more willing to invest in new measures. Implications for improving flood risk management are discussed.

*Keywords*: flood preparedness, risk perception, worry, mediation, flood risk management, Greece

## 1 Introduction

Floods are among the most costly and life-threatening weather-related hazards, causing serious concerns among societies worldwide (Barredo, 2007). Moreover, the observed increase in European flood losses is largely due to the growing exposure caused by increasing flood-prone assets (Barredo, 2009). Emphasis is therefore given to the need to address societal causes of the increasing flood risk (Treby et al., 2006). During the last two decades, flood-risk management has undergone a gradual shift, moving from the investment in costly structural measures to non-structural policies that promote the enhancement of communities' resilience to floods (Nye et al., 2011; Cardona et al., 2012; Rambonilaza et al., 2016). In this effort, public authorities and citizens share the responsibility for the consequences of flooding (Lave and Lave, 1991; Fatti and Patel, 2013). Given a basic level of protection by the managing authorities, individuals' decisions may affect their exposure to flood risk and effectively contribute to the reduction of material losses (Kron, 2005).

Individual precautionary behavior is a crucial element of a community's preparedness against flood risk. As reported by the United Nations International Strategy for Disaster Reduction (UN/ISDR, 2009), individual preparedness contributes to the effective anticipation, response and recovery from the effects of potential disasters. Therefore, a better understanding of the determinants of individual preparedness can help policy makers to improve communication and flood-risk management. Current empirical literature has shown that personal negative flood experience, trust in authorities, and risk communication locally are among the main factors that influence the level of preparedness (Bubeck et al., 2012; Kellens, et al., 2013; O'Neill et al., 2016). The role of demographic variables has also been investigated, although the results are particularly contradictory on the extent to which such factors have a significant impact on precautionary behavior (Wachinger et al., 2013).

The various predictors of individuals' preparedness can be grouped into two meaningful categories. The first category includes factors that may influence the level of citizens' awareness of flood-related issues; the second category includes factors that highlight one's confidence in the existing coping capacities. In addition to the aforementioned variables,



behavioral studies suggest that perceptual and emotional factors may also influence individual decision-making and attitude change. The perception of risk is shaped by the conceptual understanding of the expected threat (Glatron and Beck, 2008). According to protection motivation theory (PMT) introduced by Rogers (1975; 1983) in the field of psychology, if the individual does not appraise an event as severe or likely to occur, no protection motivation, and thus no behavioral change, is expected. Risk perception, therefore, is a potential driver of precautionary behavior (Bradford et al., 2012; Haer et al., 2016). In addition, prior empirical work shows that emotions, such as worry and fear of floods, are likely to trigger precautionary behavior (Miceli et al., 2008; Raaijmakers et al., 2008; Bradford et al., 2012). However, the extant literature has not yet addressed simultaneously the effects of the different awareness and confidence variables on flood-risk precautionary behavior through perceptual and emotional mechanisms. Thus, significant unmodeled relationships may have been omitted, which may result in either a partial understanding of the entire process or even misleading statistical findings.

Drawing on the above, the present study adopts an integrated approach to examine the perceptual and emotional mechanisms through which awareness-raising and confidence-related variables affect flood-risk precautionary behavior in the social context of Greece. To ensure a complete picture of precautionary behavior, both the current flood preparedness and preparedness intention are examined (Bubeck et al., 2012). To collect relevant data, we utilized an original internet-based survey targeting Greek citizens. The questionnaire was launched by the most trusted Greek meteorological site, which is also among the five most visited Greek websites of general interest. A significant number of valid responses (1,855) was received. Structural equation modeling is applied to examine the derived hypotheses.

The present study contributes to the literature in several ways. First, it informs current literature on the role of perceptual and emotional factors in explaining how awareness and confidence affect individual precautionary behavior. Second, the structure of the proposed model provides a distinctive analysis of the paths leading to the current preparedness and the preparedness intention. In this context, empirical evidence of the relationship between current preparedness and preparedness intention is provided. Finally, the study discusses practical implications for improving flood risk management in an area that has been poorly addressed.

## 2 Model specification and hypotheses

The conceptual framework of the present model has been built upon existing theories of individual attitude change, such as the initial PMT and its revised version (Rogers, 1975; 1983). The PMT introduced a model in which cognitive mediating processes facilitate fear-appeal components to stimulate behavioral change. The focus is on the cognitive appraisal of the risk rather than emotions; protection motivation is exclusively due to cognitive processes. The present research model extends alternative aspects of the mechanisms of self-protection behavior. It examines whether mechanisms that encompass both cognitive and emotional processes facilitate or discourage a person's precautionary behavior depending on the level of awareness and the confidence attitude this person has. The research model is illustrated in Figure 1 and consists of the sets of predictor (X), mediating (M), and outcome (Y) variables. Control (C) variables are also included to take into account demographic parameters associated with behavioral responses to the anticipated risk.

### 2.1 Outcomes

The outcome variables reflect the flood-risk precautionary behaviors, namely, current preparedness (Y1) and preparedness intention (Y2). Current preparedness reflects the extent to which people have taken precautionary measures (Miceli et al., 2008), while the preparedness intention measures the willingness of people to make private expenses to protect themselves against future floods. Hence, preparedness intention shows not only the general intention of the individual to change precautionary behavior but also the extent to which the individual is willing to realize the self-reported intention (Terpstra, 2011).



## 2.2 Predictors

### 2.2.1 Experience severity (X1)

Flood experience has been related to precautionary behavior (Whitmarsh, 2008; Bradford et al., 2012). Analysis of the feelings emerging from flood experience show that negative emotions may be a key factor in explaining decision-making and higher degrees of preparedness (Keller et al., 2006). The experience of low severity events may even have a negative effect on precautionary behavior, due to overestimation of individual coping capacity (Wachinger et al., 2013). The present model includes an indicator of the flood damage severity suffered by the citizens, which is considered to be a powerful awareness-raising factor due to its experiential nature.

### 2.2.2 Vulnerability awareness (X2)

Vulnerability to floods has been treated either as an objective predictive parameter relevant to the hazard proximity or as the result of flood experience (O'Neill et al., 2016). In the present study, to better simulate the actual awareness of personal vulnerability to flood hazard, a combination of exposure aspects of vulnerability is applied (Terti et al., 2015).

### 2.2.3 Risk communication (X3)

Risk communication may motivate people to prevent damage (Grothmann and Reusswig, 2006). In the present study, the level of knowledge on the existing threats due to the information disseminated from loxal authorities is assessed.

