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ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rens20

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To cite this article: Juheon Lee (2022) Preparedness behaviors for natural hazards and their association with experiences, perceptions, and social engagement in Taiwanese society, Environmental Sociology, 8:2, 161-172, DOI: 10.1080/23251042.2021.1980937

To link to this article: https://doi.org/10.1080/23251042.2021.1980937

Published online: 23 Sep 2021.

ENVIRONMENTAL SOCIOLOGY
2022, VOL. 8, NO. 2, 161–172
https://doi.org/10.1080/23251042.2021.1980937

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Preparedness behaviors for natural hazards and their association with experiences, perceptions, and social engagement in Taiwanese society

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ABSTRACT

This study examined how individuals' past experiences and perceptions of natural hazards, as well as their participation in voluntary organizations, were associated with their hazard preparedness. The study first explored how individuals' past experiences of three types of natural hazards (floods, landslides, and earthquakes), and their perceptions of hazard risk and controllability, were associated with their participation in voluntary organizations – an important indicator of social capital. This study also investigated how individuals' experiences and perceptions of natural hazards, and their participation in voluntary organizations, were associated with their adoption of preparedness behaviors for future hazards. The results of this study indicated that residents who experienced a natural hazard in the past generally reported better preparedness behaviors although the results differed according to the type of natural hazard. Both perceived risk and perceived controllability were positively associated with preparedness behavior, but perceived controllability was more strongly associated with participation in voluntary organizations.

ARTICLE HISTORY
Received 20 October 2020
Accepted 12 September 2021

KEYWORDS
Natural hazards; hazard preparedness; social capital; Taiwan; social engagement; voluntary organizations

Introduction

Hazard preparedness refers to actions that reduce the risk of damage and ensure available resources to cope with situations caused by hazards, such as relocating vehicles or household items, preparing disaster kits, and storing food and water (Najafi et al. 2017; Paton 2003). Promoting and maintaining hazard preparedness is important for the long-term development of resilience in an individual or community (Allen 2006; Hasegawa et al. 2018); however, enhancing people's hazard preparedness has proved to be complicated, since considerable government expenditure on public hazard education, and increased public awareness, have not always led to an improvement in people's preparedness behavior (Donahue 2014; Paton, Millar, and Johnston 2001). People's complacency and optimism have often caused bias and resistance to behavioral adjustments (Spittal et al. 2005; Trumbo et al. 2014), and the residents of risky areas have frequently expected government institutions and others to take care of their problems (Sadiq, Tharp, and Graham 2016). Scholars have therefore investigated the factors, such as individuals' socioeconomic backgrounds, past experiences, or perceptions of hazards, and the cognitive processes that trigger behavioral change, that may determine their hazard preparedness behaviors (Paton 2003; Reininger et al. 2013).

Apart from individual factors, more recent research has emphasized that social capital improves the level of disaster preparedness among community members. Social capital has long been studied as a resource that evolves from strong social trust, cohesion, and networking, which individuals or communities can utilize in times of need (e.g. Coleman 1990; Putnam 2001; Szreter and Woolcock 2004). Disaster scholars have examined how pre-disaster social connections, networks, and trust can be utilized during and after emergency situations – neighbors warning one another to evacuate and participating in search and rescue efforts, community members mobilizing to help each other recover and rehabilitate, and citizens working with local government to support disaster management plans (Aldrich 2019; Dynes 2006; Nakagawa and Shaw 2004). Although pre-disaster social capital has been proven to be an effective predictor of disaster response and recovery, few studies have considered how post-disaster social capital, and social capital among people with disaster experience, are associated with their preparedness for future hazards, particularly in the context of East Asia. Using a national survey conducted in 2013 across Taiwanese cities and counties, this study examined the role of social capital in enhancing individuals' hazard preparedness behaviors. Among various cognitive and behavioral indicators of social capital, it focused on people's involvement in volun-

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tary organizations, which has been an important indicator of social capital in previous studies (Curtis, Baer, and Grabb 2001; Delhey and Newton 2003; Lee and Fraser 2019; Liu and Stolle 2017; Putnam 2001). The study examined the factors associated with individuals' hazard preparedness behaviors using a two-step process: it first examined how individuals' past experiences of three main types of natural hazards in Taiwan – floods, landslides, and earthquakes – and their perceptions of the risk of natural hazards and self-rated controllability, were associated with their social behavior, as evidenced by their membership in voluntary organizations. It then examined how their experiences and perceptions, as well as their participation in voluntary organizations, were associated with their adoption of hazard preparedness actions.

