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Citizens' Perceptions of Flood Hazard Adjustments: An Application of the Protective Action Decision Model

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Abstract

Although research indicates that adoption of flood preparations among Europeans is low, only a few studies have attempted to explain citizens' preparedness behavior. This article applies the Protective Action Decision Model (PADM) to explain flood preparedness intentions in the Netherlands. Survey data (*N* = 1,115) showed that hazard-related attributes (e.g., perceived efficacy in protecting persons) were positively correlated, but failed to show that resource-related attributes (e.g., perceived costs) were negatively correlated with preparedness intentions. Although respondents rated the hazard-related attributes as more important than the resource-related attributes, moderated regression failed to detect practically meaningful interaction effects. Risk perception was also positively correlated with preparedness intentions but explained less variance than did the hazard-related attributes. Among the demographic characteristics, only female gender was consistently correlated with higher risk perception and the hazard-related attributes. Finally, risk area was correlated with perceived flood likelihood and consequences as well as the hazard-related attributes. Implications are discussed.

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flood, preparedness, hazard adjustment attributes, attribute importance, risk perception

Worldwide floods inflict great damage and destruction. In Europe alone, the period 1985 to 2000 witnessed an estimated US$35.4 billion in economic losses (Munich Re, 2000). According to Barredo and colleagues (2008), over the past decades, the average annual flood damage in Europe has amounted to about 4 billion euro per year. In addition to public flood protection, government institutions increasingly recognize the importance of raising awareness among citizens and stimulating their flood preparedness. For instance, the European Floods Directive (2007) requires that Member States produce publicly available flood maps (by the end of 2013) to inform citizens about their flood risks. According to the International Commission for the Protection of the Rhine (ICPR; Egli, 2002) preparing for flooding by planning potential actions such as moving furniture to higher floors or other safe locations can reduce property damage up to 80%.

To date, we know of only one study that surveyed flood preparedness among citizens in multiple European countries. The study revealed alarming numbers. Among 4,000 residents living in flood prone areas in Germany, the Netherlands, Norway, Sweden, and the United Kingdom, more than 80% indicated they had taken no steps to mitigate future losses or to prepare for flood emergency response (Krasovskaia, Gottschalk, Ibrekk, & Berg, 2007). In addition, a recent literature review on flood risk perception (Kellens, Terpstra, & De Mayer, in press) revealed that only a handful of studies employed psychological theories to explain why residents often exhibit low levels of flood preparedness. Although several theoretical frameworks are available, so far only protection motivation theory (PMT; Rogers & Prentice-Dunn, 1997) was employed in three studies (Grothmann & Reusswig, 2006; Kievik & Gutteling, 2011; Zaalberg, Midden, Meijnders, & McCalley, 2009). These studies indicated that especially coping appraisal—a construct that includes beliefs about efficacy and response costs of hazard adjustments—is a strong predictor of people's flood preparedness behavior. The present study was undertaken to shed more light on people's coping appraisals by applying a different theoretical framework that uses a more detailed set of variables to define efficacy beliefs and response costs: the Protective Action Decision Model (PADM; Lindell & Perry, 1992, 2004). With the results, we aim to provide recommendations for more effective flood risk communication, which has proven to be a complex task (Terpstra, Lindell, & Gutteling, 2009). The following section provides the theoretical background for this endeavor.

Theoretical Background

According to PMT (e.g., Floyd, Prentice-Dunn, & Rogers, 2000), people's coping appraisals are defined by three attributes—their beliefs that a protective action will be effective in reducing the threat (response-efficacy), their beliefs that they can perform the protective action (self-efficacy), and the perceived costs in money, time, and effort associated with performing the protective action (response costs). Grothmann and Reusswig (2006) measured coping appraisal in a survey of German flood plain residents. Their results indeed showed that coping appraisal was the strongest predictor for implementing structural measures, purchasing protection devices, and avoiding placement of expensive furniture in the basement and first floor. However, people's appraisal of informing themselves about self-protection did not correlate with information-seeking behavior. A recent risk communication experiment conducted in the Netherlands confirmed the importance of efficacy beliefs (Kievik & Gutteling, 2011). Similar to Mileti and Fitzpatrick's (1992) findings for earthquake hazard, Kievik and Gutteling (2011) found that the effects of risk perception and efficacy beliefs on intentions to take self-protective actions were partly mediated by information-seeking behavior. Compared with risk perception, efficacy beliefs showed a larger total effect (direct plus mediated effect) on the intention to take self-protective actions. These studies underline the importance of efficacy beliefs, but they shed no light on the contribution of individual coping attributes. That is, Kievik and Gutteling reported the effects of an overall measure of efficacy beliefs comprising self-efficacy and response-efficacy items, whereas Grothmann and Reusswig also included response costs in their overall measure of coping appraisal. Zaalberg et al. (2009) took these results a step further by examining the individual contributions of response- and self-efficacy among Dutch citizens. Their survey results suggested that response-efficacy is by far the best predictor of behavioral intentions. Surprisingly, however, self-efficacy was unrelated to behavioral intentions. Moreover, self-efficacy was measured as the extent to which respondents perceived impediments for carrying out flood preparedness actions, but this measure also includes the construct of response costs. Because their measure of self-efficacy includes two conceptually distinct constructs, it is impossible to determine which one (or if both) determined behavioral intentions.

In sum, each of these three studies underlined the predictive capacity of coping appraisal attributes, but it remains unclear how these attributes individually contribute to flood preparedness intentions and behavior. This study aims to improve our insights in the role of coping attributes through application of the PADM, which defines two types of coping attributes: the hazard-related and resource-related attributes.

The PADM was first developed to explain people's protective action decisions in response to imminent disasters (Lindell & Perry, 1992) and was later extended to account for people's long-term hazard adjustments (Lindell & Perry, 2000, 2004, 2012). Of main interest here are the attributes that people consider when searching for, selecting, and adopting hazard adjustments. As noted by Lindell (1997), PADM organizes these attributes as hazard-related attributes and resource-related attributes. The hazard-related attributes describe the relationship between the hazard adjustment and the hazard. There are three hazard-related attributes: perceived efficacy for protecting persons, perceived efficacy for protecting property, and perceived utility of hazard adjustments for other purposes. The resource-related attributes describe the relationship between the hazard adjustment and the household's resources. Resource-related attributes include perceived requirements for money, time and effort, knowledge and skills, tools and equipment, and cooperation from other persons in adopting hazard adjustments. PADM predicts that higher levels on the hazard-related attributes increase adoption intentions as well as actual adoption behavior, whereas higher levels on the resource-related attributes decrease adoption intentions and actual behavior. For instance, learning how to shut off utilities in case of an earthquake was one of the most popular seismic hazard adjustments among residents of the Los Angeles and Seattle areas (Lindell & Prater, 2002). Thus, average intentions of learning how to shut off utilities were high, this action was perceived as effective for protecting persons and property and useful for other purposes, whereas it was perceived as requiring little money, knowledge and skills, time, effort, and cooperation from other persons.

