The determinants affecting the intention of urban residents to prepare against flood risk in China

Tiantian Wang[1,2,*], Yunmeng Lu[1,2], Tiezhong Liu[1,2,*], Yujiang Zhang[3], Xiaohan Yan[1,2], Yi Liu[1,2]

[1]School of Management and Economics, Beijing Institute of Technology, Beijing 100081, P R China.
[2]Crisis Management Research Center, Beijing Institute of Technology, Beijing 100081, P R China.
[3]The First Topographic Surveying Brigade Of MNR.

Correspondence to: Tiantian Wang (wangtiantian@bit.edu.cn) & Tiezhong Liu (liutiezhong@bit.edu.cn)

Abstract. In the context of global warming and China's disaster response patterns, it is critical to understand how to promote the effectiveness of household flood protection measures among the public. In this study, we developed a comprehensive theoretical framework based on protection motivation theory (PMT) to identify the main determinants that influence urban residents' intention to prepare against flood risk. In addition to the fundamental factors in PMT, this framework also considered the influence of individual coping attitudes and social context. We selected urban residents in flood-prone areas of Henan Province as the study population as well as collected 857 valid questionnaires through an online survey. Firstly, the results showed that both threat perception and coping appraisal of flood risk are effective in increasing residents' intention to prevent. Secondly, negative risk coping attitudes reduced people's intention to prepare. If people do not perceive preparedness actions as absolutely necessary, they will postpone or shift to public flood protection measures. In addition, analysis of affective pathways revealed that negative emotion (worry) was primarily influenced by perceptions of flood consequences and was not significantly related to perceptions of likelihood. The analysis of trust mechanisms showed that higher levels of trust in public flood protection reduced people's perceptions of flood risk thereby hindering their intention to prepare against flood risk. Finally, we found that the positive influence of social norms on preparedness intentions makes it appropriate to focus on the power of social mobilization. The findings will provide theoretical references for government departments to design further policy measures to improve integrated flood risk management in China.

1. Introduction

China has a long history of flooding (Jiang et al., 2005). However, in China's long-term fight against floods, the phenomenon of post-disaster emergency relief over pre-disaster emergency preparedness has emerged. For example, in the case of the flooding disaster event[1] that occurred in China's Henan Province in July 2021 due to extraordinarily rainstorm, it was found during the rescue process that life jackets, medical first aid kits, and emergency lights were the much-needed supplies for the

[1] In July 2021, the extraordinary rainstorm in Zhengzhou caused 302 fatalities and economic damage of approximately $17.7 billion (Henan Province flood relief press conference (10th)).

affected people, which fully exposed the lack of emergency preparedness of the residents. In addition, according to Swiss Re, the current catastrophe insurance coverage in China is only 10%, which results in most of the flood losses being borne by the residents and the government. The phenomenon of poverty due to disasters has become an urgent problem in China now. However, at the same time, it creates an opportunity for China to implement an integrated flood risk management strategy (Van Herk et al., 2015).

Several studies provide evidence that advance implementation of flood protection measures by individuals or households can be effective in reducing flood losses (Grothmann and Reusswig, 2006; Kreibich and Thieken, 2008; Bubeck et al., 2012; Poussin et al., 2014; Poussin et al., 2015; Botzen et al., 2019). Although studies have shown that implementing flood protection measures is cost effective in many cases (Kreibich et al., 2011), people living in floodplains are not adequately prepared for potential flood events. For example, a survey of coastal residents in several U.S. states conducted by Meyer et al. (2014) showed that only 25% of residents surveyed had taken protective measures prior to the arrival of Hurricane Sandy. To this end, researchers have conducted numerous behavioural studies in an attempt to understand and influence individual decisions related to flood management (Owusu et al., 2015; Osberghaus, 2015; Liu et al., 2018). However, to date, there has been little research on the impact of key factors on residents' flood risk decisions in China. Understanding the key factors influencing the residents' motivation for flood protection in China is essential given the increasing risks associated with flooding and the changing policy environment that is devolving more responsibility to communities and the public. Besides, unlike the bottom-up model of risk governance in the West and other Asian countries (Shi et al., 2013), China currently adopts a top-down model of national disaster response (Ge et al., 2021).

Given this context, the question arises what are the determinants that influence urban residents to implement flooding precautions in the context of China's top-down disaster response model and how do these determinants interact with each other? To address these questions, this study examined the preparedness intentions of residents in flood-prone areas of Henan Province and explored the mechanisms driving residents' preparedness intentions in a structured framework. Understanding these key factors will help governments design further policy measures to improve communication with residents and flood risk management.

The remainder of this article is structured as follows. Section 2 discusses the theoretical background of flood protection actions as well as the integration model and key hypotheses. Section 3 illustrates research methodology, including measured variables, research sample and data collection procedure issues. Section 4 presents the results in terms of descriptive statistics and structural equation model. Section 5 discusses the research results. In Section 6, we conclude this research and introduce the limitation.

2. Theoretical background and conceptual framework

2.1 Theoretical background

In fact, many factors influence the intentions of individuals to implement flood protection actions, including perceptions of flood risk, experience, attitudes, and socio-demographics (Weyrich et al., 2020). Therefore, it is difficult to identify the drivers that influence individuals to implement flood protection measures. Even so, models of human behaviour provide a simplified representation of the main driving forces and resulting actions involved in certain contexts. These models have shown effectiveness in understanding, predicting, and influencing factors in human behaviour (Martin et al., 2017). To date, researchers have developed several theories to study the factors that influence the public's implementation of flood mitigation measures. However, the use of a single theory is often incomplete. Meanwhile, many of the factors that are excluded may also play a role in behaviour. Therefore, the development of a comprehensive and integrated psychosocial model is particularly important for studying the public's flood mitigation behaviour.

The theoretical basis for explaining flood mitigation intentions in this study is protection motivation theory (PMT). PMT was first introduced by Rogers in 1975 (Rogers, 1975) (Fig. S1). It was originally used to explain when individuals would take precautions to reduce their health-related risks (Milne et al., 2000). In recent years, PMT has been widely used to explain the risk reduction behaviour of residents or farmers against natural hazards (Poussin et al., 2015; Van Duinen et al., 2015). According to PMT, an individual's decision to take protective action or not is driven by two main cognitive processes, namely, threat appraisal and coping appraisal (Rogers and Prentice-Dunn, 1997). Threat appraisal includes both variables of perceived likelihood and perceived consequence. Meanwhile, some researchers have defined threat assessment as risk perception (Grothmann and Reusswig, 2006; Bubeck et al., 2018). Coping appraisal consists of three variables: perceived response efficacy, perceived self-efficacy, and perceived response cost. Perceived response efficacy is the individual's perceived usefulness of the measure in reducing losses. Perceived self-efficacy refers to an individual's self-assessment of his or her ability to implement protective action measures. The perceived response cost is the individual's expectation of the cost in terms of financial, time, and effort of the protective measures to be implemented (Poussin et al., 2014). In the context of flood risk, the threat appraisal reflects an individual's perception of flood risk, while the coping appraisal reflects the extent to which an individual expects flood protection measures to be effective, easy to implement, and not too costly.

In order to improve this theoretical model as much as possible, this study adds both coping attitude and social context components to the PMT framework. Considering the difficulty of the actual survey, the measure of social context was characterized as two variables, social norms and trust in public flood protection. A structured research framework linking the above-mentioned factors was used to identify the factors that trigger an individual's intention to implement protection. Meanwhile, the interactions between the factors were also analysed.

2.2 Integration model

Based on PMT, this study used an integrated approach to examine determinants affecting the intention of residents' flood protection actions in China. The integration model as shown in Fig. 1 is proposed.

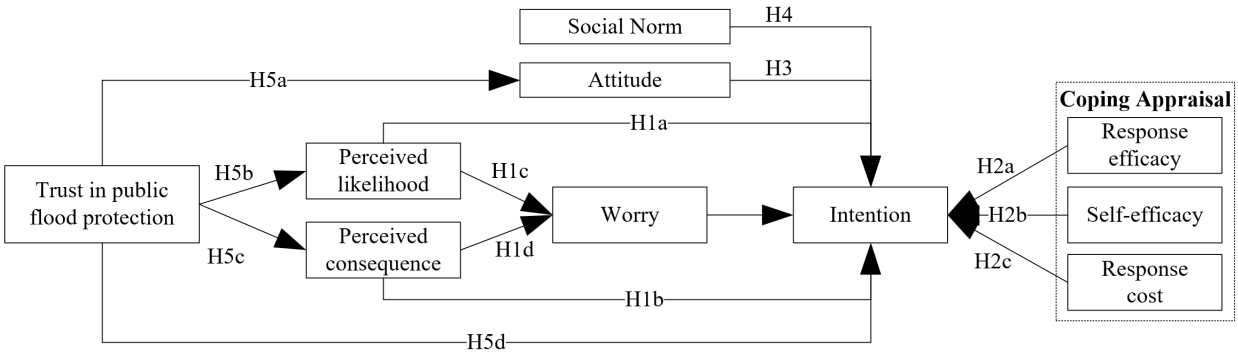

Fig. 1. Framework of the integration model.