This study makes the following contributions to the literature on social capital and disaster studies. First, it examined three of the most frequent types of natural hazards, of which floods are relatively frequent hazards that cause lesser destruction than landslides and earthquakes in Taiwan. The results add to the literature by revealing whether different hazards have different social impacts (see Lin, Hsiao, and Hsu 2018). Second, the study compared two slightly different perceptions of natural hazards (perceived risk and perceived controllability) and the comparison helped us to understand which perceptions had practical implications for individuals' behavioral adjustments (see Godin and Kok 1996; Terpstra 2011). Finally, the study examined two dimensions of participation in voluntary organizations: intensity and breadth of participation (see Lee and Fraser 2019). Similarly, people's adoption of preparedness behaviors was examined according to their adoption of preparedness behaviors and the number of behaviors adopted. The findings allowed us to distinguish the different dimensions of social participation and the adoption of hazard preparedness behaviors.

Personal hazard preparedness and the role of social capital

Personal hazard preparedness includes a variety of actions adopted by individuals or households to prepare for possible hazards, such as strengthening houses, purchasing insurance, stocking supplies, and participating in evacuation rehearsals (Kohn et al. 2012). Such actions can reduce the risk of damage and build resilience in individuals and communities; therefore, scholars have investigated the factors influencing individuals' disaster preparedness and self-protective behaviors (Allen 2006; Hasegawa et al. 2018). The earliest studies focused on the socioeconomic and demographic characteristics that influenced individuals' self-protective behaviors regarding hazards. Fothergill and Peek (2004) reported that poorer residents cannot afford to purchase insurance or fire protection equipment and strengthen their homes; therefore, they are not able to prepare for natural hazards as early as wealthier residents. Muttarak and Pothisiri (2013) showed that formal education is positively related to preparedness actions at the individual, household, and village levels, controlling for household income. Moreover, Fothergill (1996) pointed out that women are more likely to prepare their families for disaster than men although women are less frequently represented in formal emergency planning organizations. Preparedness tends to increase with age (Mishra and Suar 2007; Sattler, Kaiser, and Hittner 2000), although the very old are less likely to engage in preparation activities (Heller et al. 2005). Murphy et al. (2009) also showed that belonging to a majority racial group in the United States of America implies a higher level of emergency preparedness. However, in case of Taiwan, ethnic minorities showed greater psychological resilience than the majority group despite their lack of resources (Chen, Lin, and Hsu 2013). Finally, home ownership and duration of residence are also positively associated with disaster preparedness (Dooley et al. 1992; Reininger et al. 2013).

Another group of scholars focused on individuals' perceptions of disaster risk (Miceli, Sotgiu, and Settanni 2008; Terpstra 2011). In particular, these scholars assumed that individuals' previous experience of a hazard event could heighten their perceptions of risk and promote preparedness actions (Russell, Goltz, and Bourque 1995; Tekeli-Yeşil et al. 2010). Experiences of, and exposure to, natural hazards are often discussed interchangeably in disaster studies, but the aforementioned studies focused on people's memories of actual experiences (being a victim or survivor), rather than their childhood (or pre-natal) exposure or media exposure. Sattler, Kaiser, and Hittner (2000) argued that individuals with disaster experience are more likely to acknowledge a disaster threat, readily experience psychological distress, and efficiently choose appropriate courses of action compared to individuals without such experience. Other studies warned that people's risk assessments are not always consistent with their actual experiences: individuals' knowledge tends to make them overly optimistic with regard to the risk and, thus, resistant to adopting preparedness actions (Halpern-Felsher et al. 2001; Spittal et al. 2005; Trumbo et al. 2014).