Although there is overlap between PADM and PMT in their conceptualizations of the attributes that influence citizens' hazard adjustment behavior, there are also some distinct differences. First, as noted previously, PMT asserts that an adaptive coping response is predicted by three attributes: response-efficacy, self-efficacy, and response costs associated with performing the protective action. Two of PADM's hazard-related attributes—efficacy for protecting persons and efficacy for protecting property—are conceptually similar to PMT's response-efficacy, but PMT lacks a direct equivalent for PADM's concept of utility for other purposes. Thus, PADM's hazard-related attributes reflect a more detailed set of salient beliefs that affect the adoption of hazard adjustments. Second, although PMT includes response costs, it does not specify which response costs ought to be included. PADM conceptualizes the response costs as resource-related attributes. One of these attributes, perceived knowledge and skill requirements, seems closely related to PMT's self-efficacy.

However, unlike PMT's self-efficacy—which is a characteristic of an individual—PADM's resource requirements are characteristics of the hazard adjustments. Thus, hazard managers can assess people's beliefs about the resource requirements of different hazard adjustments and, if these beliefs are inaccurate, they can focus their hazard awareness programs on correcting the misconceptions.

Hypotheses

This study applies PADM to flood preparedness in the Netherlands, which is situated in the low-lying delta of the rivers Rhine, Meuse, and Scheldt. Because flood protection is vital to the prosperity of the nation, the coastal and riverine flood risks are managed by maintaining sizable flood defenses. Fed by discussions and strategies dealing with the consequences of the expected rising of sea level and river discharges in the future, flood authorities have only recently begun to recognize the importance of raising flood awareness among citizens (Terpstra & Gutteling, 2008).

Figure 1 presents the research model. In addition to the hazard- and resource-related attributes, the model predicts that people's intentions to adopt flood hazard adjustments are determined by their perceived risk and the perceived importance of the hazard- and resource-related attributes. In turn, hazard- and resource-related attributes and risk perception are determined by people's demographic characteristics and risk areas in which they live. This model implies a series of hypotheses that follow from the findings of previous research.

First, PADM's predictions that hazard- and resource-related attributes will affect hazard adjustment adoption intentions have received at least partial support but recent research has found that the hazard-related attributes are more important than the resource-related attributes (Lindell, Arlikatti, & Prater, 2009; Lindell & Prater, 2002; Lindell & Whitney, 2000).

Hypothesis 1a (H1a): Hazard-related attributes will be positively correlated, and resource-related attributes will be negatively correlated, with adoption intentions.

Hypothesis 1b (H1b): Hazard-related attributes will be more strongly correlated with adoption intention than will be the resource-related attributes.

The finding that the resource-related attributes seemed meaningful to the respondents but correlated less with adoption intentions than did hazard-related attributes (Lindell et al., 2009; Lindell & Prater, 2002) might be

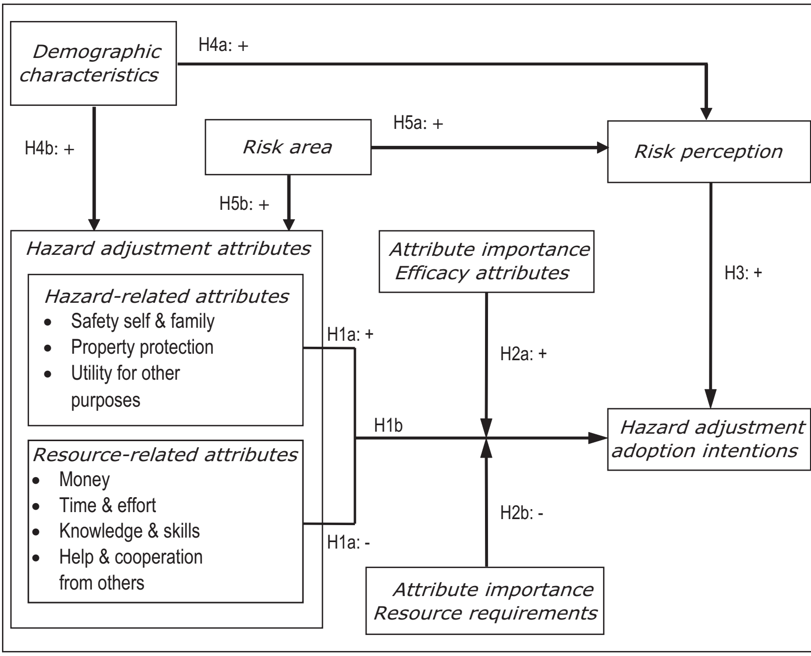

Figure 1. The protective action decision model applied to flood hazard adjustment adoption in the Netherlands.
Note: PADM = Protective Action Decision Model.

explained by the idea that hazard adjustments are not only chosen based on the perceived qualities of hazard adjustments on these attributes (e.g., buying an emergency kit costs little money) but also on the basis of whether these attributes are important to one's adoption decisions. In fact, this idea that intentions and behavior are guided by the expected outcomes on attributes (i.e., evaluation of attributes) and also their valences (i.e., perceived importance of attributes or their salience) is an underlying assumption in many attitude-behavior models (e.g., Fishbein and Ajzen's theory of reasoned action [TRA] as well as PMT and PADM). Thus, previous studies' lack of substantial correlations for the resource-related attributes with adoption intentions may only indicate that these attributes are much less important in making adjustment decisions than are the hazard-related attributes. Lindell et al. (2009) provided indirect support for an expectancy-valence effect by testing levels of interrater agreement.[1] Nevertheless, it would be preferable to test this effect more directly by asking risk area residents about the importance of each of the hazard-related and resource-related attributes for making decisions about the adoption of hazard adjustments. It is therefore predicted that attribute importance will moderate the effect of the hazard-related and resource-related attributes on adoption intentions.

Hypothesis 2a (H2a): There will be a significant positive relationship between ratings of hazard-related attributes and adoption intentions for those who regard these attributes as important for their adoption decisions but there will be no relationship for those who regard these attributes as unimportant.

Hypothesis 2b (H2b): There will be a significant negative relationship between ratings of resource-related attributes and adoption intentions for those who regard these attributes as important for their adoption decisions but there will be no relationship for those who regard these attributes as unimportant.

To test our prediction that the hazard-related attributes will be the most important predictor of adoption intentions, the model also includes risk perceptions. This finding would be consistent with TRA (Fishbein & Ajzen, 1975), which predicts that one's attitude toward an act (i.e., attitude toward adopting a hazard adjustment) is more predictive of one's behavior than one's attitude toward an object (i.e., attitude toward the hazard). Data obtained by Grothmann and Reusswig (2006) on the adoption of flood hazard adjustments also support this conclusion. Their measures of threat appraisal (i.e., perceived risk) and coping appraisal (i.e., a conjoint measure including response-efficacy, self-efficacy, and response costs) correlated positively with past adoption of flood mitigation measures, with coping appraisal showing the slightly higher correlations.