In this study, threat appraisal refers to an individual's perceived level of flood risk, including both perceived likelihood and consequence. Studies have shown that individuals with high threat appraisal are more likely to take protective measures (Grothmann and Reusswig, 2006; Poussin et al., 2014; Weyrich et al., 2020). However, some studies have found that people with high levels of risk perception caused by flood experience and trust do not necessarily take flood precautions (Wachinger et al., 2013). There is no direct relationship between risk perceptions and preparedness (Diakakis et al., 2018). In addition, researchers have found that the nature and extent of people's emotional responses during a disaster event can influence their plans and actions for the future (Slovic et al., 2005). In a study of affective and cognitive routes to flood preparedness behaviour, Terpstra (2011) found that affective mechanisms influence citizens' intention to prepare. Ejeta et al. (2018) found that perceived risk of flooding has a direct effect on negative emotions in a study of flood preparedness among residents of Dire Dawa town, Ethiopia. In addition, Papagiannaki et al. (2019) integrated people's worry about the occurrence and consequences of flood into the flood-risk prevention model as a mediator variable, and the results also found that worry had a significant positive effect on the intention to implement flood mitigation behaviours. These results are partially contradictory. This may be because this relationship can also be explained by a mismatch between the temporal dynamics of adaptive behaviours and the cross-sectional nature of the data that are usually connected (Seebauer and Babcicky, 2021; Siegrist, 2013; Bubeck et al., 2012; Bubeck et al., 2020; Hudson et al., 2019). In this study, the cross-sectional survey carried out immediately after the flood, while we focused not only on flood risk perception as a direct driver of residents' intention to prepare for disasters, but also on the influence of emotion as a mediating factor on residents' intention to prepare for disasters. Therefore, we propose the following hypotheses:

H1a-H1b: Perceived likelihood and consequence have direct effects on preparedness intention.

H1c-H1d: Worry mediates the effects of perceived likelihood and consequence on preparedness intention.

Once a certain level of threat is reached, people will consider adaptive strategies to deal with the threat. Before this step is taken, people often consider the benefits of possible actions and assess whether they have the capacity to take them. This process is defined in PMT as coping appraisal. Numerous studies have shown that coping appraisal has a more salient impact on people's intentions to implement flood mitigation measures than threat appraisal (Bubeck et al., 2018; Poussin et al., 2015). Meanwhile, perceptions of high response efficacy, high self-efficacy, and low response costs are positively associated with the intention to implement flood mitigation measures (Parker et al., 2009; Kellens et al., 2013). However, focus group interviews conducted by Haney and Mcdonald-Harker (2017) with residents of flood-prone communities in High River, Alberta, found that respondents perceived their coping capacity to be weak and lacked resources, which led to inaction in flood risk reduction. Thus, further understanding is needed for the study of individual coping abilities soon after flooding. Based on the above study, hypotheses are proposed:

H2a-H2c: Response efficacy, self-efficacy and response cost have direct effects on preparedness intention.

Attitude is one of the most mentioned factors in the study of human social behaviour and has been shown to be an important factor influencing intention and behaviour (Fishbein and Ajzen, 2011). It can be defined as an individual's positive or negative evaluative response to a person or thing, which is usually rooted in the individual's beliefs and expressed in the individual's feelings or behavioural tendencies (Eagly and Chaiken, 2005). In general, the more positive a person's attitude toward a particular behaviour, the more likely he or she is to engage in that behaviour, and vice versa. Therefore, when faced with flood risk, if people are more positive about implementing flood prevention measures, the more likely they are to do so. positive responses are those that prevent damage, such as purchasing insurance (Shao et al., 2019). Negative responses, on the other hand, include such things as denial of the threat, wishful thinking (Grothmann and Reusswig, 2006; Bubeck et al., 2013), and fatalism (Botzen et al., 2019). Bubeck et al. (2018) argued that negative risk response attitudes (fatalism, postponement and low risk aversion) have a negative impact on the implementation of flood mitigation measures. Similarly, according to expected utility theory, protection against risk (in this case flooding) is less valuable for individuals who are less risk averse (Von Neumann and Morgenstern, 1947). Based on the above studies, this study focuses on the impact of residents' negative risk attitudes. We therefore propose the following hypothesis:

H3: Attitude has a direct effect on preparedness intention.

So far, we have discussed the impact of "intra-individual" factors on preparedness, but what about the impact of "inter-individual" factors on residents' intention to prepare for floods? We first considered the power of social influence and characterized it as a social norm. Social norms are the social pressures that people feel to act in a certain way (Abrahamse and Steg, 2013). People who are important to the individual may exert pressure to perform the behaviour explicitly or indirectly (Cialdini et al., 1990). In behaviour theory, a range of norms have been shown to explain behaviour and play a role in behaviour change. Many social psychologists view social norms as potential influences. The degree to which people sometimes perceive risk may not originate from the risk itself, but indirectly influence their production of adaptive behaviour or protective actions by shaping the perception of social norms (Lo, 2013). Studies have shown that individuals are more likely to prepare for disasters if neighbours, friends or family members take mitigation measures (e.g., purchase flood insurance) (Kunreuther et

al., 1978; Bubeck et al., 2018). Meanwhile, Botzen et al. (2019) also considered norms as a driving force for people to prepare and adopt flood-risk mitigation measures. We assume that similar relationships exist in our data. Meanwhile, we assume that there are two main sources of such social pressure: informal social networks (neighbours, friends or relatives) and government policies. The hypothesis is:

H4: Social norm has a direct effect on preparedness intention.

Since most flood control efforts in China rely on public flood control measures, it is also important to assess the impact of this factor on individuals' flood control intentions. Although laypeople lack the expertise needed to calculate the actual level of protection provided by flood protection facilities, they can deduce the likelihood of flooding based on the level of trust inspired by their observations. Grothmann and Reusswig (2006) surveyed citizens in the German city of Cologne and found that those citizens who had more confidence in public flood protection showed lower perceptions of flood risk and took less precautionary measures. Meanwhile, Terpstra (2011) also found that the perception of flood risk is reduced by a high level of trust in flood protection facilities, which in turn discourages citizens from planning to prepare for potential flood disasters. This conclusion was also supported by subsequent studies (Wachinger et al., 2013; Buchanan et al., 2019). Papagiannaki et al. (2019) used survey data from a representative sample of Greek households to show that trust in government flood control measures had a negative impact on flood fear, leading to lower levels of preparedness. Based on the above study, we assume the same relationship for our data. Also, we focused on the effect of people's trust in public flood protection on their attitude toward flood protection. We propose the following hypotheses:

H5a: Attitude mediates the effect of trust in public flood protection on preparedness intention.

H5b-H5c: Perceived likelihood and perceived consequence mediate the effects of trust in public flood protection on worry and preparedness intention.

H5d: Trust in public flood protection has a direct effect on preparedness intention.

3. Materials and methods

3.1 Measurements

In order to empirically test the hypotheses, this study used a questionnaire to collect data. To ensure the reliability and validity of the scales in this study, the measurement scales were compiled mainly through research analysis of the existing literature and appropriate revisions in the context of the actual situation in China. Table 1 provided the operational definitions and sources for these constructs. In the survey, respondents were asked to assess their level of agreement with the measured items. All items measured were administered on a five-point Likert scale. For the complete questionnaire, please see Table A (in Supplement).

In this study, we focus on five types of adaptation measures, categorizing them into structural, non-structural, and risk transfer measures (Poussin et al., 2014; Dillenardt et al., 2021). The structural measures directly studied in this paper are the reinforcement of houses or /and construction of water retaining walls. Non-structural measures fall into three main categories:

low, medium, and high-cost. Low-cost measures include participation in emergency drills or / and learning about flooding. Medium-cost measures include the preparation of sandbags, life jackets and other emergency supplies. High-cost measure is moving the shelter to a safe area away from flooding. Finally, the risk transfer measure is the purchase of flood-related insurance.

Before the main survey, a pre-test was conducted to ensure the logical consistency and ease of understanding of the designed questionnaire in July 2021. Firstly, some of the questions in the questionnaire were adjusted and amended based on the opinions of relevant experts in this field. Then we selected the subjects through WeChat (a social software like Facebook). Using snowball sampling, these people provided us with further contacts (Weyrich et al., 2020). Finally, we conducted online or telephone semi-structured interviews with 40 contacts who had different education level, age and life backgrounds. A content analysis was implemented based on the responses of the contacts. The analysis included further categorization, merging and deletion of questions. In order to further improve the comprehensibility, the wording was modified according to the way of thinking of the respondents. The modified constructions and its measurement items are shown in Table S1.