A third group of scholars particularly delved into the inconsistency between peoples' risk perceptions and their levels of preparation. They focused on the emotions that victims attached to their hazard experiences and argued that people may interpret their hazard experiences differently depending on whether these experiences evoke negative emotions, which is a key factor in explaining why victims tend to take

substantially more precautionary actions against future hazards (Siegrist and Gutscher 2008; Slovic et al. 2007). Other studies indicated that peoples' knowledge and risk perceptions do not sufficiently motivate them to take self-protective actions. For example, Terpstra (2011) argued that people's actions must be preceded by their actual intention to prepare for a natural hazard, which depends on their cognitive mechanisms (e.g. what people think with regard to the consequences of a hazard) and their affective mechanisms (e.g. how they feel about having a hazard in their area). Paton (2003) also argued that the connection between intentions and actions can be disrupted by people's lack of resources for implementation, them transferring responsibility for their safety to others, their lack of a sense of belonging to their communities, and their lack of trust in information sources (Paton 2003)

Beyond individuals' sense of community, perceived responsibility, or trust, a fourth group of scholars considered social capital to be the main source of community resilience and preparedness (Aldrich 2019; Cutter et al. 2008; Norris et al. 2008). Social capital is a critical resource resulting from social cohesion and networks and utilized for collective benefit, particularly in the face of an emergency: kin, friends, and neighbors help the vulnerable to evacuate and handle stress and anxiety; town leaders reach out to sister towns for resources; and pre-disaster networks of powerful politicians and non-government organizations facilitate recovery (Aldrich 2019). Some social capital scholars have distinguished between such different resources by defining bonding social capital as a person's network of close ties (i.e. kin, neighbors, and coworkers), bridging social capital as a person's networks with socially heterogeneous groups, and linking social capital as a person's vertical networks with more powerful and resourceful bodies (see Aldrich and Meyer 2015; Szreter and Woolcock 2004). In a hazard situation, social capital encourages people to take more preparedness actions, and high social capital can increase disaster preparedness by effectively disseminating urgent and relevant information (Allen 2006; Hausman, Hanlon, and Seals 2007; Moore et al. 2004; Reininger et al. 2013).

This study built on the aforementioned studies by quantitatively examining Taiwanese individuals' demographic factors and experiences, their perceptions of natural hazards, and their social capital, all of which could affect their hazard preparedness. Among the various measures of social capital, this study focused on the behavioral aspects. According to Aldrich and Meyer (2015), behavioral manifestations of social capital are evidenced by people's participation in various social organizations (such as non-profit organizations, religious groups, and sports clubs) or by the depth of their social connections (such as number of friends and contacts to discuss problems with), while the cognitive and attitudinal aspects of social capital are measured by individuals' levels of trust in various groups of people. Although this study did not use a dataset that offered a well-rounded measure of social capital, which was a limitation of the study, participation in voluntary organizations was expected to have behavioral implications for hazard preparedness, as a few recent studies have shown that participation in voluntary organizations is closely associated with community resilience against various emergencies (Lee and Cho 2018; Lee and Fraser 2019; Lee 2020, 2021). This study first examined how people's experiences and perceptions of hazards were associated with their participation in voluntary organizations, and then investigated how participation in voluntary organizations, in turn, affected people's hazard preparedness behaviors.

Data, variables, and methods

The dataset was obtained from the Taiwan Social Change Survey (TSCS), an annual survey carried out by the Institute of Sociology, Academia Sinica, in Taiwan. The 2013 survey was especially designed to measure Taiwan citizens' perceptions of natural hazards and societal risks. Samples were selected using a stratified multistage sampling method: Taiwan's 22 county-level administrative divisions were divided into 6 categories – the metropolitan core, industrialized townships, newly developed townships, traditional industry boroughs, less-developed boroughs, and aging and remote boroughs. In each category, townships (the primary sampling unit) and villages (the secondary sampling unit) were selected and villagers older than 18 were randomly chosen for face-to-face interviews. A total of 2,005 individuals from 14 county-level divisions responded to this survey between September 2013 and November 2013, and all the responses were anonymous. The dataset was accessible through the public website of the Institute of Sociology, Academia Sinica (https://www2.ios.sinica.edu.tw/sc/en/home2.php).