Hypothesis 3a (H3a): Risk perceptions will be a significant predictor of flood hazard adjustment intentions.

Hypothesis 3b (H3b): The amount of variance in hazard adjustment intentions explained by perceived risk will be less than the amount of variance explained by the hazard-related attributes.

Previous research has also reported some significant correlations of demographic characteristics with risk perception (Adeola, 2000; Fothergill, 1996; Fothergill, Maestas, & Darlington, 1999; Fothergill & Peek, 2004; Lindell & Hwang, 2008; Lindell & Prater, 2002) and hazard adjustment attributes (Lindell et al., 2009). With regard to the latter, older respondents, Whites, and homeowners gave lower ratings to those adjustments' resource requirements, but they also gave lower ratings to those hazard adjustments' effectiveness. Moreover, women considered the hazard adjustments to be more effective and cost more but were no different from men in their assessments of the remaining resource requirements. Nonetheless, the effects of these demographic variables were much smaller than the tendency of respondents with higher hazard experience, risk perception, and hazard intrusiveness (all of which were intercorrelated, see Lindell & Prater, 2002) to rate the hazard adjustments higher on the effectiveness attributes.

Hypothesis 4a (H4a): Demographic characteristics—gender (women higher), age (negative correlation), and homeownership (homeowners lower)—will be significantly related to risk perception.
Hypothesis 4b (H4b): Demographic characteristics—gender (women higher), age (negative correlation), and homeownership (homeowners lower)—will be significantly related to the hazard- and resource-related attributes.

Recent research has shown that location in a risk area is a significant predictor of risk perception, indirectly (via hazard experience, Terpstra, 2011) and directly (Lindell & Hwang, 2008). However, it seems plausible that location in a risk area would also affect people's perceptions of hazard adjustments, particularly their perceptions of efficacy in protecting persons and property.

Hypothesis 5a (H5a): Risk area will be correlated with risk perception.
Hypothesis 5b (H5b): Risk area will be correlated with two hazard-related attributes, efficacy for protecting persons and efficacy for protecting property, but not the remaining attributes.

Method

Study Areas and Samples

An Internet-based questionnaire survey was performed in two risk areas: a coastal area and an inland river area. The flood defenses in these areas provide protection against water levels that have an estimated annual probability of 1 in 4,000 (coastal area) and 1 in 1,250 (river area). Because the flood probabilities differ between these areas, the flood hazards may differ in their salience to those at risk (i.e., addressing slightly different hazards provides some measure of generalizability). Samples of 5,000 (coastal risk area) and 7,000 (river risk area) household addresses were drawn at random from a telephone book. Sample members were sent a letter explaining our research and inviting them to participate in our Internet survey. Each letter contained the Internet address and a password for taking the questionnaire. All invitations were sent on April 1, 2008, followed by two reminders 3 and 5 weeks after the invitation letter. The questionnaire entries were closed on May 31, 2008. Response rates were 12.9% (coastal area) and 9.6% (river area), respectively. About 15% of the respondents failed to complete substantial parts of the questionnaire and were therefore omitted from the analyses.

The resulting samples consisted of 553 (coastal area) and 562 (river area) questionnaires, respectively. The two samples were similar with respect to the distribution of gender (Mann–Whitney U, $z = -.07$, *ns*), mean age ($t_{1,106} = -.66$, *ns*), education ($\chi^2_3 = 2.88$, *ns*), homeownership (Mann–Whitney U, $z = -1.55$, *ns*), and income ($\chi^2_4 = 4.24$, *ns*). Overall, 68% were males, mean age was 53.3 years ($SD = 13.2$), 82% owned their house, median education was higher level secondary school (which is 5 or 6 years of formal education after primary school) or higher level of vocational school (a bachelor's degree), and median income was between €34,000 and €56,000 per year (before taxes). In all 7 persons failed to report their age, and 14 persons failed to report their homeownership and income. We handled these missing data by pairwise selection of observations for the analyses. Consequently, the analyses involving these demographic variables consisted of between 1,101 and 1,115 observations.

The response rate is lower than desired, which might be due in part to the use of web-based rather than mailed questionnaires. However, Manfreda, Bosnjak, Berzelak, Haas, and Vehovar (2008) found that the former had average response rates only 11% lower than the latter. More significantly, the response rate raises questions about sample representativeness. Indeed, comparison of the respondents from each risk area to the NRM2004 database[2] (Goudappel Coffeng, 2004) showed that the sample overrepresented males, homeowners, and older residents and higher levels of education—just as in U.S. samples using mail questionnaires (e.g., Lindell et al., 2009; Lindell & Hwang, 2008). However, overrepresentation of some demographic categories will produce bias in psychological variables only to the degree the latter are correlated with demographic variables. Such correlations are generally low (Lindell, in press; Lindell & Perry, 2000). Moreover, reports by Curtin, Presser, and Singer (2000) and Keeter, Miller, Kohut, Groves, and Presser (2000) indicate that low response rates do not appear to have biased surveys' estimates of means and proportions. The effect of nonresponse on correlation coefficients is somewhat more complex because the magnitude of any bias depends on the differences between respondents' and nonrespondents' means and correlations. We will return to this issue in the section "Discussion."

Measures

The online appendix (http://eab.sagepub.com/) contains the translated questionnaire items, response scales, and coding of all variables under study. The questionnaire measured hazard- and resource-related attributes, attribute importance, and adoption intentions in relation to six different flood hazard adjustments: (a) an emergency kit (including food, water, battery powered radio, etc.); (b) information about flood consequences (e.g., depth), evacuation routes, safe/high places in the neighborhood; (c) a list telling what to do in case of an evacuation or flood (household emergency plan); (d) agreements with family/relatives, friends, and neighbors about how to help each other during an evacuation or flood; (e) sandbags and/or flood skirts; and (f) flood insurance.[3] All measurements were performed on 5-point Likert-type scales except for attribute importance. Inspired by results obtained in previous studies (Van der Pligt, De Vries, Manstead, & Van Harreveld, 2000; Van Harreveld & Van der Pligt, 2004), attribute importance was measured by asking respondents to tick off the attributes they regarded as the most important for their decision to adopt hazard adjustments. Participants were allowed to select as many attributes as they wanted (minimum zero, maximum seven). In addition, participants reported their perceptions of flood likelihood (one item) and their perceptions of flood consequences (four items). The flood consequences formed a consistent scale ($\alpha = .91$). Subsequently, perceived likelihood was multiplied by the mean of the four perceived consequences items to form a single measure of risk perception ranging from 1 to 25. Finally, respondents reported their sex, age, highest level of education, homeownership, and income. In addition, we coded the risk areas (coastal area vs. river area) of respondents' homes.