3.2 Sample

Sample size needs to be calculated before conducting the survey. According to (Chin, 1998), the sample size of the questionnaire is determined by the number of variables studied and the corresponding measurement items, and the sample size should be at least 10 times the total number of measurement items. In this present study, the total number of items measured was 44. Therefore, the sample size should be more than 440. Considering the response rate and invalidation, the sample size for this study was 1000.

Henan Province is a flood-prone area in China. Spanning four major river basins: Huai River, Yangtze River, Yellow River and Hai River, it has a well-developed water system and a dense river network (Liu et al., 2018). In recent decades, flooding has occurred almost every year in the region due to a significant and continuous increase in precipitation and its uneven spatial and temporal distribution. According to incomplete statistics, there were 1152 floods in Henan Province in 1950-2004. The cumulative death toll exceeded 20,000 and the direct economic loss was about US$ 3.5 billion (Liu et al., 2017). Therefore, this paper took Henan Province as the study area and selected residents with stable income for the online survey, which was conducted from mid-August to late September 2021. The distribution of the sample is shown in Fig. 2.

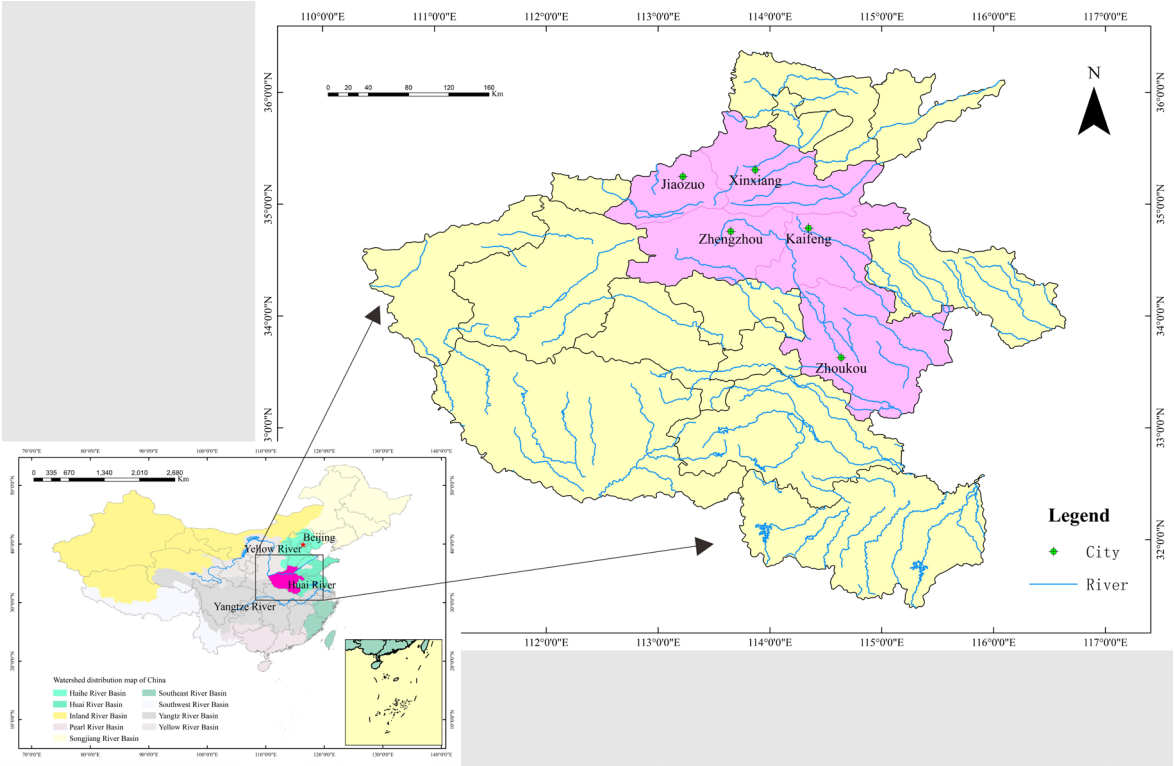

Fig. 2. Location of survey sample.

3.3 Data collection

The impact of COVID-19 prevention and control policy and frequent rainfall weather made it quite difficult to implement the field research. Therefore, we chose a professional online questionnaire platform called WenJuanXing (http://www.wjx.cn) to conduct online surveys. In addition to overcoming the above two problems, online surveys also have the advantages of saving survey time and costs, reducing data entry errors and reaching a wider group of people (Wang et al., 2019a). In China, researchers commonly use this questionnaire platform to conduct online surveys, which has over 28.7 million registered members (Zhai et al., 2020). Firstly, the designed questionnaire was uploaded to the platform, and then the platform generated an online questionnaire and an URL (Uniform Resource Locator) link of the online questionnaire. Respondents can access the questionnaire through this URL link. With the help of a computer program, this platform randomly selected 1,000 eligible people from its member roster as potential respondents and sent them the URL link to answer the survey.

To better motivate respondents to participate in the survey and increase the response rate of the questionnaire, we assured respondents that their responses were strictly anonymous and confidential, and they would be paid 9.50 RMB as remuneration upon finishing the questionnaire survey. 857 questionnaires were finally obtained after eliminating those with missing main variables and those with response time less than 180 seconds.

Table1

Operational definitions and sources for constructs.

Construct	Operational definition	Source
Intention	The extent to which individuals intend to implement measures in terms of flood prevention.	Papagiannaki et al. (2019); Terpstra (2011).
Perceived likelihood	Perceive the possibility of flood disasters.	Poussin et al. (2014); Bubeck et al. (2013).
Perceived consequence	Perceive the consequences of a flood disaster.	Poussin et al. (2014); Bubeck et al. (2013).
Response efficacy	Perceived effectiveness and usefulness of the measures in reducing losses.	Poussin et al. (2014); Bubeck et al. (2013); Bubeck et al. (2018); Grothmann and Reusswig (2006).
Self-efficacy	Perceived personal ability to implement measures.	Poussin et al. (2014); Bubeck et al. (2013); Bubeck et al. (2018).
Response cost	Individuals' expectations of the financial cost of the measures, but also the time and effort required to implement them, etc.	Poussin et al. (2014); Bubeck et al. (2013); Bubeck et al. (2018); Grothmann and Reusswig (2006).
Attitude	Personal views on the implementation of flooding measures.	Botzen et al. (2019); Grothmann and Reusswig (2006); Shao et al. (2019).
Social norm	The social pressure that people feel to act in a certain way.	Bubeck et al. (2013).
Worry	Fear of flooding and its consequences.	Papagiannaki et al. (2019); Ejeta et al. (2018).
Trust in public flood protection	Rate of trust in local authorities.	Papagiannaki et al. (2019); Lin et al. (2008); Terpstra (2011).

3.4 Research method

This study used structural equation modelling (SEM) method to analyse the survey data. It is a multivariate statistical analysis technique that is used to analyse structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyse the structural relationship between measured variables and latent constructs. This method is preferred by the researcher because it estimates the multiple as well as interrelated dependence in a single analysis and represents such relationships in the form of causal models, path diagrams, etc. Currently, this method is widely used in the social sciences. SEM is divided into two methods: covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM) (Haenlein and Kaplan, 2004). In this study, PLS-SEM is chosen for analysis because it performs more efficiently and clearly in estimating complex models involving multiple constructs compared to CB-SEM (Hair Jr et al., 2017). In addition, its assumptions on the distribution of variables and error terms are less stringent (Zhang, 2007).

SEM consists of two models: the measurement model and the structural model. The measurement model focuses on the relationship between the measured items and the constructs. The structural model focuses on the relationship between the

constructs. In the following data analysis, the reliability and validity of the variables were assessed by measurement models with the help of SmartPLS 3.0 and SPSS 22 software package, while the hypothesized relationships between the constructs were tested by structural models.

This study assessed the reliability of the measurement model using two indicators, Cronbach's alpha values and composite reliability (CR). The critical value for both indicators is 0.7 (Fornell and Larcker, 1981). For the validity evaluation of the measurement model, the factor loadings of the measurement items and the average variance extracted (AVE) of the latent variables were used to assess the convergent validity, where the critical value of factor loading value is 0.5 and the critical value of AVE is 0.5 (Fornell and Larcker, 1981). The Fornell-Larcker Criterion was used to evaluate the discriminant validity. When the square root of the AVE values of the constructs are greater than the correlation coefficient between the construct and any other constructs, the discriminant validity of the construct is acceptable (Fornell and Larcker, 1981). Meanwhile, the Heterotrait-Monotrait (HTMT) ratio of correlation was selected as an auxiliary criterion for the determination of discriminant validity (Henseler et al., 2015). Kline (2016) suggested that the HTMT ratio should be lower than 0.85.