The first dependent variable was the respondents' adoption of preparedness behaviors. In previous studies, individuals' emergency preparedness was measured either by asking people how many possible things they had done to prepare for emergencies (Hausman, Hanlon, and Seals 2007), or by directly asking people to indicate their levels of preparedness on a Likert scale (Reininger et al. 2013). The TSCS adopted the former approach and asked respondents if they had done any of the following things to prepare for a natural hazard: (1) 'relocate vehicles or household items to a safe place,' (2) 'obtain insurance protection against natural disasters,' (3) 'secure cabinets and shelves or domestic appliances at home,' (4) 'prepare

Table 2. Descriptive Statistics for Variables.

Variables	Value label	Mean	SD
Preparedness behavior			
Adopting any preparedness behaviors	0 No 1 Yes	0.73	0.45
Number of adopted preparedness behaviors	1–6	1.61	1.43
Participation in voluntary organizations			
Having a membership in any organizations	0 No 1 Yes	0.40	0.49
Active participation in any organization	0 No 1 Yes	0.20	0.40
Number of memberships in organization	1–6	0.62	0.96
Number of actively participating organization	1–6	0.30	0.70
Natural hazards experience			
Damage from floods	0 No 1 Yes	0.23	0.42
Damage from landslides	0 No 1 Yes	0.03	0.17
Damage from earthquakes	0 No 1 Yes	0.15	0.36
Perceptions of natural hazards			
Perceived risk	1 Very unlikely 2 3 4 5 Very likely	2.42	0.97
Perceived controllability	1 Cannot control at all 2 3 4 5 Can control	2.34	1.23
Demographic factors			
Age	20–100	47.25	17.19
Education	0 None – 21 Doctoral degree	10.48	6.51
Gender	0 Male 1 Female	0.49	0.50
Social status (self-evaluated)	1–10	4.63	1.75
Urbanization	1 Aging and remote borough 2 Less developed borough 3 Traditional industry borough/townships 4 Newly developed townships 5 Industrialized townships 6 Metropolitan cores	4.26	1.40

disaster kits,' (5) 'plan or become aware of emergency evacuation procedures,' (6) 'attend emergency evacuation rehearsals, and' (7) 'none of the above.' Two variables were created out of this question: one variable coded respondents' adoption of any of preparedness behaviors (Yes = 1/No = 0) to discover the factors associated with people's adoption/non-adoption of preparedness behaviors; the other variable coded the number of adopted preparedness behaviors (0–6) to discover the factors that helped people to increase their levels of preparedness.

Respondents' participation in voluntary organizations was used both as an output variable (in Table 3) and an explanatory variable (in Table 4) in this study. The TSCS asked the respondents if they participated in any of the following seven suggested types of voluntary organizations: political, residential, volunteer, religious, recreational, professional, and other organizations. The respondents were further asked whether they were simply members of the suggested organizations or actively participating in them. Table 1 illustrates the frequencies and percentages of participation in voluntary organizations – 39.8% of the respondents were members of at least one of the seven suggested types of organizations and 20.0% were active participants in at least one of the organizations. Furthermore, religious, recreational, and professional organizations were the three most popular types of organizations, but professional organizations had the largest number of members who were not active participants. A total of four variables were created out of this question to measure the depth and breadth of

Table 1. Participation in Voluntary Organization in Taiwan.

	Membership		Active Participation	
Organization type	Frequency	% of total respondents	Frequency	% of total respondents
Political organization	63	3.1%	14	0.7%
Residential organization	123	6.1	60	3.0%
Volunteer organization	215	10.7%	134	6.7%
Religious organization	282	14.1%	155	7.7%
Recreational organization	240	12.0%	153	7.6%
Professional organization	278	13.9%	54	2.7%
Others	52	2.6	24	1.2%
Participation in any of above organization	797	39.8%	401	20.0%

Table 3. The experience and perception of natural hazards and participation in voluntary organizations.