Analysis

Dutch citizens' unfamiliarity with private flood hazard adjustments poses a potential problem for survey researchers because people who are asked for their opinions about issues for which they have no information can be extremely unreliable (Lindell et al., 2009; Lindell & Perry, 1990). Accordingly, we examined the construct validity of hazard- and resource-related attribute ratings. As indicated in the online appendix, the data met four conditions for construct validity, so it is appropriate to proceed with the tests of the five substantive hypotheses.

To address the predictive validity of the hazard-related (H1a) and resource-related attributes (H1b), we performed a series of hierarchical regression analyses of adoption intentions onto the hazard-related (Step 1) and resource-related attributes (Step 2), separately for each of the hazard adjustments. In addition, we calculated the correlations among all variables under study, separately for each of the six hazard adjustments to check for multicollinearity among variables that might adversely affect the stability of the regression coefficients. The correlation matrices can be found in the online appendix, Tables A3 and A4.

To determine whether there was an interaction between the hazard adjustment attributes and attribute importance (H2a and 2b), we conducted a moderated regression analysis of adoption intentions onto these two variables consistent with the recommendations of Edwards (2009). We first constructed scales by calculating the mean across the six hazard adjustments separately for each of the four hazard-related attributes, the three resource-related attributes, and adoption intentions. These eight scales showed sufficient internal consistency, as indicated by the Cronbach's alpha values that ranged from .73 to .88 (see Table 1). Next, the attribute scales and the importance items were centered (i.e., mean equal to zero). Finally, we performed a hierarchical regression analysis of adoption intentions onto the attributes and attribute importance (Step 1), and the interaction between attributes and their importance (Step 2). This analysis was performed separately for each of the hazard- and resource-related attribute scales and their corresponding importance measure.

We tested the effects of risk perception (H3a and 3b), demographic variables (H4a and 4b), and location (H5a and 5b) on adoption intentions by evaluating their correlations and by adding these variables to the regression model of H1 to test the predictive capacity of the complete model (Step 3, risk perception; Step 4, demographic variables and risk area). Because of the large number of variables and statistical tests on those variables, there was a potential for a substantial experiment-wise error rate that could result from using the conventional Type I error rate of $p = .05$. Accordingly, all analyses reported below use only the .01 and .001 levels.

Table 1. Attribute Standard Deviations on Each of the Six Hazard Adjustments.

	Emergency kit			Emergency information			Household plan			Family agreements			Sandbags			Flood insurance			Scale reliability	Attribute importance
Variable	*M*	Md	*SD*	*M*	Md	*SD*	*M*	Md	*SD*	*M*	Md	*SD*	*M*	Md	*SD*	*M*	Md	*SD*	Alpha	Proportion[a]
Adoption intention	2.54	2	1.14	2.83	3	1.10	2.63	3	1.09	2.43	2	1.03	1.77	2	0.88	2.24	2	1.10	0.88	—
Protect persons	3.27	4	1.24	3.67	4	1.14	3.40	4	1.15	3.19	3	1.16	2.55	3	1.22	2.95	3	1.31	0.87	0.76
Protect property	2.38	2	1.21	2.84	3	1.32	2.78	3	1.26	2.67	3	1.23	2.54	2	1.26	3.21	3	1.37	0.87	0.54
Other uses	2.83	3	1.21	2.70	3	1.24	2.80	3	1.21	2.75	3	1.19	1.98	2	1.13	2.29	2	1.30	0.88	0.55
Cost	2.49	2	0.85	1.93	2	0.87	1.66	1	0.84	1.60	1	0.82	3.19	3	0.99	3.97	4	0.92	0.73	0.24
Knowledge and skill	1.84	2	0.84	2.40	2	1.03	2.31	2	0.99	2.26	2	0.98	3.03	3	1.24	2.47	2	1.11	0.84	0.36
Time and effort	2.25	2	0.90	2.75	3	1.02	2.58	3	0.97	2.62	3	1.01	3.48	4	1.11	2.71	3	1.09	0.83	0.34
Cooperation	1.71	1	0.96	2.33	2	1.21	2.10	2	1.10	2.55	2	1.23	2.75	3	1.35	2.13	2	1.15	0.83	0.37
Risk perception	7.65	7	4.60																	
Gender	0.32	0	0.47																	
Age	53.28	54	13.23																	
Education	2.53	3	0.87																	
Homeownership	0.83	1	0.38																	
Income	3.66	4	1.06																	
Risk area	0.50	1	0.50																	

Note: The number of cases ranges from N = 1,101 to 1,115.
[a]Proportion of respondents who selected attributes as “most important” when preparing for floods.
M = Mean, Md = Median, SD = Standard Deviation

Results

Table 1 reports the means, medians, and standard deviations of all the variables under study. The data show that flood risk perception was well below the midpoint of the scale range (7.65 on a scale from 1 to 25) and that there was only minor variation in respondents' judgments of their likelihood of adopting any of the flood preparedness measures (1.77 for sandbags to 2.83 for emergency information on a scale from 1 to 5). Emergency kit, emergency information, household plan, and family agreements were rated as effective in protecting persons (i.e., had ratings above the scale midpoint) but none of them were regarded as effective in protecting property or useful for other purposes. All the actions other than sandbags and flood insurance were rated as low in resource requirements. Sandbags were rated as moderately high in cost as well as requirements for knowledge and skill, and time and effort. Flood insurance was rated relatively high in cost.

The hierarchical regression analysis partially supported H1a. As indicated in Table 2, all but one of the standardized regression coefficients (Step 1) for the protection of persons (median = .41, $.35 \leq \beta \leq .43$), protection of property (median = .14, $.05 \leq \beta \leq .21$), and utility for other purposes (median = .18, $.15 \leq \beta \leq .22$) were positive and statistically significant at $p < .001$. The one coefficient that was not significant was obtained for the degree to which sandbags were perceived to protect property against flood damage, which was due to high collinearity with the protection of persons (r_{ij} = .80, see the online appendix, Table A4).

In contrast to H1a, the regression coefficients of the resource-related attributes were sometimes not statistically significant or—in some cases—of the wrong sign (Table 2, Step 2). Of the 24 coefficients (4 resource-related attributes × 6 hazard adjustments), only 6 (25%) were significantly negative, 8 (33%) were significantly positive, and 10 (42%) of the coefficients did not deviate significantly from zero.

Because of the finding that the resource-related attributes yielded many nonsignificant or positive regression coefficients (75%) but only few negative coefficients (25%), there was no point in further tests of H1b (hazard-related adjustment attributes will be more strongly correlated with adoption intentions than will be the resource-related adjustment attributes). However, it should be noted that—apart from the one nonsignificant regression coefficient of the protection of property by means of sandbags (see Table 2)—all regression coefficients of the hazard-related attributes were larger than were any of the negative coefficients of the resource-related attributes.

Table 2. Regression Analysis of Adoption Intentions.