Structural models are designed to reflect the causal pathway relationships between constructs and are the most important element in multivariate studies. This study used the coefficient of determination (R^2) to characterize the extent to which the independent variables of the current model explain the variation in the dependent variable (Chin, 1998). It is generally considered that an R^2 of 0.67 for constructs is considered to have high explanatory power, reaching 0.33 indicates moderate explanatory power, and reaching 0.19 indicates weak explanatory power. The predictive relevance of the model was assessed using the Stone-Geisser cross-validation method (Geisser, 1974), and was tested by calculating the Q^2 value through the Blindfolding Procedure. Q^2 higher than 0 indicates that the variables in the model have predictive relevance for the constructs, while Q^2 lower than 0 indicates a lack of predictive relevance (Hair Jr et al., 2021). In addition, this study used the GoF (Goodness of fit) index to verify the overall goodness of fit of the model (Tenenhaus and Amato, 2004), which is calculated as $GoF = \sqrt{\overline{communality} * \overline{R^2}}$, where communality represents the commonality of latent variables. The thresholds of GoF are 0.1, 0.25 and 0.36, which indicate that the model has weak, moderate and strong fitness, respectively (When GOF is less than 0.1, the model is unacceptable) (Wetzels et al., 2009).

4. Results

4.1 Descriptive sample information

Table 2 provides the socio-economic characteristics information of 857 respondents. The number of female respondents (53.12%) was slightly higher than the number of male respondents (46.88%). This difference is commonly statistically expected based on population statistics. Meanwhile, the respondents were concentrated between the ages of 20-40 (87.89%), which can be explained by the fact that children were excluded from the survey. A majority of respondents had a high level of education, with 74.96% holding an associate or bachelor degree, followed by master's or doctoral degree (13.51%). The

distribution of respondents' age and education level shows that the respondents are relatively young and their education levels are relatively high. This may be due to the fact that younger and better educated people are more likely to be online (Wang et al., 2019a), more concerned about heavy rainfall issues, as well as more likely to have a higher intention to answer the questionnaire. About 70.18% of respondents earn a yearly income below RMB 200,000. However, the percentage of income between 200,000-300,000 RMB is still 17.12%, which is related to the level of economic development in the regions studied. More than half of the respondents are homeowners (73.5%), and only 26.5% of the respondents are renters. In addition, the majority of respondents in this survey are from urban areas and live in areas with more than 3 floors, which is related to the level of urbanization in the surveyed cities.

Table 2

Socio-economic characteristics information of respondents (N=857).

Items	Category	Number	Percent
Gender	Male	402	46.88
	Female	455	53.12
Age	<20	1	0.12
	20-30	332	38.79
	31-40	421	49.10
	41-60	95	11.12
	>60	7	0.87
Personal yearly income (Ten thousand RMB)	<10 (<1.5 thousand US $)	351	40.94
	10-20 (1.5-3.1 thousand US $)	251	29.24
	20-30 (3.1-4.7 thousand US $)	147	17.12
	30-40 (4.7-6.3 thousand US $)	45	5.24
	40-50 (6.3-7.9 thousand US $)	37	4.37
	>50 (>7.9 thousand US $)	26	3.09
Education level	junior high school or below	29	3.44
	Senior high school	69	8.10
	Associate degree or bachelor degree	642	74.96
	Master's degree or PhD degree	116	13.51
Housing	Home ownership	630	73.50
	Tenancy	227	26.50
Floor level	First floor or basement	86	10.02
	Second floor	112	13.10
	Third or upper floors	629	73.38
	other	30	3.49

We conducted a frequency analysis of the five adaptation measures mentioned in this study, as shown in Fig. 3. About 45% of respondents were unwilling or unsure to implement structural measures, which was largely in line with our expectations, with urban residents more likely to blame housing developers for the implementation of structural measures. Of the non-structural

measures, the low-cost measures were the most attractive, with about 83% of respondents expressing a clear willingness to participate in emergency drill activities or learn about flooding. In addition, for medium-cost measures such as the purchase of emergency items, nearly 70% of respondents said they were willing to implement them, a result that far exceeded expectations and should be related to the timing of the survey we chose. People had just experienced a flood caused by a 100-year heavy rainstorm, and were impressed by the disastrous consequences of the flood and the shortage of supplies, so most residents began to pay attention to the stockpiling of emergency supplies. At the same time, we also found that 62% of respondents were unwilling or unsure about moving their homes out of the floodplain, which was strongly related to the cultural influence. Finally, on the issue of flood insurance, 53% of the respondents had the intention to purchase it. This survey also revealed that although the current prevalence of catastrophe insurance in China was low, residents had a high willingness to purchase it, which could provide an opportunity for the development and improvement of flood insurance mechanism in China.

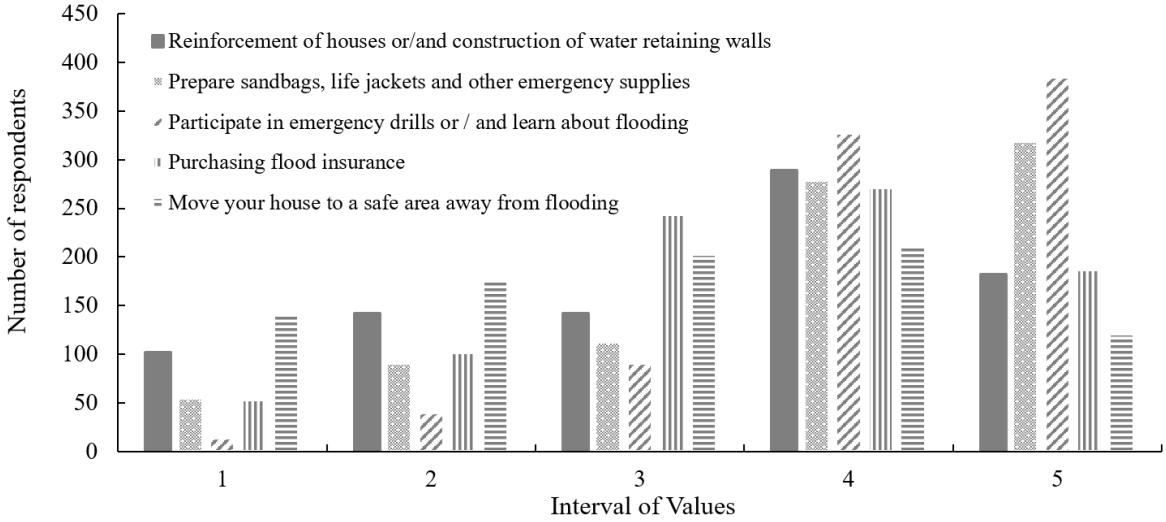

Fig. 3. Results of frequency analysis of five adaptive measures. 1=strongly unwilling, 2=unwilling, 3=undecided, 4=willing, 5=strongly willing.

4.2 Common method bias

When all data have the same source, they may have common method bias, which may have an impact on the validity of the study. Since our questionnaires were collected online, the samples were not restricted to a particular group. However, we still used Harman's one-factor test to identify any potential common method bias (Podsakoff and Organ, 1986). The effect of common method bias can be high if a single factor accounts for more than 50% of the variance (Shiau et al., 2020). Principal component factor analysis in SPSS produced 10 principal components, accounting for 61.55% of the total variance, with the first (largest) factor accounting for 15.84% of the variance, not exceeding 50%. Therefore, it can be concluded that there is no serious common method bias in this scale.

Moreover, before the factor analysis, this study first conducted the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of Sphericity on the scale (Table 3). The KMO value was 0.812 (the measurement criterion was 0.5) and the p-value of Bartlett's

test of Sphericity was 0 (the measurement criterion was $p<0.05$), which passed the significance test with a significance level of 1%. This shows that this data is suitable for factor analysis.

Table 3

Results of KMO and Bartlett's Test of Sphericity.

Kaiser-Meyer-Olkin test		0.812
Bartlett's test of Sphericity	Approximate chi-square	1019.724
	df	210.000
	Sig.	0.000

4.3 Measurement model

The scales used in this study were derived from those used in the relevant literature. These scales were modified according to the needs and usage scenarios of this study. Therefore, the scales used are content-valid.

The results of reliability and validity analysis were summarized in Table S2-S4. As can be seen from Table S2, the Cronbach's alpha values and CR of the 9 latent variables were greater than 0.7, indicating good internal consistency reliability. Meanwhile, the loadings of the measured items and the AVE values of the latent variables were greater than 0.5, indicating the convergent validity was supported. Because response cost (RC) is not a psychological construct, we did not calculate the reliability value of this variable, but instead used it as an independent variable for direct analysis. In addition, we kept the first four items according to Intention (IN). As shown in Table S3, the square roots of AVE values were ranged from 0.711 to 1. The square root of AVE value for each latent variable was larger than its correlations with other latent variables, thus proving support for discriminant validity. Besides, as presented in Table S4, HTMT values ranged from 0.026 to 0.714, which indicates that the latent variable has good discriminant validity.