### 2.2.4 Trust in authorities (X4)

Feelings of trust in authorities have been found to discourage precautionary behavior (Terpstra, 2011) and to promote passive behavior (Poussin et al., 2014). Wachinger et al. (2013) argued that the lack of trust is likely to activate people who believe there is no other choice. Drawing on the above, the present model considers both trust and lack of trust in local authorities, combined in one indicator of the citizen's trust in authorities.

### 2.2.5 Self-confidence (X5)

Indicators of coping appraisal or self-efficacy have been used as predictors of preparedness intention; however, the results are contradictory, particularly with respect to the effect of resource-related attributes (Reusswig, 2006; Bubeck et al., 2012; Grothmann and Terpstra and Lindell, 2013). The present model introduces an indicator of the respondent's self-reported awareness of local hazards and protection measures.

## 2.3 Mediators

### 2.3.1 Risk perception (M1)

According to the 'motivational hypothesis' (Weinstein et al., 1998), perception of high personal risk is assumed to motivate people to adopt precautionary behavior. Risk perception has been associated with precautionary behavior to cope with flood risk (Grothmann and Reusswig, 2006; Botzen et al., 2009). Bradford et al. (2012) suggested that increasing risk perception on its own would not necessarily result in increased preparedness. For example, flood risk may be differently perceived as a result of the level of human exposure to floods (Kellens et al., 2013). Kreibich and Thieken (2008) found a positive correlation between risk perception and the adoption of precautionary measures among people who were affected by a recent flood event in their area. In addition, the level of information obtained may influence risk perception, especially when there is a lack of personal flood experience (Wachinger et al., 2013). A person without flood experience may underestimate danger (Ruin et al., 2007). Additionally, feelings of security may be associated with reduced risk perception (Wachinger et al., 2013; Poussin et al., 2014). Thus, the following hypotheses are developed:



Hypothesis 1. Risk perception (M1) mediates the effects of the predictor variables on current preparedness (Y1).
Hypothesis 2. Risk perception (M1) mediates the effects of the predictor variables on preparedness intention (Y2).

#### 2.3.2 Worry (M2)

With respect to the emotions, recent studies have shown that worry and fear of floods may affect individual preparedness behavior (Miceli et al., 2008; Zaleskiewicz et al., 2002). In addition, both the prior experience of flooding and the distance to the perceived flood zone have been associated with negative emotions (O'Neill et al., 2016). We therefore developed the following hypotheses:
Hypothesis 3. Worry (M2) mediates the effects of the predictor variables on current preparedness (Y1).
Hypothesis 4. Worry (M2) mediates the effects of the predictor variables on preparedness intention (Y2).

### 2.4 Current preparedness and preparedness intention

The existing literature has pointed out the need to examine whether the existing individual flood preparedness at the time of the behavioral survey relates to the intention of the individual to take precautions (Bubeck et al., 2012, Poussin et al., 2014). To our knowledge, however, no concrete empirical evidence exists regarding the direction and significance of this relationship. While it seems likely that the existence of protective measures will make further precautionary behavior less necessary, it is equally likely that the proven effectiveness of measures already in place will enhance precautionary behavior. Thus, we cannot a priori specify the relationship between Y1 and Y2 in our model. Instead, we expect that there is a significant relationship and, thus, the following hypothesis is tested:
Hypothesis 5. Current preparedness (Y1) is associated with preparedness intention (Y2).

### 2.5 Controls

The preparedness model includes control variables to account for the demographic attributes that previous research has identified as potential antecedents of individual precautionary behavior. However, literature has not reached to a consensus on the effects of demographics (for a thorough review see Kellens et al., 2011), which are occasionally found to have only a marginal effect on preparedness (Terpstra and Lindell, 2013; Wachinger et al., 2013). The majority of homeowners were found to be more worried and better prepared; employment and income were associated with preparedness intention; and people that live in a less urbanized area appeared to perceive higher flood risk (Scolobig et al., 2012).

## 3 Method

### 3.1 Data collection

Greek citizens were approached via an online questionnaire launched by the www.meteo.gr website, which provides weather, wave, lightning, and dust forecasts produced by the weather forecasting group at the Institute for Environmental Research, National Observatory of Athens (IERSD/NOA) (Lagouvardos et al., 2003; Lagouvardos et al., 2017). This website is the most trusted Greek meteorological website and among the five most visited websites of general interest in Greece. The average number of daily unique visitors of the website exceeds 350,000. Surveys related to weather hazards are systematically posted with a very strong public response. The research findings of these surveys are then posted on the website to raise public awareness and to promote the benefits of taking part in surveys.

Our questionnaire was posted on 23 October 2016 and received 1,855 valid responses within a 5-day period. It contained 41 questions and aimed to examine preparedness in the country through the perspective of citizens and investigate drivers of preparedness before a flood hazard or following a flood disaster. It was structured in the following order: Section A. Flood experience; Section B. Perceived risk and concern about predefined flood-related hazards and feelings of worry; Section C.



Precautionary measures taken and intention to invest in such measures; Section D. Means of risk communication, information sources, confidence attitudes, and perceived causes of flood occurrence; and Section E. Settlement type, exposure attributes, and demographics. The full questionnaire is available upon request.

### 3.2 Sample profile

Table 1 provides the demographic characteristics of the respondents. Sixty eight percent of the respondents were males. Their ages ranged from 15 to 86 years. Compared to the last national census in 2011, the middle age category (31-60 years old) is overrepresented in the sample (74% compared to the 43% in the census), while older people (61-86 years old) are underrepresented (6% compared to the 23% in the census). These percentages probably reflect the low use of internet by older people. Since prior studies largely question the effect of age and gender on precautionary behavior, the difference from the census data does not raise concerns about the reliability of the model (Wachinger et al., 2013). In contrast, rates of home ownership (79%) and unemployment (14%), which are parameters that have been associated with precautionary behavior (Burningham et al., 2008), are representative of the census data. Twenty percent (n=370) of the survey population had been affected by floods. The majority of the affected respondents (67%) lived in urban areas of the country.