	Emergency kit				Emergency information				Household plan				Family agreements				Sandbags				Flood insurance			
Predictors	Step 1	Step 2	Step 3	Step 4	Step 1	Step 2	Step 3	Step 4	Step 1	Step 2	Step 3	Step 4	Step 1	Step 2	Step 3	Step 4	Step 1	Step 2	Step 3	Step 4	Step 1	Step 2	Step 3	Step 4
Protect persons	.40**	.41**	.39**	.38**	.41**	.40**	.35**	.36**	.35**	.35**	.31**	.32**	.37**	.37**	.34**	.35**	.41**	.40**	.38**	.38**	.43**	.42**	.41**	.39**
Protect property	.15**	.14**	.13**	.13**	.12**	.12**	.12**	.11**	.21**	.20**	.20**	.20**	.21**	.20**	.19**	.17**	.05	.04	.05	.06	.13**	.13**	.13**	.14**
Other uses	.22**	.22**	.20**	.21**	.15**	.16**	.14**	.15**	.16**	.16**	.14**	.15**	.17**	.17**	.15**	.17**	.22**	.20**	.19**	.18**	.19**	.17**	.16**	.17**
Cost		.01	.01	−.03		−.04	−.04	−.05		.04	.05	.03		.08**	.08**	.06		−.05	−.06	−.05		−.11**	−.12**	−.13**
Knowledge and skill		−.02	−.02	−.01		−.09**	−.10*	−.11**		.05*	.04	−.04		−.01	−.03	−.03		−.09**	−.09*	−.12**		−.02	−.04	−.04
Time and effort		−.07**	−.07*	−.05		.07*	.05	.06		−.10**	−.11**	−.08**		−.09**	−.09*	−.08*		−.05	−.07	−.05		−.05	−.04	−.05
Cooperation		.05	.04	−.01		.08**	.07*	.07		.06**	.05	.07		.06*	.06	.07		.07**	.06	.05		.08**	.10*	.10**
Risk perception			.15*	.15*			.19**	.19**			.19**	.19**			.17**	.17**			.16**	.15**			.15**	.15**
Gender				.04				.07				.03				.03				.04				.04
Age				.05				.08*				.08*				.10**				.09*				.03
Education				−.04				.02				.03				.02				.02				.03
Homeownership				.01				.02				.02				−.04				−.06				−.07
Income				.00				.05				−.02				−.03				−.05				.03
Risk area				.02				.04				.07*				.06				.09**				.07*
Multiple R	.63	.63	.65	.65	.57	.58	.60	.62	.61	.62	.65	.66	.62	.64	.66	.67	.58	.60	.62	.64	.64	.66	.67	.68
Adjusted R^2	.39	.39	.41	.41	.32	.32	.35	.36	.37	.37	.41	.42	.39	.39	.42	.43	.33	.35	.37	.39	.41	.42	.44	.45

Note: Cell entries are standardized regression coefficients. The number of cases ranges from N = 1,101 to 1,115.
$^*p < .01$. $^{**}p < .001$.

There was weak support for H2a and H2b, that attribute importance would moderate the effect of the hazard adjustment attributes (hazard- and resource-related attributes) on hazard adjustment adoption intention (see Table 3). Although the analysis detected a statistically significant moderation effect in the expected direction on one attribute (knowledge and skill), the increment in R^2 was extremely small and attribute importance failed to moderate the effects of the six remaining attributes on adoption intentions.

Despite the poor support for a moderation effect, the attribute importance selection task supported the prediction that the respondents would regard the hazard-related attributes as more important than the resource-related attributes. That is, as shown in Table 1, the proportions of respondents who selected the hazard-related attributes as important (protection of persons, 76%; protection of property, 54%; and utility for other purposes, 55%) were substantially larger than the proportions that selected resource requirements as important (cost, 24%; knowledge/skill, 36%; time/effort, 34%; and cooperation requirements, 37%).

As predicted by H3a (see Table 2, Step 3), risk perception (median = .17, $.15 \leq \beta \leq .19$) significantly predicted intentions of adopting each of the six flood hazard adjustments. In addition, there was support for H3b that the hazard-related attributes together would explain more variance in adoption intentions than would risk perception. That is, for each of the hazard adjustments, the multiple R of the hazard-related attributes with adoption intentions (median = .62, $.57 \leq R \leq .64$, see Table 2, results for Step 1) was greater than the correlation r of risk perception with adoption intentions (median = .31, $.22 \leq r \leq .34$, see Tables A3 and A4 in the online appendix). As one would expect from inspecting the zero-order correlations, the regression coefficients showed that the efficacy of protecting persons was the best predictor of adoption intentions (Step 1, median = .41, $.35 \leq \beta \leq .43$). The two remaining hazard-related attributes—efficacy in protecting property (Step 1, median = .14, $.05 \leq \beta \leq .21$) and utility for other purposes (Step 1, median = .18, $.15 \leq \beta \leq .22$)—had smaller regression coefficients due to the substantial level of multicollinearity among the three hazard-related attributes (median = .49, $.33 \leq r_{ij} \leq .80$, see the online appendix). Consequently, the coefficients of these two latter hazard-related attributes were similar in magnitude to those of the risk perception coefficients (Step 3, median = .17, $.15 \leq \beta \leq .19$). As Table 2 indicates, the addition of the resource-related attributes in Step 2 contributed only trivial increments to the multiple correlations.

H4 tested the effects of demographic characteristics. Results generally showed small correlations (i.e., 109/210 or 52% was less than ±.10, see the online appendix Table A4). Nevertheless, consistent with H4a, women had

Table 3. Hierarchical Regression Analysis of Adoption Intentions Onto the Attributes and Attribute Importance (Step 1), and the Interaction Between Attributes and Their Importance (Step 2).

Attributes	Step 1	Step 2
Hazard-related attributes		
Protection of persons	.55**	.55**
Importance	.08*	.08*
Interaction		.00
Δ Adjusted R^2	.33	.00
Protection of property	.49**	.50**
Importance	.08*	.08*
Interaction		−.01
Δ Adjusted R^2	.27	.00
Suitability for other uses	.41**	.41**
Importance	.11**	.11**
Interaction		.06
Δ Adjusted R^2	.20	.00
Resource-related attributes		
Cost	.16**	.16**
Importance	.12**	.12**
Interaction		−.02
Δ Adjusted R^2	.04	.00
Knowledge and skills	.13**	.13**
Importance	.09*	.09*
Interaction		−.10*
Δ Adjusted R^2	.02	.01*
Time and effort	.10*	.10*
Importance	.05	.05
Interaction		−.05
Δ Adjusted R^2	.01	.00
Cooperation from other persons	.22**	.22**
Importance	.10*	.10*
Interaction		−.06
Δ Adjusted R^2	.05	.00

Note: Δ Adjusted R^2 is the initial explained variance (Step 1) and the increase in explained variance (from Step 1 to Step 2). Analyses are performed separately for each of the attributes. N = 1,115.
*p < .01. **p < .001.

greater risk perceptions (r_{ij} = .20), whereas age (r_{ij} = −.08), homeownership (r_{ij} = −.08), and income (r_{ij} = −.11) were negatively related to risk perception. Consistent with H4b, women rated the hazard adjustments higher on the hazard- and resource-related attributes (hazard-related attributes, median = .16, $.12 \leq r_{ij} \leq .25$; resource-related attributes, median = .09, $-.03 \leq r_{ij} \leq .18$). However, the remaining predictions from H4b were only partially supported. Specifically, most of the correlations of the hazard- and resource-related attributes with homeownership (33/42, 79%) and age (23/43, 55%) were statistically nonsignificant.