4.4 Structural model

According to the evaluation steps of the structural model, it is necessary to first analyse whether there is a multicollinearity problem between the structural model's constructs. Garson (2016) argued that multicollinearity increases the error and makes the significance test of independent variables unreliable. In PLS-SEM, the variance inflation factor (VIF) was used to evaluate the multicollinearity between latent variables. The results showed that all VIF was lower than 2.1 (the critical value is 3.3.) (Hair Jr et al., 2021). Therefore, it can be determined that there is no multicollinearity problem between the predictor variables of the structural model.

Table 4 shows the results of R^2, Q^2 and GoF for PMT and the proposed model. In terms of explained variance, the R^2 of IN (intention) was 0.381, indicating that the explanatory power of PL (perceived likelihood), PC (perceived consequence), RE (response efficacy), SE（self-efficacy), RC (response cost), AT (attitude), SN(social norm), TR (trust in public flood protection) as well as W (worry) on the variance of IN was 38.1%; the R^2 of W was 0.145, which meant that PL and PC explained 14.5% of the variation in W; the R^2 of PC was 0.019, indicating that the explanatory power of TR on the variance of PC was 1.9%;

the R^2 of PL was 0.018, indicating that the explanatory power of TR on the variance of PL was 1.8%; the R^2 of AT was 0.010, indicating that the explanatory power of TR on the variation of AT was 1%. The Q^2 values of all endogenous latent variables in this study were greater than 0, which indicated that the model had good predictive power. In addition, the GoF value of the structural model was 0.375, which was greater than 0.36, indicating that the model had a good goodness of fit. In addition, Table 4 showed that the framework had a stronger explanatory power for residents' flood preparedness intentions, in addition to its stronger overall fitting and predictive power, compared to PMT (Wang et al., 2019b).

Table 4

Results of GoF, R^2 and Q^2.

Model	GoF	R^2					Q^2				
		IN	W	PC	PL	AT	IN	W	PC	PL	AT
PMT	0.432	0.323					0.197				
Proposed model	0.375	0.381	0.145	0.019	0.018	0.01	0.212	0.096	0.013	0.016	0.009

Note: IN: Intention; W: Worry; PC: Perceived consequence; PL: Perceived likelihood; AT: Attitude.

4.4.1 Direct effect analysis

The path coefficient (β), significance level, and f-square effect size (f^2) were used to determine the hypothesized relationships of the model. Significance tests for structural equation model path relationships were performed using Bias-Corrected and Accelerated (BCa) Bootstrap and two-tailed tests (significance level set at 0.05). The test results of the hypotheses are shown in Fig. 4 and Table S5.

First, the analysis supported the predicted effects of perceived likelihood (H1a; $\beta = 0.072, p < 0.01, f^2 = 0.015$) and perceived consequence (H1b; $\beta = 0.171, p < 0.001, f^2 = 0.139$) on intention. Meanwhile, we also found that perceived consequence was a significant predictor of worry ($\beta = 0.383, p < 0.001, f^2 = 0.173$). However, the analysis rejected the predicted effect of perceived likelihood on worry ($\beta = -0.003, \mathrm{ns}$). This suggested that worry only mediated between perceived consequences and preparedness intentions, so H1c ($\beta = -0.000, \mathrm{ns}$) was rejected and H1d ($\beta = 0.047, p < 0.001$) was supported. Besides, the results supported the predicted direct positive effect of worry on intention ($\beta = 0.124, p < 0.001, f^2 = 0.136$).

Second, response efficacy (H2a; $\beta = 0.358, p < 0.001, f^2 = 0.176$) and self-efficacy (H2b; $\beta = 0.190, p < 0.001, f^2 = 0.153$) had significant positive effects on intention. However, response cost (H2c; $\beta = -0.067, p < 0.05, f^2 = 0.076$) had a negative effect on intention.

Third, attitude ($\beta = -0.079, p < 0.001, f^2 = 0.097$) had a significantly negative effect on intention. Thus, H3 was supported. At the same time, there was a significant positive effect of social norms on intention (H4; $\beta = 0.084, p < 0.001, f^2 = 0.114$). Finally, the model supported the predict effects of trust in public flood protection on attitude ($\beta = -0.068, p < 0.05, f^2 = 0.089$), perceived likelihood ($\beta = -0.134, p < 0.001, f^2 = 0.135$) and perceived consequence ($\beta = -0.140, p < 0.001, f^2 = 0.149$), but rejected the predicted effect of trust in public flood protection on intention (H5d; $\beta = 0.007, ns$). As

expected, the effects of trust in public flood protection on attitudes, perceived likelihood, and perceived consequences were all negative.

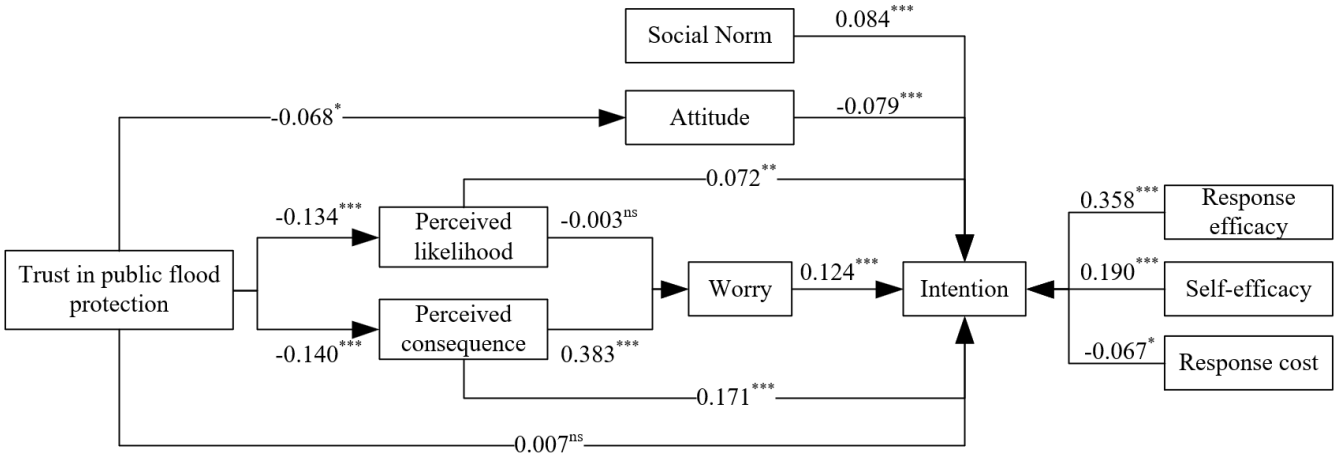

Fig. 4. Significance testing results of the structural model path coefficient. (1) Only the statistically significant direct effects are reported; (2) n=857; (3) Path significance: *** p < 0.001, ** p < 0.01, * p < 0.05, ns p>0.05.

4.4.2 Mediation effects analysis

This study abandoned the traditional Sobel method and instead used the bias-corrected nonparametric percentile Bootstrap method (Wen, 2012) to test for mediating effects. This is due to studies found that the bias-corrected nonparametric percentile Bootstrap method is more accurate than the Sobel method and has higher test power (Hayes and Scharkow, 2013). According to the mediation test procedure process provided by (Wen and Ye, 2014), Bootstrapping in PLS-SEM was used for the calculation in this study (Table S6).

First, the results supported the predicted both direct ($\beta = 0.171, p < 0.001$) and indirect effects ($\beta = 0.047, p < 0.001$) of perceived consequence on intention, so that worry mediated between perceived consequence and intention. As expected, indirect effects on preparedness intention due to the mediation of worry were found positive for perceived consequence. In line with the direction of direct effect, worry therefore acts as a complementary mediator.

Second, the results indicated that attitude mediated the effects of trust in public flood protection on preparedness intention ($\beta = 0.005, p < 0.05$). Perceived consequence mediated the effect of trust in public flood protection on worry ($\beta = -0.054, p < 0.001$) and preparedness intention ($\beta = -0.024, p < 0.001$). Meanwhile, perceived likelihood mediated the effect of trust in public flood protection on preparedness intention ($\beta = -0.010, p < 0.01$). However, the analysis rejected the mediating effect of perceived likelihood on worry ($\beta = 0.000, ns$), suggesting that H5b was rejected while H5c was supported.

Third, the output indicated that the total effect of trust in public flood protection on intention was not significant ($\beta = -0.036, ns$). Meanwhile, there was no support for a direct effect of trust in public flood protection on preparedness intention (H5d; $\beta = 0.007, ns$). Rather, the total indirect effect was significant ($\beta = -0.043, p < 0.01$) — that is, the significant effects

of attitude, perceived likelihood, perceived consequence and worry on intention fully mediated the effect of trust in public flood protection on preparedness intention. However, the effects of perceived likelihood, perceived consequence, worry, and attitude acted in opposite directions, thus leading to an insignificant total effect of trust in public flood protection on intention.