Figure 2 contains information on the spatial and temporal distribution of the flood events recorded in the survey. Figure 2a shows the flood distribution of the questionnaire in the 51 prefectures of Greece in relation to the distribution of the total damaging floods recorded in the high-impact weather event database (HIWE) developed by the Institute for Environmental Research and Sustainable Development of the National Observatory of Athens - IERSD/NOA (Papagiannaki et al., 2013). The HIWE database is available online and is constantly updated to include the latest events (NOA, 2018). Both distributions correspond to the period of 2000-2016, for which HIWE provides a complete flood inventory. The largest proportion of floods in both distributions is attributed to the prefecture of Attica, which is the most densely populated and urbanized area in the country. Moreover, a statistically significant and positive correlation was estimated for the two distributions (Spearman's rho=0.50, $p < .001$). The estimated correlation shows a good representation of the country flood profile, thus enhancing the validity of the questionnaire responses and the reliability of the model analysis. Figure 2b shows the annual distribution of the survey flood record. One quarter of the experiences were related to floods that occurred during the most recent year (2016); however, the events reported cover a long period of time, which shows that the interest of the survey participants was not only driven by a very recent flood experience.

To assess the objectivity of the respondents about flood experience severity, the reported flood events were identified and evaluated based on the HIWE database. Each recorded flood was then attributed to the maximum 24 h rainfall observed in the corresponding municipality where the flood event occurred. This was feasible for 281 (76%) out of the 370 reported flood events. The correlation between the 24 h rain and the flood severity was positive and statistically significant (Spearman's rho=0.21, $p < .001$). This indicates that people more adversely affected by floods in their residential area were more likely to report a stronger flood impact. Thus, there is consistency between the rainfall hazard and the reported impact severity.

### 3.3 Measures

A detailed description of all variables used in the empirical analysis, including the associated items we used to construct them, is available in Table A1 of the Appendix A.

#### 3.3.1 Outcomes

Various indicators have been used in recent literature to measure individual preparedness across different regions, namely, the extent to which households implement flood damage mitigation measures (Bradford et al., 2012; O'Sullivan et al., 2012; Poussin et al., 2014; O'Neill et al., 2016) or intend to prepare (Brilly and Polic, 2005; Terpstra, 2011; Bubeck et al., 2012). In



the present study, the current preparedness was measured as the sum of the items related to various preventive measures, weighted for their significance in relation to the relative personal time and the cost required for their implementation. Preparedness intention was measured by a question concerning the intention of the respondent to invest in precautionary measures.

#### 3.3.2 Predictors

Experience severity was measured by a question about the severity of the damage suffered by the respondent from flooding. Vulnerability awareness results from the synthesis of two elements related to a) the level of perceived exposure and b) actual exposure, meaning the hazard proximity (the distance from the closest hazardous water source). The indicator of risk communication is a synthesis of six items about the means of risk communication used by local authorities to approach and inform the citizens. The risk communication means are weighted to take into account the extent to which communication is effectively performed. In particular, it was considered that seminars on local dangers requiring the physical presence of the citizen and visualization of risks with maps and special warning signs are more effective means of communication. Alternative weights were also tested on the basis of different estimates made by colleagues with relevant experience without affecting the results of the analysis.

Trust in authorities was measured by two questions that assess the individual's opinion about the adequacy of the preventive measures taken by local authorities and about the authorities' inability to cope with floods in the past. Self-confidence was measured as the average of two discrete questions about the respondent's perception of being aware of the local flood hazards and the existing protection measures.

#### 3.3.3 Mediators

Risk perception has been defined as the subjective assessment of the likelihood of occurrence of a particular type of accident and of the severity of the potential consequences (Sjöberg et al., 2004). Miceli et al. (2008) suggested combining these two elements of risk perception into an overall, more comprehensive indicator. Following this concept, a single variable was included in the preparedness model. The reliability of the risk perception indicator is high (Cronbach's alpha=.88) according to recommended thresholds (Tavakol and Dennick, 2011). Worry was measured by a question about how concerned the respondent feels about a possible future flood event.

#### 3.3.4 Controls.

The demographic variables under consideration are home ownership, gender, family size, employment status, age, and urbanization. To measure the degree of urbanization, the participants were asked to characterize their settlement based upon urbanization criteria (cottage area, village, small town or city).

### 3.4 Statistical method

Path analysis, a structural equation modeling (SEM) methodology (Hayes, 2013), was applied to test the preparedness model hypotheses. The use of SEM allows for a simultaneous evaluation of the relationships in a hypothesized mediation process, the direct effect of the predictor variable on the outcome, and the indirect (mediating) effect explaining how an exogenous variable affects the outcome variable through the mediator (Iacobucci, 2010). SEM produces parameters that indicate the nature and size of the relationship between the model variables, and information about the overall fit of the model. To address possible interdependence that could bias the path analysis results, the specification model assumes covariance between the two outcome variables (Y1 and Y2). The Stata statistical software was used for all data analysis.

Note that the main specification does not include the age variable due to many missing values (34% of the population sample). The rest of the variables had a very low number of missing values, up to 3% of the population sample. In



unreported analysis, we included age as control variable (n=1,227); age had only a marginal positive effect on current preparedness, while the effect on preparedness intention was statistically insignificant. The results remained qualitatively the same.

Table 2 presents descriptive statistics and correlations between the variables. We employed the non-parametric Spearman's rank correlation method, which does not assume normality of data and is appropriate for correlating both continuous and discrete variables (McDonald, 2014; Shipley, 2016). None of the correlations is high enough (Spearman's rho < 0.40) to raise any concerns for the subsequent analysis (Gujarati, 2004).

## 4 Results

Table 3 includes the path analysis results. To assess the model validity, we report multiple fit indices (Marsh et al., 2004; Iacobucci, 2010). The comparative fit index (CFI) was above the threshold of 0.9 and both the standardized root mean square residual (SRMR) and the root mean square error of approximation (RMSEA) fit indices were below the threshold of 0.10. These results indicate a very good fit of the data (Hu and Bentler, 1999; Iacobucci, 2010).

To facilitate interpretation of the path analysis results, Figure 3 shows the direct and indirect effects (standardized coefficients) of the predictor variables on the current preparedness (Fig. 3a) and the preparedness intention (Fig. 3b). The overall indirect effect is divided into the mediated effects attributed to risk perception and worry. The sum of the direct and the indirect effect equals the total effect of the predictor on the outcome variable. The results suggest that risk perception does not mediate the effects of the awareness-raising and confidence variables on current preparedness. Hypothesis 1 therefore is not confirmed. Risk perception mediates the effects of three predictor variables, namely, experience severity, vulnerability awareness and trust in authorities, on preparedness intention. Hypothesis 2 therefore is partly confirmed.