Contrary to H5a, risk area was uncorrelated with the conjoint measure of risk perception ($r_{ij} = -.03$, *ns*). However, considering the two risk perception components separately revealed that the river risk area residents had higher perceptions of flood likelihood ($r_{ij} = .22$) and lower perceptions of flood consequences ($r_{ij} = -.38$) than the coastal risk area residents. Consistent with H5b, risk area was correlated with efficacy for protecting persons (median = .09, $-.06 \leq r_{ij} \leq .14$) and efficacy for protecting property (median = .11, $.01 \leq r_{ij} \leq .15$) but not with the resource-related attributes. That is, among the two hazard-related attributes, 67% (8/12) of the correlations with risk area were positive and statistically significant, whereas none of the resource-related attributes were correlated with risk area. Unpredicted, however, risk area was also correlated with the perceived utility of hazard adjustments for other purposes ($r_{ij} = .11$, $.03 \leq r_{ij} \leq .13$). Thus, in the river risk area, hazard adjustments were generally regarded as slightly more effective.

Finally, Table 2 shows that the overall predictive power (R^2) of the model in Figure 1 varies between 36% and 45%. In line with the small correlations of the demographic characteristics, the results also reveal that demographic variables and risk area (Step 4) add little to the explanation of adoption intentions (0%-2%).

Discussion

The aim of this study was to identify the key variables that influence citizens' behavior with regard to flood risk. Results of three previous studies (Grothmann & Reusswig, 2006; Kievik & Gutteling, 2011; Zaalberg et al., 2009) suggested that coping variables such as response-efficacy and self-efficacy are strong predictors of citizens' behavioral intentions in adjusting to flood risk. This study focused on a more detailed set of coping attributes—that is, PADM's hazard-related and resource-related attributes. We applied these attributes to predict Dutch citizens' intentions to adopt flood hazard adjustments and compared their predictive capacity with the effects of risk perceptions, demographic variables, and citizens' location in two different flood risk areas. Finally, we examined whether perceived importance of the hazard- and resource-related attributes would improve their predictive capacity for adjustment intentions.

The study results provided partial support for our hypotheses. First, as predicted by H1a, respondents who expressed greater faith in the efficacy of hazard adjustments to protect people and property, and who perceived hazard adjustments as more useful for other purposes than flood protection alone were substantially more inclined to adopt these hazard adjustments in the future. Together, these three hazard-related attributes explained between 32% (searching emergency information) and 41% (taking out flood insurance) of the variance in respondents' adoption intentions, which is substantial. For example, low scores on each of the three hazard-related attributes were the most important reason that sandbags was the least popular flood hazard adjustment among the respondents.

Contrary to H1a, the resource-related attributes (i.e., perceived cost, time, knowledge, and cooperation to adopt hazard adjustments) yielded many (75%) nonsignificant or positive correlations with adoption intentions and only a few of the negative correlations (25%) that were predicted. Moreover, these correlations were small and therefore explained little variance in addition to the hazard-related attributes. Although there is not one clear reason for these findings, they are consistent with results reported by Lindell and Prater (2002), who found similar small correlations in relation to seismic adjustment adoption intentions. These results are also broadly consistent with those of Zaalberg et al. (2009), who reported that response-efficacy, but not self-efficacy, predicted intentions to adopt flood hazard adjustments. Thus, despite the positive correlations of the resource-related attributes, these results do support H1b that the hazard-related attributes would be a stronger predictor of people's intentions to adopt flood hazard adjustments than the resource-related attributes.

This study also hypothesized (H2a/H2b) that attribute importance would moderate the effects of the hazard-related and resource-related attributes on adoption intentions. Moderation would also be a possible explanation for the unexpected small correlations of the resource-related attributes with adoption intentions. That is, although people may have meaningful perceptions of these attributes, they may consider them of little importance for their adoption decisions, as was previously suggested by Lindell et al. (2009) in relation to the adoption of seismic hazard adjustments. Indeed, this explanation was supported because the proportions of respondents who selected the resource-related attributes as important attributes of their adoption decisions (between 24% and 37%) were substantially smaller than the proportions of respondents who selected hazard-related attributes as important (between 54% and 76%).

However, the specific mechanism by which attribute importance influences adoption decisions remains unclear because, contrary to H2a and H2b, the results only weakly supported the predicted moderation effects of attribute importance. That is, the interaction between attribute outcome expectancy and their valences (i.e., judged importance) was statistically significant on only one attribute and that effect only explained a trivial amount of variance in adoption intentions. It is possible that the moderation effects were underestimated because of the use of a dichotomous measure of attribute importance. However, this seems unlikely because previous studies by Van der Pligt (Van der Pligt et al., 2000; Van Harreveld & Van der Pligt, 2004) have found satisfactory results with a dichotomous attribute importance measure. Nonetheless, future studies should consider using importance rating scales with a greater number of categories.

There was strong support for the hypothesis that risk perception would be significantly correlated with adoption intentions (H3a) but that the hazard-related attributes (efficacy in protecting persons, efficacy in protecting property, and utility for other purposes) would explain more variance in adoption intentions (H3b). The fact that the hazard-related attributes are even more important than risk perception is consistent with a proposition from the TRA (Fishbein & Ajzen, 1975) that one's attitude toward an object (e.g., flood hazard) is less predictive of behavior than one's attitude toward an act (e.g., flood hazard adjustments) relevant to that object. This result is also consistent with Grothmann and Reusswig's (2006) finding that adoption of flood hazard adjustments was correlated more strongly with coping appraisal than with threat appraisal.

Respondents' demographic characteristics played only a marginal role in their decisions to adopt flood hazard adjustments. Among the demographic characteristics, female gender seems to have the largest effects because females tend to have higher risk perceptions (consistent with H4a) and have greater confidence in the effectiveness of hazard adjustments (consistent with H4b). The correlation of female gender and risk perception replicates what is arguably the most robust finding in the risk perception literature (Davidson & Freudenberg, 1996; Fothergill, 1996). Moreover, the positive correlations of female gender with ratings of the hazard-related attributes are consistent with the findings of Lindell et al. (2009) but not Lindell and Whitney (2000). The latter study had a much smaller sample size ($N = 168$), so it might have simply lacked the statistical power to detect what appears to be a small effect.