5. Discussion

To better understand the motivation of urban residents' intention to prepare against flood risk, this study developed a comprehensive theoretical framework based on PMT with a sample of urban residents in flood-prone areas of Henan Province, China. These areas experienced severe pluvial flooding events prior to the survey. The results showed that the framework had a stronger explanatory power for residents' flood preparedness intentions, in addition to its stronger overall fitting and predictive power, compared to PMT. Meanwhile, the findings suggested that the framework is useful in assessing residents' perceptions of flood risk and their intention to adopt risk-reducing behaviours.

Firstly, our study confirmed that risk perceptions about flooding can promote residents' preparedness intentions and worry emotion. The former is consistent with the study of Weyrich et al. (2020), which concluded that the higher the public's threat appraisal of flood risk, the higher the intention to implement flood mitigation measures. The latter further supports the study of Ejeta et al. (2018) that perceived risk of flooding has a direct effect on negative emotions. However, we also found that the perceived consequences of flooding alone triggered negative emotions among residents, while the perception of the likelihood did not trigger worrying emotions. From Table S7, we found that urban residents generally had higher perceived consequence to flood hazards but lower perceived likelihood of flood hazards. Besides, the perceived consequences had a greater effect on residents' worry than their intention to prepare for flooding. Also perceived consequence has a greater effect on preparedness intention than perceived likelihood. A review of post-disaster health damage showed that high-impact disasters result in more severe health impairments than moderate or low-impact disasters, and that symptoms of health impairments usually diminished over time (Norris et al., 2002). As we conducted a survey of residents' intentions to prepare immediately after the disaster, people were still impressed by the catastrophic consequences of the flood and had a great deal of negative emotions. These perceived consequences and negative emotional state made people more willing to take disaster preparedness measures.

We also found that individuals' negative emotions can effectively contribute to their flood preparedness intentions, which is consistent with the findings of Siegrist and Gutscher (2008), who suggest that negative emotions explain why flood victims take more measures than non-victims. We try to provide a reasonable explanation for the phenomenon from the perspective of emotional dysregulation (Squires et al., 2021). It is about to be argued that people's negative emotional state in response to a disaster is a dysregulated state, and people will adopt a series of psychological activities or behaviours to release this undesirable state in order to regain the balance. It becomes one of the options for residents to take certain protective measures in order to eliminate their concerns about flood risks.

Secondly, our results confirmed H2. Response efficacy and self-efficacy have a facilitating effect on residents' preparedness intentions, while response cost acts as a disincentive. This is consistent with Parker et al. (2009) study that high response

efficacy, high self-efficacy, and low response costs are positively associated with an individual's intention to take protective action. This also suggested that when a flood control strategy is perceived by residents as having high response efficacy and self-efficacy as well as low response costs, the likelihood of the strategy being implemented will be greatly increased.

Besides, H3, stating that negative risk response attitudes had negative effects on residents' flood preparedness intentions, was confirmed. As Ajzen (1991) mentions in the theory of planned behaviour, attitudes toward behaviour can effectively predict behavioural intentions. Negative attitudes towards precautionary measures lead to a reduced willingness to protect against flooding. However, the respondents seemed to have overlooked the important fact that flood risk is still a significant threat even when relatively well-established public flood protection facilities are in place (Bubeck et al., 2013). Unrealistic ideas and attitudes about individual flood safety are a barrier to preparedness intentions.

Finally, in the study of the influence of social context on residents' intention, it was found that social norms play an effective role in promoting residents' intention to prepare. These include the influence of family, neighbours or friends, and government policies. Although the contribution of norms or social networks to residents' intention to prepare has been reported in numerous literatures (Kunreuther et al., 1978; Mileti and Darlington, 1997; Bubeck et al., 2018), no plausible explanation has been given. Deutsch and Gerard (1955) argued that social norms can trigger conformity behaviour in individuals. This stems from the individual's desire to be liked by others, and there is often an emotional cost to people deviating from group norms. This conformity, triggered by social norms, may be one of the reasons why people adopt disaster preparedness measures. The facilitating effect of social norms on preparedness intentions makes it appropriate to focus on the power of social mobilization. Another social context factor to consider is public flood protection measures. In exploring the effect of trust mechanisms, contrary to our expectation, trust in public flood protection measures had not a direct effect on the preparedness intentions of urban residents. The findings also suggested that attitudes, risk perceptions, and emotions fully mediated the effect of trust in public flood protection on intention. This is in line with the findings of Terpstra (2011). It is that higher trust reduces people's perceived level of risk and ill feelings, thus reducing the intention to prepare. As Poussin et al. (2014) mentioned, trust in public flood protection brings a sense of security and therefore may be an important reason why residents are reluctant to take preventive measures.

In summary, for intra-individual factors, it was found that perceptions and affective-attitudinal paths jointly influence residents' intention, and that affect is largely influenced by perceptions. Research on social context showed that social norms and trust mechanisms were also key factors influencing residents' intention to prepare. Among them, trust in public flood protection plays an important central role. This suggests that effective communication, active social mobilization and sound policies and regulations are effective measures to increase the public's intention to prepare for floods.

6. Conclusion

Based on PMT, this study comprehensively analyses the factors that influence the willingness of Chinese urban residents to prepare for floods. Firstly, it was found that perceived risk of flooding can effectively promote residents' preparedness intention,

and therefore there is a need to raise public awareness of flood protection as well as to establish a proper relationship between citizens and government. Secondly, high response efficacy, high self-efficacy, and low response costs are positively correlated with individuals' intention to take flood protective actions. Therefore, government departments need to clearly tell residents what scientific and effective disaster prevention and mitigation measures should be taken in case of extreme flood events exceeding standards. Meanwhile, they should focus publicity on the effectiveness and ease of implementation of the measures. Besides, negative risk response attitudes negatively impacted preparedness intentions. If people do not perceive preparedness actions as absolutely necessary, they may delay implementing flood protection measures (e.g., not going to purchase flood protection products or delaying things like reinforcing their houses) or move to public flood protection measures. Therefore, government departments should implement relevant policies to stimulate residents' preparedness behaviours, such as subsidies and incentives that can be offered to households that implement measures, which can also further reduce response costs. Finally, we found that the positive effect of social norms on preparedness intentions makes it appropriate to focus on the power of social mobilization. Government departments should actively express that building resilience to flood risk at the community level requires the participation of all people and encourage the participation of the whole community in risk response in order to increase the resilience of society to risk.

However, there are still some limitations that need to be noted. On the one hand, as with all cross-sectional studies, the conclusive causal inferences drawn from this study are limited. That is, if two variables are correlated, the causal relationship between A and B is ambiguous (Lindell and Hwang, 2008). On the other hand, this study only focused on residents' preparedness intentions, and did not extend to behaviour. As mentioned by (Schifter and Ajzen, 1985), after a person has the intention to act, there may be uncertainty about his or her actual actions. Individuals may indefinitely postpone their behaviours due to non-urgency, so further questions are needed to assess the actual behaviours of respondents.

Data availability

The raw and processed data from the co-authors' research findings cannot be shared at this time, as these data are also part of the ongoing research.

Supplement

The supplement related to this article is available at Supplement.docx.

Author contributions

TW and TL initiated and led this research. TW conducted online interviews, designed questionnaires, analysed the performance of this model, and wrote the paper. YL dealt with the questionnaires and helped analyse the results. TL defined the framework of the research and revised the manuscript. XY and YiL helped in collecting data.

Competing interests

The contact author has declared that neither they nor their co-authors have any competing interests.

Acknowledgments

We are grateful to Dr. Xiaowei Li, Jiaqi Wang, Hao Li and Prof. Zhixiang Li for their valuable suggestions on our research. Meanwhile, we would like to thank the two anonymous reviewers for their careful reading, helpful comments and constructive suggestions, which greatly improved the presentation of our manuscript. Finally, thanks very much for editor Daniela Molinari's kind work and consideration on our paper.

Financial support

This research has been supported by the National Social Science Foundation of China: Fermentation Mechanism and Guidance Strategies of Extreme Social Emotions under the Situations of Combination of Routine Exercises and Actual Emergency Response (grant no. 21BGL299).

References

Abrahamse, W. and Steg, L.: Social influence approaches to encourage resource conservation: A meta-analysis, Global Environmental Change, 23, 1773-1785, https://doi.org/10.1016/j.gloenvcha.2013.07.029, 2013.

Ajzen, I.: The theory of planned behavior, Organizational Behavior and Human Decision Processes, 50, 179-211, https://doi.org/10.1016/0749-5978(91)90020-T, 1991.

Botzen, W. J. W., Kunreuther, H., Czajkowski, J., and de Moel, H.: Adoption of Individual Flood Damage Mitigation Measures in New York City: An Extension of Protection Motivation Theory, Risk Analysis, 39, 2143-2159, https://doi.org/10.1111/risa.13318, 2019.