With regard to the role of emotion, the results indicate that worry mediates the effects of experience severity on both the current preparedness and preparedness intention. Worry was also found to fully mediate (i.e., no direct effect of the predictor on the outcome was found) the effect of vulnerability awareness on current preparedness and the largest part of the mediated effect on preparedness intention (as indicated previously vulnerability awareness is also mediated by risk perception). The effect of risk communication on preparedness intention was fully mediated by the feelings of worry. In contrast, risk communication appeared to have only a direct effect on current preparedness without the interference of emotional process. As expected, worry was found to mediate the effect that trust in authorities has on precautionary behavior. The effect was negative on both the current preparedness and preparedness intention. Moreover, the effect of trust in authorities on preparedness intention was fully mediated by the emotional process. Finally, worry was not found to mediate any of the effects of self-confidence on the preparedness variables. The above findings provide partly support to Hypotheses 3 and 4.

Path analysis detected a positive covariance between current preparedness (Y1) and preparedness intention (Y2) (Table 3). Moreover, the Spearman's rank correlation analysis showed a positive and significant correlation between Y1 and Y2 (Table 2). Further correlation analyses also indicated the strong relationship between Y1 and Y2 among citizens with prior flood experience. Specifically, the Spearman's rho between Y1 and Y2 was 0.40 ($p < .001$) for the population sample with flood experience and 0.44 ($p < .001$) if the experience severity was over 3 (in a scale from 0 to 5). To examine Hypothesis 5, according to which Y1 relates to Y2, we assessed the correlations between Y2 and each of the items that consist Y1 (Table A1, Y1i items). The Spearman's rho varied from 0.11 to 0.27 ($p < .001$) if the precautionary measure referred to investing money for simple flood-defense measures, for insurance, or for structural changes. The correlations were also positive when accounting for the application of non-costly measures (from 0.13 to 0.23, $p < .001$). In contrast, the correlations between Y2 and the 'no adaptation' items (Table A1, items Y11,2) were negative (from -0.14 to -0.21, $p < .001$). Based on the above findings, Hypothesis 5 is confirmed.



Overall, the control variables performed as expected. They were found to be related to preparedness, as presumed, except for gender. Home ownership had the largest effect, particularly on the current preparedness, which indicates that people owning a home are more likely to be already prepared to a certain extent. Family size and employment were also associated with increased preparedness. Higher urbanization, on the other hand, was related to reduced preparedness, in line with the results of Scolobig et al. (2012).

## 5 Discussion

### 5.1 Theoretical implications

The aim of this study was to advance understanding of the mechanisms that link awareness-raising and confidence-related variables with current flood preparedness and with preparedness intention. Hence, the findings may help researchers to build more comprehensive models that would better predict flood-risk precautionary behavior.

Overall, the results demonstrate that risk perception and worry are significant mechanisms of precautionary behavior. Both perceptual and emotional processes appear to trigger preparedness intention in the presence of an environment that increases citizens' awareness of flood-related issues and decreases confidence on the authorities' coping capacities to protect them against floods (Wachinger et al., 2013). The severity of a prior flood experience and how it relates to precautionary behavior is also associated with the stimulation of flood risk perception and feelings of worry. With regard to worry, the finding is in line with Siegrist and Gutscher (2008), who suggested that flood victims might have taken more precautionary measures than citizens without flood experience, due to negative emotions.

The only variable not filtered by either risk perception or emotion is self-confidence, which appears to have only direct effects on precautionary behavior. The more confident a person feels about knowing the local flood hazards and the available protective measures, the higher the level of current preparedness and the intention to adopt precautionary behavior. In contrast, higher trust in authorities is shown to relate to decreased worry, in line with Terpstra's findings (2011), as well as to decreased flood risk perception. Trust brings security feelings and thus may be an important cause of the reluctance of citizens to take precautionary measures (Poussin et al., 2014).

The emotional mediating process is stronger when compared to the perceptual one. The majority of the preparedness predictors are stimulated by the feelings of worry for a flood event. Risk perception at the time of the survey is associated only with preparedness intention. Thus, risk perception does not answer why awareness and confidence have triggered the existing level of preparedness. However, it is likely that past risk perceptions might have affected prior preparedness motivations, associated with what we call 'current preparedness'. Prior experiences and a broad framework of past references might have influenced the perception of risk over time. A possible time-dependent relationship between risk perception and precautionary behavior could partly be the answer to the concerns raised about the paradox that high risk perception does not necessarily lead to higher preparedness or that it may even lead to lower preparedness (Siegrist and Gutscher, 2008; Wachinger et al., 2013). A longitudinal study could therefore provide more evidence on the impact of risk perception on individual precautionary behavior.

An interesting finding of the study is the positive correlation of current preparedness and preparedness intention that may seem paradoxical at first glance. Why do citizens that are currently more prepared appear to be more willing to invest in future precautionary measures? On the basis of further analyses discussed in the previous section, we argue that people may acknowledge the benefits of precautionary measures previously implemented. Furthermore, citizens who are already well informed and familiar with implementing measures probably feel more willing to repeat this behavior. We should also take into account that flood precaution is not a one-off action. Precautionary measures may need refreshment over time. The correlation results also indicate that people evaluate the final benefit independent of the resources needed for a protection measure. According to the review of behavioral theories on disaster and emergency health preparedness by Ejeta, Ardalan



and Paton (2015), there is evidence that resource-related attributes are even negatively associated with preparedness intentions.

We also acknowledge that there may be uncertainty regarding the actual behavior that will follow one's intention to adopt precautionary behavior (Schifter and Ajzen, 1985). That is, people may declare willingness simply because they know that is the right thing to do. However, the online survey has the advantage that it protects respondent anonymity, while it removes the presence of the judge-researcher. Hence, it allows for objective rather than 'satisfactory' answers and reduces potential social desirability bias (Podsakoff at el., 2003). Nevertheless, the concluding remark is that the relationship between the two preparedness variables is not straightforward. Variables that could intervene in this relationship might be the self-estimated effectiveness of the previously applied measures, the usefulness of each of these measures based on previous flood experience, and the assessment of the cost-saving the individual achieved. In addition, further questions to evaluate the 'actual' intention of the respondent could be included in a future survey.