Finally, contrary to H5a, the net effect of risk area on respondents' risk perceptions was nonsignificant. However, additional analyses revealed that—in line with the lower protection level in the river area—river risk area respondents perceived higher flood likelihood but less extreme flood consequences. Moreover, river risk area respondents also had greater confidence in the efficacy of flood hazard adjustments to protect people and property (as predicted by H5a), but unexpectedly, also in the suitability of hazard adjustments for other purposes. These findings suggest that citizens in the river area are more open to flood risk communication.

It is important to acknowledge that this study has its limitations. First, although samples were drawn from two relatively large geographic locations and the total sample size had adequate power to detect even small correlations, the response rate was low (overall 11%), which would seem to raise a question about the generalizability of the results. The response rate itself is not the issue because there is no bias in estimates of correlations if the data are missing completely at random (Newman, 2009). If there is a systematic basis for nonresponse, the effect of the response rate on a correlation depends on the response rate, the difference between the respondents and nonrespondents with respect to their correlations on the two variables, and the corresponding differences with respect to the means of the two variables (Newman, 2009). The only available data on the differences between respondents and nonrespondents in the present study are for the demographic variables, where the characteristics of the respondents can be compared with census data on the population as a whole. As is often the case for mail surveys, the respondents from both risk areas in this study identically overrepresented males, older ages, and higher income classes. However, these biases are only meaningful to the extent that the demographic variables are correlated with risk perception, the hazard adjustment attributes, and adoption intentions. Because age and income mostly produced small and sometimes even inconsistent (i.e., positive and negative) correlations with risk perception, hazard adjustment attributes, and adoption intentions, the demographic variables provide no basis for drawing any conclusions about the effects of the response rate on the observed correlations.

A related concern is a selection effect in which those who had the greatest intentions of adopting the hazard adjustments would be the most likely to participate in the study. However, as Lindell and Perry (2000) noted, this particular form of systematic nonresponse would reduce the variance in adoption intentions, a consequence that would be most likely to reduce the correlations of those dependent variables with hazard-related attributes, resource-related attributes, risk perception, demographic characteristics, and risk area (Nunnally & Bernstein, 1994). That is, such a selection effect would underestimate the true correlations.

In addition, this study—like all cross-sectional designs—has limited ability to draw conclusive causal inferences because we cannot unequivocally identify the temporal ordering of the variables or guarantee that all relevant variables have been included within the regression equation. However, it is difficult to explain how reversing the temporal ordering (i.e., a causal direction from hazard adjustments to hazard adjustment attributes) would produce significant results for the hazard-related attributes but not for the resource-related attributes. Similarly, it is also difficult to explain how any omitted causal variables would bias the regression analysis results by being more strongly correlated with the hazard-related attributes than the resource-related attributes.

Notwithstanding the sample's limitations, this study does have some theoretical and practical implications. First, the regression analysis showed that the hazard-related attributes together explained between 32% and 41% of the variance in adoptions intentions. Because each of the three hazard-related attributes explained a unique portion of the variance, it seems that PADM's hazard-related attributes provide a better conceptualization of the coping appraisal of flood hazard adjustments than does PMT's single measure of response-efficacy.

Second, the low correlations of the resource-related attributes lead to the important theoretical question of why framing a relationship between a person and task as a characteristic of the task (e.g., required knowledge and skill) produces nonsignificant correlations with protective actions although other theories that frame that same relationship as a characteristic of the person (self-efficacy in the case of PMT or personal control in the case of Ajzen's, 1991, theory of planned behavior) produce positive correlations. This is an issue that requires additional theoretical analysis as well as empirical research.

Third, results imply that Dutch citizens generally have low intentions to adopt flood hazard adjustments. Searching for emergency information was the most popular adjustment primarily because respondents on average believed that through searching information, they would be better able to protect themselves and their families from a flood's consequences. Still, only 29% of the respondents indicated that they would search for information about floods in the near future. The percentage of respondents with positive intentions on the remaining flood hazard adjustments was even lower, that is, adopting an emergency kit (22%), making a household plan (21%), making agreements with family and friends (15%), taking out flood insurance (14%), and buying sandbags (4%), respectively. Remarkably, only flood insurance was typically regarded as an effective way to cope with flood damage. However, flood insurance is currently unavailable in the Netherlands. If authorities would like to stimulate the adoption of flood hazard adjustments among Dutch citizens, explaining which hazard adjustments are effective for their own protection and the protection of their property is imperative.

In sum, the results of this study underline the importance of coping appraisals, which can be more fully understood when we not only ask questions about the efficacy of hazard adjustments in general but also more specifically about their efficacy for protecting persons, their efficacy for protecting property, and their utility for other purposes. These hazard-related attributes consistently provided a much better prediction than did perceived risk or other variables such as demographics. Thus, understanding people's perceptions of the available hazard adjustments is even more important than understanding their perceptions of a hazard if risk managers are to improve community emergency preparedness. An important challenge for future research is to improve our understanding of the response costs and other barriers that impede people's preparedness for floods.

Authors' Note

This research was carried out at the University of Twente (Psychology of Conflict, Risk and Safety, the Netherlands) and at Texas A&M University (Hazard Reduction and Recovery Center, USA) in the framework of the PROMO project in the Netherlands. None of the conclusions expressed here necessarily reflects views other than those of the authors.

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Notes

1. Interrater agreement in ratings of a single object can be measured by the variance in the ratings of that object by different raters. The smaller the variance, the greater the interrater agreement. Lindell, Arlikatti, and Prater (2009) compared levels of interrater agreement on the hazard- and resource-related attributes with

the levels of interrater agreement on the hazard adjustment adoption intentions. They argued that, even if people agree on the rating of a hazard adjustment on an attribute, they are still likely to differ in the valences that they attach to that attribute (i.e., its perceived importance for adopting hazard adjustments). As a consequence, respondents would be expected to show less agreement on their adoption intentions than on their attribute ratings. Consistent with this reasoning, they indeed found that there was less agreement in adoption intentions than on the attribute ratings.

2. The NRM2004 database provides information about the demographic characteristics of the Dutch population on the level of zip codes within predefined flood risk areas (so-called dike rings). The primary source of NRM is the demographic population characteristics from Statistics Netherlands, which is the responsible organization in the Netherlands for collecting and processing data to publish statistics to be used in practice, by policy makers and for scientific research.
3. Currently, the Netherlands lacks a flood insurance arrangement. However, this study investigated citizens' responses to flood insurance should it become available in the future.

References

Adeola, F. O. (2000). Endangered community enduring people—Toxic contamination, health, and adaptive responses in a local context. *Environment and Behavior, 32*, 209-249.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179-211.

Barredo, J. I., Salamon, P., Feyen, L., Dankers, R., Bódis, K., & De Roo, A. (2008). *Flood damage potential in Europe*. Luxembourg, Europe: Office for Official Publications of the European Communities.