Bubeck, P., Botzen, W. J. W., Kreibich, H., and Aerts, J. C. J. H.: Long-term development and effectiveness of private flood mitigation measures: an analysis for the German part of the river Rhine, Nat. Hazards Earth Syst. Sci., 12, 3507-3518, https://doi.org/10.5194/nhess-12-3507-2012, 2012.

Bubeck, P., Botzen, W. J., and Aerts, J. C.: A review of risk perceptions and other factors that influence flood mitigation behavior, Risk Anal, 32, 1481-1495, 10.1111/j.1539-6924.2011.01783.x, 2012.

Bubeck, P., Botzen, W. J. W., Kreibich, H., and Aerts, J. C. J. H.: Detailed insights into the influence of flood-coping appraisals on mitigation behaviour, Global Environmental Change, 23, 1327-1338, https://doi.org/10.1016/j.gloenvcha.2013.05.009, 2013.

Bubeck, P., Wouter Botzen, W. J., Laudan, J., Aerts, J. C. J. H., and Thieken, A. H.: Insights into Flood-Coping Appraisals of Protection Motivation Theory: Empirical Evidence from Germany and France, Risk Analysis, 38, 1239-1257, https://doi.org/10.1111/risa.12938, 2018.

Bubeck, P., Berghauser, L., Hudson, P., and Thieken, A. H.: Using Panel Data to Understand the Dynamics of Human Behavior in Response to Flooding, Risk Anal, 40, 2340-2359, 10.1111/risa.13548, 2020.

Buchanan, M. K., Oppenheimer, M., and Parris, A.: Values, bias, and stressors affect intentions to adapt to coastal flood risk: a case study from New York City, Weather, Climate, and Society, 11, 809-821, 2019.

Chin, W. W.: The partial least squares approach to structural equation modeling, Modern methods for business research, 295, 295-336, 1998.

Cialdini, R. B., Reno, R. R., and Kallgren, C. A.: A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places, Journal of Personality and Social Psychology, 58, 1015-1026, https://doi.org/10.1037/0022-3514.58.6.1015, 1990.

Deutsch, M. and Gerard, H. B.: A study of normative and informational social influences upon individual judgment, The Journal of Abnormal and Social Psychology, 51, 629-636, https://doi.org/10.1037/h0046408, 1955.

Diakakis, M., Priskos, G., and Skordoulis, M.: Public perception of flood risk in flash flood prone areas of Eastern Mediterranean: The case of Attica Region in Greece, International Journal of Disaster Risk Reduction, 28, 404-413, https://doi.org/10.1016/j.ijdrr.2018.03.018, 2018.

Dillenardt, L., Hudson, P., and Thieken, A. H.: Urban pluvial flood adaptation: Results of a household survey across four German municipalities, Journal of Flood Risk Management, 10.1111/jfr3.12748, 2021.

Eagly, A. H. and Chaiken, S.: Attitude Research in the 21st Century: The Current State of Knowledge, in: The handbook of attitudes., Lawrence Erlbaum Associates Publishers, Mahwah, NJ, US, 743-767, 2005.

Ejeta, L. T., Ardalan, A., Paton, D., and Yaseri, M.: Emotional and cognitive factors influencing flood preparedness in Dire Dawa town, Ethiopia, Natural Hazards, 93, 715-737, https://doi.org/10.1007/s11069-018-3321-0, 2018.

Fishbein, M. and Ajzen, I.: Predicting and Changing Behavior, Psychology press, https://doi.org/10.4324/9780203838020, 2011.

Fornell, C. and Larcker, D. F.: Evaluating Structural Equation Models with Unobservable Variables and Measurement Error, Journal of Marketing Research, 18, 39-50, https://doi.org/10.1177/002224378101800104, 1981.

Garson, G. D.: Partial Least Squares: Regression and Structural Equation Models, NC: Statistical Associates Publishers, Asheboro, 2016.

Ge, Y., Yang, G., Wang, X., Dou, W., Lu, X., and Mao, J.: Understanding risk perception from floods: a case study from China, Natural Hazards, 105, 3119-3140, https://doi.org/10.1007/s11069-020-04458-y, 2021.

Geisser, S.: A predictive approach to the random effect model, Biometrika, 61, 101-107, https://doi.org/10.1093/biomet/61.1.101, 1974.

Grothmann, T. and Reusswig, F.: People at Risk of Flooding: Why Some Residents Take Precautionary Action While Others Do Not, Natural Hazards, 38, 101-120, https://doi.org/10.1007/s11069-005-8604-6, 2006.

Haenlein, M. and Kaplan, A. M.: A Beginner's Guide to Partial Least Squares Analysis, Understanding Statistics, 3, 283-297, https://doi.org/10.1207/s15328031us0304_4, 2004.

Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M.: A primer on partial least squares structural equation modeling (PLS-SEM), Sage publications, 2021.

Hair Jr, J. F., Matthews, L. M., Matthews, R. L., and Sarstedt, M.: PLS-SEM or CB-SEM: updated guidelines on which method to use, International Journal of Multivariate Data Analysis, 1, 107-123, https://doi.org/10.1504/ijmda.2017.087624, 2017.

Haney, T. J. and McDonald-Harker, C.: "The River Is Not the Same Anymore": Environmental Risk and Uncertainty in the Aftermath of the High River, Alberta, Flood, Social Currents, 4, 594-612, https://doi.org/10.1177/2329496516669351, 2017.

Hayes, A. F. and Scharkow, M.: The Relative Trustworthiness of Inferential Tests of the Indirect Effect in Statistical Mediation Analysis: Does Method Really Matter? Psychological Science, 24, 1918-1927, https://doi.org/10.1177/0956797613480187, 2013.

Henseler, J., Ringle, C. M., and Sarstedt, M.: A new criterion for assessing discriminant validity in variance-based structural equation modeling, Journal of the Academy of Marketing Science, 43, 115-135, https://doi.org/10.1007/s11747-014-0403-8, 2015.

Hudson, P., Thieken, A. H., and Bubeck, P.: The challenges of longitudinal surveys in the flood risk domain, Journal of Risk Research, 23, 642-663, 10.1080/13669877.2019.1617339, 2019.

Jiang, T., Zhang, Q., Blender, R., and Fraedrich, K.: Yangtze Delta floods and droughts of the last millennium: Abrupt changes and long term memory, Theoretical and Applied Climatology, 82, 131-141, https://doi.org/10.1007/s00704-005-0125-4, 2005.

Kellens, W., Terpstra, T., and De Maeyer, P.: Perception and Communication of Flood Risks: A Systematic Review of Empirical Research, Risk Analysis, 33, 24-49, https://doi.org/10.1111/j.1539-6924.2012.01844.x, 2013.

Kline, R. B.: Principles and practice of structural equation modeling, Guilford publications, New York, 2016.

Kreibich, H. and Thieken, A. H.: Coping with floods in the city of Dresden, Germany, Natural Hazards, 51, 423-436, https://doi.org/10.1007/s11069-007-9200-8, 2008.

Kreibich, H., Christenberger, S., and Schwarze, R.: Economic motivation of households to undertake private precautionary measures against floods, Nat. Hazards Earth Syst. Sci., 11, 309-321, https://doi.org/10.5194/nhess-11-309-2011, 2011.

Kunreuther, H., Ginsberg, R., Miller, L., Sagi, P., Slovic, P., Borkan, B., and Katz, N.: Disaster insurance protection: Public policy lessons, Wiley New York1978.

Lin, S., Shaw, D., and Ho, M.-C.: Why are flood and landslide victims less willing to take mitigation measures than the public ?, Natural Hazards, 44, 305-314, https://doi.org/10.1007/s11069-007-9136-z, 2008.

Lindell, M. K. and Hwang, S. N.: Households' Perceived Personal Risk and Responses in a Multihazard Environment, Risk Analysis, 28, 539-556, https://doi.org/10.1111/j.1539-6924.2008.01032.x, 2008.

Liu, D., Li, Y., Fang, S., and Zhang, Y.: Influencing factors for emergency evacuation capability of rural households to flood hazards in western mountainous regions of Henan province, China, International Journal of Disaster Risk Reduction, 21, 187-195, https://doi.org/10.1016/j.ijdrr.2016.12.008, 2017.

Liu, D., Li, Y., Shen, X., Xie, Y., and Zhang, Y.: Flood risk perception of rural households in western mountainous regions of Henan Province, China, International Journal of Disaster Risk Reduction, 27, 155-160, https://doi.org/10.1016/j.ijdrr.2017.09.051, 2018.

Lo, A. Y.: The role of social norms in climate adaptation: Mediating risk perception and flood insurance purchase, Global Environmental Change, 23, 1249-1257, 10.1016/j.gloenvcha.2013.07.019, 2013.

Martin, V. Y., Weiler, B., Reis, A., Dimmock, K., and Scherrer, P.: 'Doing the right thing': How social science can help foster pro-environmental behaviour change in marine protected areas, Marine Policy, 81, 236-246, https://doi.org/10.1016/j.marpol.2017.04.001, 2017.