We should note that results about the mediating emotional and perceptual processes that lead to preparedness cannot easily be compared to previous findings, as the recent literature has focused on the direct relationships between the factors relating to individual precautionary behaviors. However, our empirical findings support the theoretical argumentation about the regulating role of emotions in the relationship between the individual and the environment (Miceli et al., 2008). The role of emotion has been treated with caution in the PMT. Rogers (1975) supported that the cognitive processes may better explain the effects of fear-appeal components on attitude change. Our findings show that risk perception, as a cognitive process, may indeed stimulate the intention of the individual to adopt flood precautionary behavior.

### 5.2 Practical implications

Results show a poor performance of the current preparedness and a modest performance of the preparedness intention. Individual preparedness among the flood-affected respondents is higher, but again the average performance is marginally close to the average level, which is 5 for the current preparedness (max=12) and 2 for the preparedness intention (max=4). This indicates that there is significant potential for improvement of the overall preparedness of citizens, with support from the local authorities.

Moreover, the profile of the survey participants shows that Greek people tend to perceive low risk from flooding but not due to ignorance. In fact, the path analysis does not demonstrate an association between risk communication and risk perception. As Brown (2014) points out, risk perception draws on much more than facts alone. Indeed, the results show that risk perception is also associated with trust in authorities and vulnerability awareness.

Collective findings from the present study could inform policy makers on specific options that they could support to improve flood-risk management at the local level. These options are related both to raising public awareness and to establishing the right relationship between citizens and local authorities. As the results show, the effectiveness of these options will be significantly affected by the individual perception and emotions against flood risk. A successful campaign thus should involve the promotion of information that clearly shows the vulnerability of citizens on the basis of objective risks and past flood incidents. This strategy will lead to increased awareness and activation of citizens due to increased concern and flood risk perception.

Investment in the effective communication of local flood hazards and risks should be local authorities' priority. The analysis of the survey participants' profiles shows that Greek citizens are not effectively approached by flood-risk managers; the vast majority of citizens never received any information about local flood hazards from the local authorities. This indicates a noticeable gap in the risk communication process or a highly inefficient top-down risk management. Both cases may constitute significant weaknesses of Greek communities' resilience to floods. The high frequency of catastrophic flood events due to rainfall has already been demonstrated in a previous study targeting Greece (Papagiannaki et al., 2013). In addition, recent studies of the individual flood emergency responses in Attica found a low degree of individual response to



flood alerts, limited knowledge of flood risks and ineffectiveness of risk communication as well as low trust in authorities (Diakakis et al., 2017; Papagiannaki et al, 2017).

According to the survey results, people in more urbanized areas are manifesting higher trust in authorities and lower vulnerability awareness. Moreover, the urban environment is associated with reduced flood precautionary behavior. These findings indicate a high dependency of urban citizens on local authorities, which in turn may conceal complacency against flood risk. Therefore, policy makers should clearly reach the public audience with the message that building resilience against flood risk at the community level needs the involvement of the citizens.

## 6 Conclusions

This study examined the hypotheses that risk perception and worry mediate the effects of awareness-raising and confidence-related variables on individual precautionary behavior against flood risk. The methodological approach meant to integrate key-explanatory variables within a model that focused on important mechanisms of self-protective behavior. In this context, we further analyzed the association between the current flood preparedness and preparedness intention to provide an overview of behavior modifications.

According to the results, both risk perception and worry constitute mechanisms of the individual's flood-risk precautionary behavior. Worry was demonstrated to stimulate both the current preparedness and preparedness intention. On the other hand, risk perception was only found to lead to preparedness intention. Interestingly, current preparedness and preparedness intention were found to have a positive relationship. Citizens who have undertaken preparedness measures in the past appear to be more willing to invest in new measures, probably motivated by the benefits they gained from the efforts to protect themselves in the past.

The present study extends current knowledge of the drivers of citizens' flood precautionary behavior. The research findings could help researchers to build more comprehensive models of flood-risk precautionary behavior; they could also become useful material for the local authorities. Flood-risk managers could identify possible gaps in risk communication, advance their understanding of citizens' precautionary behaviors, and adjust their strategies to improve flood resilience.

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**Appendix A**

Table A1. Variable description and synthesis

| Variable | Items involved | Description |
|---|---|---|
| Predictors | | |
| Awareness-raising | | |
| Experience severity (X1) | 1 item, to measure the level of the impact suffered by the respondent | Ordinal: 0 "no flood impact" to 5 "high flood impact" |
| Vulnerability awareness (X2) | Ratio of 2 items ($X2_i$): 'perceived exposure' to 'actual exposure' | Ordinal: 0.5 "low awareness" to 3 "high awareness" |
| | $X2_1$'Perceived exposure': Do you think you are more threatened due to residing in a flood-prone area? | Ordinal: 1 "no", 2 "maybe", 3 "yes" |
| | $X2_2$ 'actual exposure': Distance of residence from the nearest water source (river, stream, canal, lake). | Ordinal: 1 ">1 km", 2 "<1 km" |
| Risk communication (X3) | Sum of 6 dichotomous items ($X3_i$) weighted for immediacy in communication: | Ordinal: 0 "no risk communication" to 8 "very high risk communication" |
| | X3=0*[ $X3_1$, no communication] + 1*[ $X3_2$,media + $X3_3$, leaflets] + 2*[ $X3_4$,panels + $X3_5$,risk maps + $X3_6$, seminars] | |
| Confidence attitudes | | |
| Trust in authorities (X4) | Average of 2 items ($X4_i$). (The items follow a Likert scale, 0 - 4): | Ordinal: 0 "no trust" to 4 "high trust" |
| | $X4_1$. How adequate do you think the local authorities' measures taken to strengthen your area against future heavy rainfall/floods are? | |
| | $X4_2$ (reversed). How much do you think inefficient state measures have contributed to floods in your area? | |
| Self-confidence (X5) | Average of 2 items ($X5_i$). (The items follow a Likert scale, 0 - 4): | Ordinal: 0 "lack of knowledge" to 4 "substantial knowledge" |
| | $X5_1$. How well do you know the flood risks in your area? | |