Curtin, R., Presser, S., & Singer, E. (2000). The effects of response rate changes on the index of consumer sentiment. *Public Opinion Quarterly, 64*, 413-428.

Davidson, D. J., & Freudenberg, W. R. (1996). Gender and environmental risk concerns: A review and analysis of available research. *Environment and Behavior, 28*, 302-339.

Edwards, J. R. (2009). Seven deadly myths of testing moderation in organizational research. In C. E. Lance & R. J. Vandenberg (Eds.), *Statistical and methodological myths and urban legends* (pp. 143-164). New York, NY: Routledge.

Egli, T. (2002). *Non structural floodplain management: Measures and their effectiveness*. Sankt Augustin, Germany: International Commission for Protection of the Rhine (ICPR).

European Floods Directive. (2007). Directive 2007/60/ec of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks. *Official Journal of the European Union, 50*, 27-34.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior*. Reading, MA: Addison-Wesley.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*, 407-429.

Fothergill, A. (1996). Gender, risk, and disaster. *International Journal of Mass Emergencies and Disasters, 14*, 33-56. Available from www.ijmed.org

Fothergill, A., Maestas, E. G. M., & Darlington, J. D. (1999). Race, ethnicity and disasters in the United States: A review of the literature. *Disasters, 23*, 156-173.

Fothergill, A., & Peek, L. A. (2004). Poverty and disasters in the United States: A review of recent sociological findings. *Natural Hazards, 32*(1), 89-110.

Goudappel Coffeng. (2004). *NRM-basisbestand 2004* [NRM-database 2004]. Delft: Rijkswaterstaat: Dienst Verkeer en Scheepvaart [Centre for Transport and Navigation].

Grothmann, T., & Reusswig, F. (2006). People at risk of flooding: Why some residents take precautionary action while others do not. *Natural Hazards, 38*, 101-120.

Keeter, S., Miller, C., Kohut, A., Groves, R. M., & Presser, S. (2000). Consequences of reducing nonresponse in a national telephone survey. *Public Opinion Quarterly, 64*, 125-148.

Kellens, W., Terpstra, T. and De Maeyer, P. (2012), Perception and Communication of Flood Risks: A Systematic Review of Empirical Research. *Risk Analysis*. doi: 10.1111/j.1539-6924.2012.01844.x

Kievik, M., & Gutteling, J. M. (2011). Yes we can: Motivate Dutch citizens to engage in self-protective behavior with regard to flood risks. *Natural Hazards, 59*, 1475-1490.

Krasovskaia, I., Gottschalk, L., Ibrekk, A. S., & Berg, H. (2007). Perception of flood hazard in countries of the North Sea region of Europe. *Nordic Hydrology, 38*, 387-399.

Lindell, M. K. (with Alesch, D., Bolton, P. A., Greene, M. R., Larson, L. A., Lopes, R., . . . Whitney, D. J.). (1997). Adoption and implementation of hazard adjustments. *International Journal of Mass Emergencies and Disasters Special Issue, 15*, 327-453. Available from www.ijmed.org

Lindell, M. K. (in press). North American cities at risk: Household responses to environmental hazards. In T. Rossetto, H. Joffe, & J. Adams (Eds.), *Cities at risk: Living with perils in the 21st century*. Dordrecht, Netherlands: Springer.

Lindell, M. K., Arlikatti, S., & Prater, C. S. (2009). Why people do what they do to protect against earthquake risk: Perceptions of hazard adjustments and their attributes. *Risk Analysis, 29*, 1072-1088.

Lindell, M. K., & Hwang, S. N. (2008). Households' perceived personal risk and responses in a multihazard environment. *Risk Analysis, 28*, 539-556.

Lindell, M. K., & Perry, R. W. (1990). Effects of the Chernobyl accident on public perceptions of nuclear plant accident risks. *Risk Analysis, 10*, 393-399.

Lindell, M. K., & Perry, R. W. (1992). *Behavioral foundations of community emergency planning*. Washington, DC: Hemisphere Publishing Corporation.

Lindell, M. K., & Perry, R. W. (2000). Household adjustment to earthquake hazard—A review of research. *Environment and Behavior, 32*, 461-501.

Lindell, M. K., & Perry, R. W. (2004). *Communicating environmental risk in multiethnic communities*. Thousand Oaks, CA: SAGE.

Lindell, M. K., & Perry, R. W. (2012). The Protective Action Decision Model: Theoretical modifications and additional evidence. *Risk Analysis, 32*, 616-632.

Lindell, M. K., & Prater, C. S. (2002). Risk area residents' perceptions and adoption of seismic hazard adjustments. *Journal of Applied Social Psychology, 32*, 2377-2392.

Lindell, M. K., & Whitney, D. J. (2000). Correlates of seismic hazard adjustment adoption. *Risk Analysis, 20*, 13-25.

Manfreda, K. L., Bosnjak, M., Berzelak, J., Haas, I., & Vehovar, V. (2008). Web surveys versus other survey modes: A meta-analysis comparing response rates. *International Journal of Market Research, 50*, 79-104.

Mileti, D. S., & Fitzpatrick, C. (1992). The causal sequence of risk communication in the Parkfield earthquake prediction experiment. *Risk Analysis, 12*, 393-400.

Munich Re. (2000). *topics 2000: Natural catastrophes—The current position*. Munich, Germany: Author.

Newman, D. A. (2009). Missing data techniques and low response rates. In C. E. Lance & R. J. Vandenberg (Eds.), *Statistical and methodological myths and urban legends* (pp. 7-36). New York, NY: Routledge.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). New York, NY: McGraw-Hill.

Rogers, R. W., & Prentice-Dunn, S. (1997). Protection motivation theory. In D. S. Gochman (Ed.), *Handbook of health behavior research* (pp. 113-132). New York, NY: Plenum.

Terpstra, T. (2011). Emotions, trust and perceived risk: Affective and cognitive routes to flood preparedness behavior. *Risk Analysis, 31*(10), 1658-1675.

Terpstra, T., & Gutteling, J. M. (2008). Households' perceived responsibilities in flood risk management in the Netherlands. *International Journal of Water Resources Development, 24*, 555-565.

Terpstra, T., Lindell, M. K., & Gutteling, J. M. (2009). Does communicating (flood) risk affect (flood) risk perceptions? Results of a quasi-experimental study. *Risk Analysis, 29*, 1141-1155.

Van der Pligt, J., De Vries, N. K., Manstead, A. S. R., & Van Harreveld, F. (2000). The importance of being selective: Weighing the role of attribute importance. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 32, pp. 135-200). New York, NY: Academic Press.

Van Harreveld, F., & Van der Pligt, J. (2004). Attitudes as stable and transparent constructions. *Journal of Experimental Social Psychology, 40*, 666-674.

Zaalberg, R., Midden, C., Meijnders, A., & McCalley, T. (2009). Prevention, adaptation, and threat denial: Flooding experiences in the Netherlands. *Risk Analysis, 29*, 1759-1778.

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