Meyer, R. J., Baker, J., Broad, K., Czajkowski, J., and Orlove, B.: The Dynamics of Hurricane Risk Perception: Real-Time Evidence from the 2012 Atlantic Hurricane Season, Bulletin of the American Meteorological Society, 95, 1389-1404, https://doi.org/10.1175/bams-d-12-00218.1, 2014.

Mileti, D. S. and Darlington, J. D.: The Role of Searching in Shaping Reactions to Earthquake Risk Information, Social Problems, 44, 89-103, https://doi.org/10.2307/3096875, 1997.

MILNE, S., SHEERAN, P., and ORBELL, S.: Prediction and Intervention in Health-Related Behavior: A Meta-Analytic Review of Protection Motivation Theory, Journal of Applied Social Psychology, 30, 106-143, https://doi.org/10.1111/j.1559-1816.2000.tb02308.x, 2000.

Norris, F. H., Friedman, M. J., Watson, P. J., Byrne, C. M., Diaz, E., and Kaniasty, K.: 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981-2001, Psychiatry, 65, 207-239, https://doi.org/10.1521/psyc.65.3.207.20173, 2002.

Osberghaus, D.: The determinants of private flood mitigation measures in Germany — Evidence from a nationwide survey, Ecological Economics, 110, 36-50, https://doi.org/10.1016/j.ecolecon.2014.12.010, 2015.

Owusu, S., Wright, G., and Arthur, S.: Public attitudes towards flooding and property-level flood protection measures, Natural Hazards, 77, 1963-1978, https://doi.org/10.1007/s11069-015-1686-x, 2015.

Papagiannaki, K., Kotroni, V., Lagouvardos, K., and Papagiannakis, G.: How awareness and confidence affect flood-risk precautionary behavior of Greek citizens: the role of perceptual and emotional mechanisms, Nat. Hazards Earth Syst. Sci., 19, 1329-1346, https://doi.org/10.5194/nhess-19-1329-2019, 2019.

Parker, D. J., Priest, S. J., and Tapsell, S. M.: Understanding and enhancing the public's behavioural response to flood warning information, Meteorological Applications, 16, 103-114, https://doi.org/10.1002/met.119, 2009.

Podsakoff, P. M. and Organ, D. W.: Self-Reports in Organizational Research: Problems and Prospects, Journal of Management, 12, 531-544, https://doi.org/10.1177/014920638601200408, 1986.

Poussin, J. K., Botzen, W. J. W., and Aerts, J. C. J. H.: Factors of influence on flood damage mitigation behaviour by households, Environmental Science & Policy, 40, 69-77, https://doi.org/10.1016/j.envsci.2014.01.013, 2014.

Poussin, J. K., Wouter Botzen, W. J., and Aerts, J. C. J. H.: Effectiveness of flood damage mitigation measures: Empirical evidence from French flood disasters, Global Environmental Change, 31, 74-84, https://doi.org/10.1016/j.gloenvcha.2014.12.007, 2015.

Rogers, R. W.: A Protection Motivation Theory of Fear Appeals and Attitude Change1, The Journal of Psychology, 91, 93-114, https://doi.org/10.1080/00223980.1975.9915803, 1975.

Rogers, R. W. and Prentice-Dunn, S.: Protection motivation theory, in: Handbook of health behavior research 1: Personal and social determinants., Plenum Press, New York, NY, US, 113-132, 1997.

Schifter, D. E. and Ajzen, I.: Intention, perceived control, and weight loss: an application of the theory of planned behavior, J Pers Soc Psychol, 49, 843-851, https://doi.org/10.1037/0022-3514.49.3.843, 1985.

Seebauer, S. and Babcicky, P.: (Almost) all Quiet Over One and a Half Years: A Longitudinal Study on Causality Between Key Determinants of Private Flood Mitigation, Risk Anal, 41, 958-975, 10.1111/risa.13598, 2021.

Shao, W., Feng, K., and Lin, N.: Predicting support for flood mitigation based on flood insurance purchase behavior, Environmental Research Letters, 14, https://doi.org/10.1088/1748-9326/ab195a, 2019.

Shi, P., Jaeger, C., and Ye, Q.: Integrated risk governance: Science plan and case studies of large-scale disasters, Springer2013.

Shiau, W.-L., Yuan, Y., Pu, X., Ray, S., and Chen, C. C.: Understanding fintech continuance: perspectives from self-efficacy and ECT-IS theories, Industrial Management & Data Systems, 120, 1659-1689, https://doi.org/10.1108/imds-02-2020-0069, 2020.

Siegrist, M. and Gutscher, H.: Natural Hazards and Motivation for Mitigation Behavior: People Cannot Predict the Affect Evoked by a Severe Flood, Risk Analysis, 28, 771-778, https://doi.org/10.1111/j.1539-6924.2008.01049.x, 2008.

Siegrist, M.: The necessity for longitudinal studies in risk perception research, Risk Anal, 33, 50-51, 10.1111/j.1539-6924.2012.01941.x, 2013.

Slovic, P., Peters, E., Finucane, M. L., and MacGregor, D. G.: Affect, risk, and decision making, Health Psychology, 24, S35-S40, https://doi.org/10.1037/0278-6133.24.4.S35, 2005.

Squires, L. R., Hollett, K. B., Hesson, J., and Harris, N.: Psychological Distress, Emotion Dysregulation, and Coping Behaviour: a Theoretical Perspective of Problematic Smartphone Use, International Journal of Mental Health and Addiction, 19, 1284-1299, http://doi.org/10.1007/s11469-020-00224-0, 2021.

Tenenhaus, M. and Amato, S.: A global goodness-of-fit index for PLS structural equation modelling, Proceedings of the XLII SIS Scientific Meeting, 739-742,

Terpstra, T.: Emotions, Trust, and Perceived Risk: Affective and Cognitive Routes to Flood Preparedness Behavior, Risk Analysis, 31, 1658-1675, https://doi.org/10.1111/j.1539-6924.2011.01616.x, 2011.

van Duinen, R., Filatova, T., Geurts, P., and van der Veen, A.: Coping with drought risk: empirical analysis of farmers' drought adaptation in the south-west Netherlands, Regional Environmental Change, 15, 1081-1093, https://doi.org/10.1007/s10113-014-0692-y, 2015.

van Herk, S., Rijke, J., Zevenbergen, C., and Ashley, R.: Understanding the transition to integrated flood risk management in the Netherlands, Environmental Innovation and Societal Transitions, 15, 84-100, https://doi.org/10.1016/j.eist.2013.11.001, 2015.

Von Neumann, J. and Morgenstern, O.: Theory of games and economic behavior, 2nd rev, 1947.

Wachinger, G., Renn, O., Begg, C., and Kuhlicke, C.: The Risk Perception Paradox—Implications for Governance and Communication of Natural Hazards, Risk Analysis, 33, 1049-1065, https://doi.org/10.1111/j.1539-6924.2012.01942.x, 2013.

Wang, S., Wang, J., Lin, S., and Li, J.: Public perceptions and acceptance of nuclear energy in China: The role of public knowledge, perceived benefit, perceived risk and public engagement, Energy Policy, 126, 352-360, https://doi.org/10.1016/j.enpol.2018.11.040, 2019a.

Wang, Y., Liang, J., Yang, J., Ma, X., Li, X., Wu, J., Yang, G., Ren, G., and Feng, Y.: Analysis of the environmental behavior of farmers for non-point source pollution control and management: An integration of the theory of planned behavior and the protection motivation theory, J Environ Manage, 237, 15-23, https://doi.org/10.1016/j.jenvman.2019.02.070, 2019b.

Wen, Z.: Analysis of moderating and mediating effects, Educational Science Publishing House2012.

Wen, Z. and Ye, B.: Analyses of Mediating Effects: The Development of Methods and Models, Advances in Psychological Science, 22, 731-745, https://doi.org/10.3724/sp.J.1042.2014.00731, 2014.

Wetzels, M., Odekerken-Schroder, G., and van Oppen, C.: Using Pls Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration, Mis Quarterly, 33, 177-195, https://doi.org/10.2307/20650284, 2009.

Weyrich, P., Mondino, E., Borga, M., Di Baldassarre, G., Patt, A., and Scolobig, A.: A flood-risk-oriented, dynamic protection motivation framework to explain risk reduction behaviours, Nat. Hazards Earth Syst. Sci., 20, 287-298, https://doi.org/10.5194/nhess-20-287-2020, 2020.

Zhai, Q. G., Wang, S. F., and Weadon, H.: Thriving at work as a mediator of the relationship between workplace support and life satisfaction, Journal of Management & Organization, 26, 168-184, https://doi.org/10.1017/jmo.2017.62, 2020.

Zhang, j.: Comparison of structural equation model construction methods, Statistics & Decision, 137-139, 2007.