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| Variable | Items involved | Description |
|---|---|---|
| | $X5_2$. How well do you know the protective measures and strategies implemented by local authorities in your area? | |
| | | |
| Mediators | | |
| Risk perception (M1) | M1=Σi(Prob(i)*Severity(i))/Σi, where i=5 items evaluated by the respondent: a) for impact occurrence probability, Prob(i), and b) for the consequent severity, Severity(i). (The items follow a Likert scale, 0 - 4):<br><br>i=1. Power/water cut-offs<br><br>i=2. Transportation problems<br><br>i=3. Serious damage to properties (e.g., vehicle, outside space/surface of residence)<br><br>i=4. Residence partly/completely destroyed<br><br>i=5. Injuries/loss of family and friends | Continuous: Level of risk perception (0-16) |
| Worry (M2) | 1 item, to measure the level of worry for a future flood event. | Ordinal: 0 “not at all worried” to 4 “extremely worried” |
| Outcomes | | |
| Current preparedness (Y1) | Sum of 8 dichotomous items ($Y1_i$), weighted for their significance in terms of required time and cost:<br><br>0*[2 items for no adaptation]:<br>$Y1_1$: none of the measures was adopted; the state has implemented appropriate protective measures<br>$Y1_2$: it was not necessary<br><br>1*[2 items for basic preparedness]: $Y1_3$: obtained information for risks and protective measures | Continuous: Level of current preparedness (0-12) |



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| Variable | Items involved | Description |
|---|---|---|
| | $Y1_4$: family plan for emergency<br>2*[2 items for flood avoidance measures]:<br>$Y1_5$:storm drains and spouts cleaned<br>$Y1_6$: power pump, generator or sandbags stored<br>3*[2 items for advanced measures]: $Y1_7$: private insurance for natural hazards<br>$Y1_8$: construction or other changes in residence | |
| Preparedness intention (Y2) | 1 item, to measure the intention to invest in precautionary measures | Ordinal: 0 “no intention” to 4 “high intention” |
| Control variables | | |
| Ownership (C1) | | Dummy: 1=ownership |
| Gender (C2) | | Categorical: 1 "female", 2 "male" |
| Family size (C3) | | Ordinal: 1 "1 member", 2 "2 members", 3 "3 members", 4 "4 members", 5 "more than 4 members" |
| Employment (C4) | | Ordinal: 1 "unemployed", 2"student", 3 "homemaker", 4"retired", 5 "employed" |
| Urbanization (C5) | 1 item, to specify the settlement’s degree of urbanization | Ordinal: 1 "cottage", 2 "village", 3 "small town", 4 "city" |
| Age (C6) | | Continuous |



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Table 1. Demographic characteristics of the survey sample

| Demographic characteristics | Percentage (rounded off values) |
|---|---|
| Gender | |
| Female | 32 |
| Male | 68 |
| Age | |
| 15 - 30 | 20 |
| 31 - 60 | 74 |
| > 60 | 6 |
| Employment | |
| Employed | 72 |
| Retired | 10 |
| Homemaker | 1 |
| Student | 4 |
| Unemployed | 14 |
| Family size | |
| 1 member | 8 |
| 2 members | 18 |
| 3 members | 25 |
| 4 members | 38 |
| > 4 members | 11 |
| Ownership | |
| Home ownership | 79 |
| Rent | 21 |

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Table 2. Descriptive statistics and correlations (Spearman's rank coefficient (rho))

| Variable | Y1 | Y2 | M1 | M2 | X1 | X2 | X3 | X4 | X5 | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Y1 | | | | | | | | | | | | | | | |
| Y2 | 0.36*** | | | | | | | | | | | | | | |
| M1 | 0.07** | 0.24*** | | | | | | | | | | | | | |
| M2 | 0.16*** | 0.34*** | 0.51*** | | | | | | | | | | | | |
| X1 | 0.21*** | 0.08*** | 0.08*** | 0.22*** | | | | | | | | | | | |
| X2 | + | + | 0.17*** | 0.17*** | 0.07** | | | | | | | | | | |
| X3 | 0.09*** | 0.08** | + | + | 0.05* | + | | | | | | | | | |
| X4 | -0.12*** | + | -0.25*** | -0.17*** | -0.07** | -0.13*** | 0.23*** | | | | | | | | |
| X5 | 0.21*** | 0.14*** | -0.07** | + | + | -0.06* | 0.32*** | 0.19*** | | | | | | | |
| C1 | 0.18*** | 0.10*** | + | 0.05* | 0.06** | + | -0.05* | + | + | | | | | | |
| C2 | 0.06** | + | -0.13*** | -0.10*** | + | -0.05* | 0.06* | + | 0.12*** | + | | | | | |
| C3 | 0.09*** | 0.07** | + | 0.05* | + | + | + | + | + | 0.18*** | 0.05* | | | | |
| C4 | 0.05* | 0.07** | + | + | + | + | + | + | + | + | 0.05* | + | | | |
| C5 | -0.13*** | -0.09*** | -0.06** | + | -0.10*** | 0.06** | + | 0.06* | + | -0.12*** | -0.05* | -0.07** | + | | |
| C6 | 0.18*** | 0.09** | + | 0.18*** | 0.11*** | -0.06* | -0.10*** | + | 0.06* | 0.19*** | -0.07* | + | 0.08** | + | |
| max 24 h rain | | | | | 0.21*** | | | | | | | | | | |
| year of most recent flood experience | | | | | | | | | | | | | | | |
| | + | + | + | 0.18*** | -0.12* | 0.16** | + | -0.10* | + | | | | | | |
| Mean | 3.87 | 1.85 | 5.37 | 2.18 | 0.59 | 1.10 | 0.39 | 1.09 | 1.51 | 0.79 | 1.68 | 3.28 | 1.76 | 3.58 | 42.1 |
| Std. Dev. | 2.70 | 1.14 | 3.65 | 1.17 | 1.30 | 0.58 | 0.93 | 0.83 | 1.10 | 0.41 | 0.47 | 1.11 | 1.42 | 0.78 | 12.2 |
| Min | 0 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 15 |
| Max | 12 | 4 | 16 | 4 | 5 | 3 | 8 | 4 | 4 | 1 | 2 | 5 | 5 | 4 | 86 |

Y1:current preparedness, Y2:preparedness intention, M1:risk perception, M2:worry, X1:experience severity, X2:vulnerability awareness, X3:risk communication, X4:trust in authorities, X5:self-confidence, C1:ownership, C2:gender, C3:family size, C4:employment, C5:urbanization, C6:age

*Note.* The sample size ($n$) in the correlations between pairs of variables is 1,810, except for the correlations with 'age' ($n$=1,227), 'year of most recent flood experience' ($n$=368), and 'max 24 h rain' ($n$=281). The 'max 24 h rain' is the maximum 24 h rain accumulated during the flood events reported by the survey respondents. Statistical significance, $p$ value, is symbolized as: +$p$ > .05 (not significant), *$p$≤ .05, **$p$< .01, ***$p$< .001.



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Table 3. Path analysis results

| Variables | SEM parameters | | SEM parameters |
|---|---|---|---|
| Indirect effects | | | |
| Mediated by risk perception | | Mediated by worry | |
| X1→M1→Y1 | + | X1→M2→Y1 | 0.04(0.01)*** |
| X2→M1→Y1 | + | X2→M2→Y1 | 0.06(0.02)*** |
| X3→M1→Y1 | + | X3→M2→Y1 | + |
| X4→M1→Y1 | + | X4→M2→Y1 | -0.05(0.01)*** |
| X5→M1→Y1 | + | X5→M2→Y1 | + |
| X1→M1→Y2 | 0.01(0.00)** | X1→M2→Y2 | 0.05(0.01)*** |
| X2→M1→Y2 | 0.02(0.01)** | X2→M2→Y2 | 0.08(0.01)*** |
| X3→M1→Y2 | + | X3→M2→Y2 | 0.02(0.01)* |
| X4→M1→Y2 | -0.03(0.01)*** | X4→M2→Y2 | -0.06(0.01)*** |
| X5→M1→Y2 | + | X5→M2→Y2 | + |
| Direct effects | | | |
| on current preparedness | | on preparedness intention | |
| X1→Y1 | 0.29(0.05)*** | X1→Y2 | + |
| X2→Y1 | + | X2→Y2 | + |
| X3→Y1 | 0.18(0.07)** | X3→Y2 | + |
| X4→Y1 | -0.50(0.07)*** | X4→Y2 | + |
| X5→Y1 | 0.52(0.06)*** | X5→Y2 | 0.13(0.02)*** |
| M1→Y1 | + | M1→Y2 | 0.03(0.01)*** |
| M2→Y1 | 0.22(0.06)*** | M2→Y2 | 0.27(0.03)*** |
| C1→Y1 | 0.94(0.15)*** | C1→Y2 | 0.19(0.06)** |
| C2→Y1 | + | C2→Y2 | + |
| C3→Y1 | 0.13(0.05)* | C3→Y2 | 0.05(0.02)* |
| C4→Y1 | 0.15(0.04)*** | C4→Y2 | 0.06(0.02)*** |
| C5→Y1 | -0.28(0.08)*** | C5→Y2 | -0.09(0.03)** |
| Direct effects | | | |
| on risk perception | | on worry | |
| X1→M1 | 0.27(0.06)*** | X1→M2 | 0.19(0.02)*** |
| X2→M1 | 0.74(0.15)*** | X2→M2 | 0.29(0.05)*** |
| X3→M1 | + | X3→M2 | 0.07(0.03)* |
| X4→M1 | -1.00(0.10)*** | X4→M2 | -0.21(0.03)*** |



| Variables | SEM parameters | | SEM parameters |
|---|---|---|---|
| X5→M1 | + | X5→M2 | + |
| Covariance Y1-Y2 | 0.29(0.02)*** | | |
| *Observations* (*n*) | 1,810 | | |
| Fit statistics | | | |
| *Chi-square* | 53.96 | *CFI* | 0.97 |
| *d.f.* | 10 | *SRMR* | 0.02 |
| *p* | 0.00 | *RMSEA* | 0.05 |
| *cd* | 0.28 | | |

*Symbols*: Y1=current preparedness, Y2=preparedness intention, M1=risk perception, M2=worry, X1=experience severity, X2=vulnerability awareness, X3=risk communication, X4=trust in authorities, X5=self-confidence, C1=ownership, C2=gender, C3=family size, C4=employment, C5=urbanization

*Note*. Statistical significance, *p* value, is symbolized as: +*p* > .05 (not significant), **p*≤ .05, ***p*< .01, ****p*< .001. The parameter estimates are standardized coefficients with standard errors in parentheses.

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Figure Titles

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Figure 2. (a) Distributions of the HIWE flood record (NOA, 2018; Papagiannaki et al., 2013) and the survey flood reports by prefecture (2000-2016). (b) Annual distribution of the survey flood reports (1955-2016).

Figure 3. Effects (path analysis, stand. coefficients) of the model's predictor variables on a) the current preparedness and b) the preparedness intention. Each total effect is further analyzed into direct effect and indirect effects mediated by risk perception and worry.

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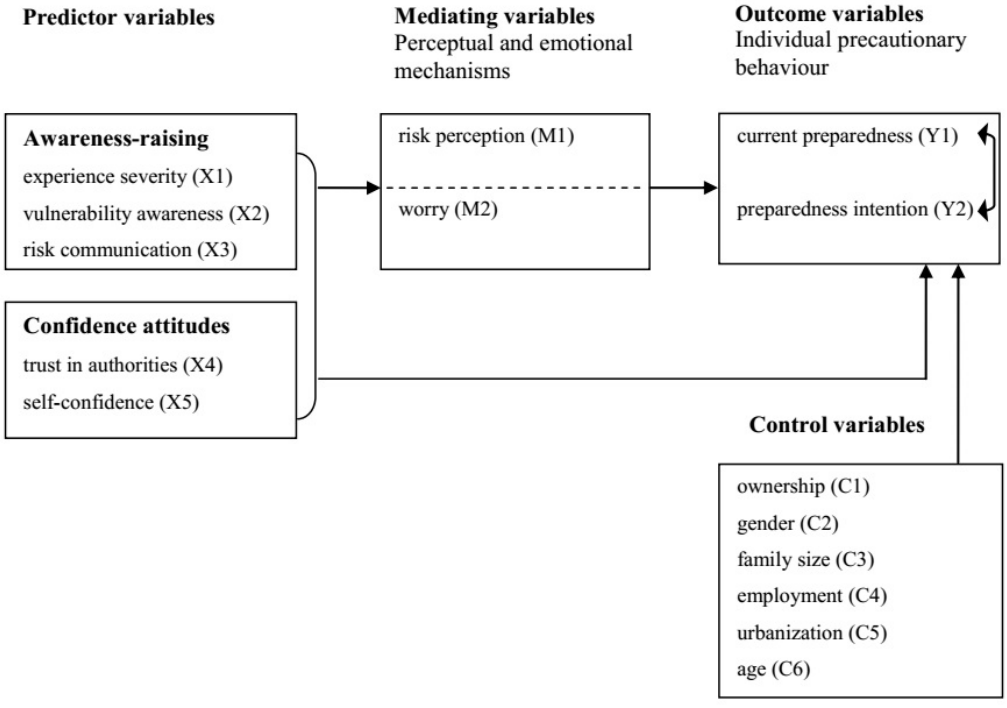


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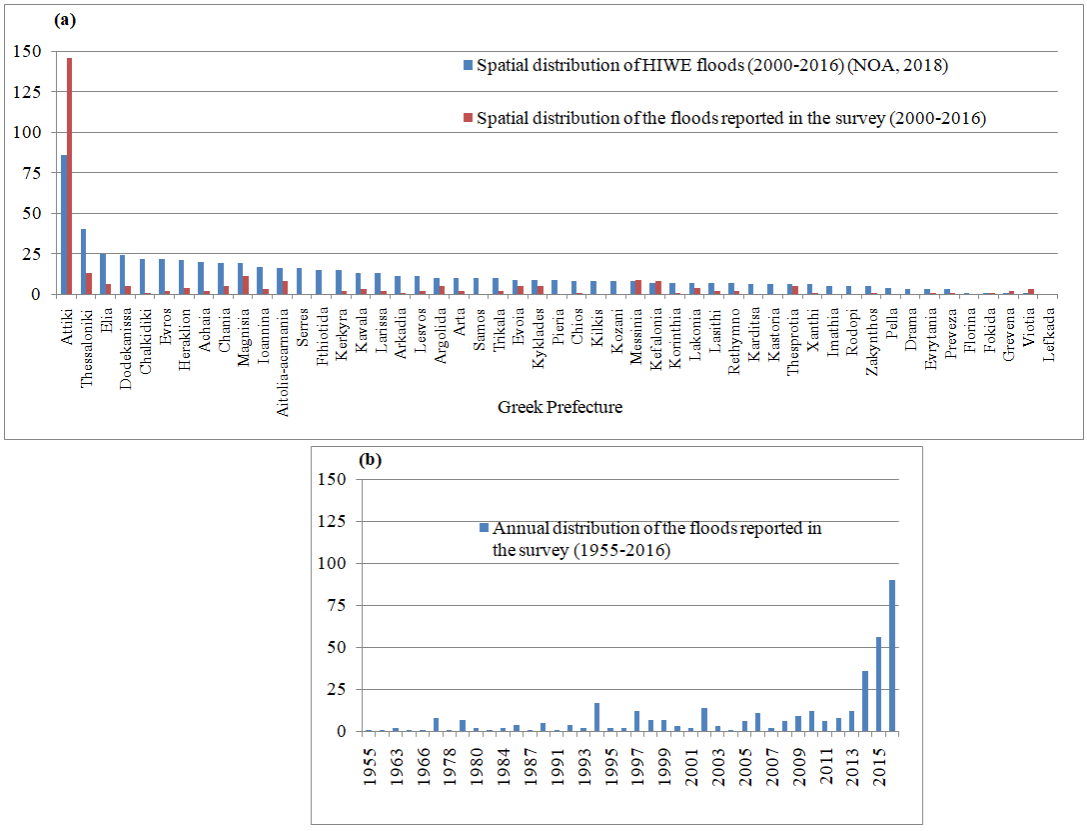


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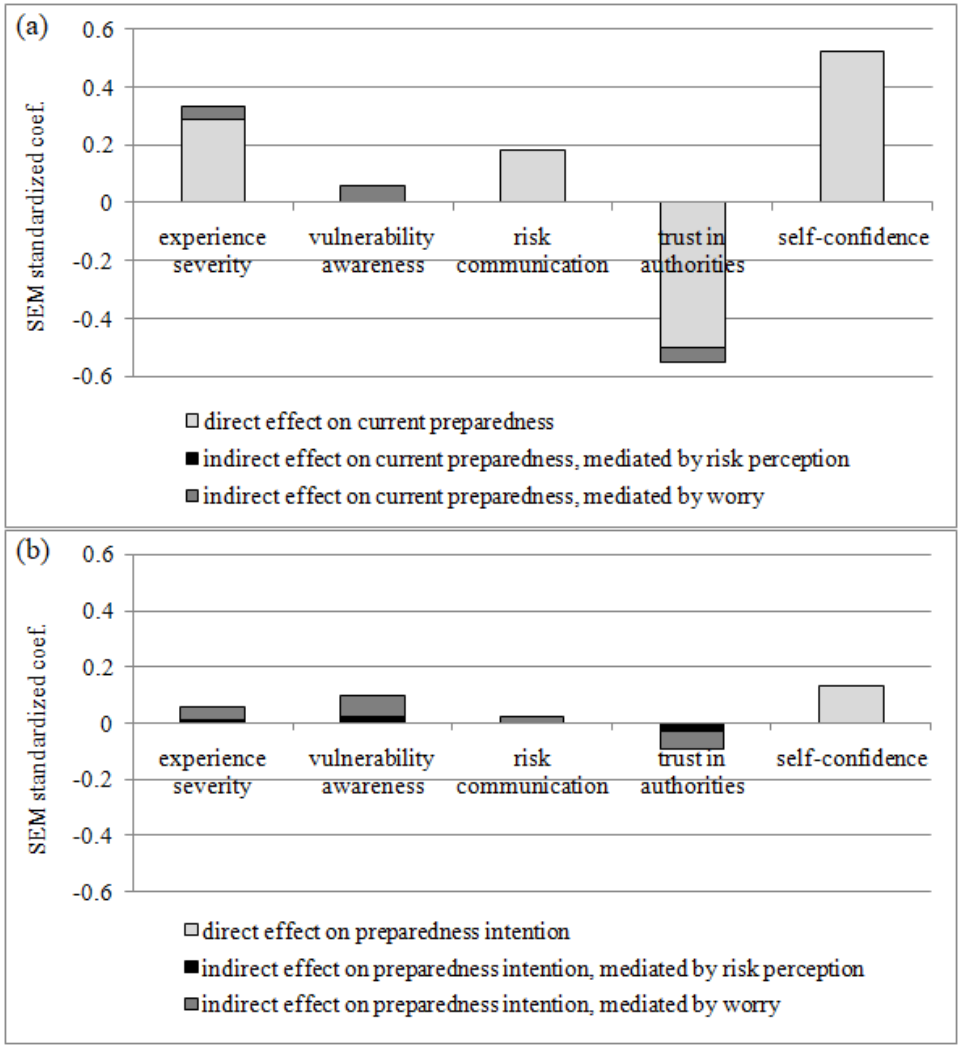


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