	Participation in any organizations		Number of participating organizations	
Participation in voluntary organizations	Having membership (1)	Active participation (2)	Having membership (3)	Active participation (4)
Natural hazard experience				
Damage from floods	0.015	−0.026	0.033	−0.015
	(0.019)	(0.024)	(0.036)	(0.033)
Damage from landslides	0.047	0.140**	0.262*	0.263**
	(0.083)	(0.058)	(0.150)	(0.129)
Damage from earthquakes	0.110***	0.091***	0.202***	0.073*
	(0.034)	(0.030)	(0.073)	(0.044)
Perceptions of natural hazards				
Perceived risk	0.007	−0.007	0.016	0.013
	(0.015)	(0.013)	(0.019)	(0.012)
Perceived controllability	0.029***	0.019***	0.070***	0.033**
	(0.006)	(0.006)	(0.008)	(0.015)
Demographic factors				
Age	0.005***	0.004***	0.011***	0.007***
	(0.001)	(0.0004)	(0.001)	(0.001)
Education	0.006***	0.006***	0.012**	0.009***
	(0.002)	(0.002)	(0.005)	(0.003)
Gender	−0.025	0.006	−0.044	0.017
	(0.016)	(0.018)	(0.036)	(0.028)
Social status	0.020***	0.024***	0.044***	0.032***
	(0.006)	(0.004)	(0.008)	(0.006)
Urbanization	0.018	0.0003	0.016	−0.002
	(0.021)	(0.014)	(0.027)	(0.024)
Duration of residence	0.013	0.012**	0.019	0.012
	(0.012)	(0.006)	(0.015)	(0.009)
County dummies				
Observations	1,917	1,917	1,917	1,917
Log Likelihood	−1,224.4	−880.3	−2,005.0	−1,258.7
AIC	2,506.8	1,818.7	4,068.0	2,575.4
Theta (std.err)	0.159	0.186	1.902*** (0.287)	0.587*** (0.083)
Pseudo R^2 (Nagelkerke)	0.120	0.120	0.176	0.155
Pseudo R^2 (CoxSnell)			0.158	0.118

Notes: *p < 0.1; **p < 0.05; ***p < 0.01; (1) and (2) are logistic regression models, and (3) and (4) are negative binomial regression models; coefficients are marginal effects at the means; standard errors are clustered by region; county dummies as fixed-effects were included but not reported in the table.

participation: (1) having a membership in any of the suggested organizations, (2) actively participating in any of the suggested organizations, (3) number of memberships in the suggested organizations, (4) number of organizations in which there was active participation.

As a key explanatory variable, people's past experience of natural hazards was included. The TSCS asked respondents whether they experienced damage from natural hazards in the past 10 years, such as bodily injury, property loss, unemployment, trauma, or other. Three frequent types of natural hazards in Taiwan were suggested: floods, landslides, and earthquakes. Table 2 shows that 23% of respondents sustained damage from floods, 3% from landslides, and 15% from earthquakes in the past. This showed that landslides and earthquakes were relatively rare types of disasters compared to floods. In order to compare the effects of different types of hazards, three separate variables were created: damage from floods; damage from landslides; damage from earthquakes.

Peoples' perceptions of natural hazards were also included. The TSCS considered people's perceived risk of hazards by asking: 'How likely do you think natural hazards, such as typhoons and earthquakes, are to occur in your neighborhood?' Answers were provided on a five-point scale ranging from 1 ('Very unlikely') to 5 ('Very likely'). Another question asked the respondents: 'How much ability do you think you have to control (or deal well with) a hazard situation if it occurs?' Answers were provided on a five-point scale, ranging from 1 ('Cannot control at all') to 5 ('Can control'). Two perception variables were created: perceived risk and perceived controllability. Perceived controllability was included in addition to perceived risk because it was similar to the concept of self-efficacy in the face of natural hazards, defined as believed personal capacity to act effectively during emergency situations (Paton 2003). Other demographic factors were also included: age, education level, gender, social status, urbanization, and duration of residence. It is important to note that coding people's ethnic background, especially for the group of indigenous people, can provide important information as previous studies have shown indigenous people's vulnerability and resilience (e.g. Chen, Lin, and Hsu 2013; Lin, Hsiao, and Hsu 2018; Huang 2018); however, in this study, ethnic background was not included because indigenous people were not represented well in the sample (there are only 26 respondents in over 2000 respondents) which can cause bias in the interpretation of the regression models. A goal of this study is to report generalizable trends of preparedness behavior among Taiwanese citizens; therefore, a focused study will

Table 4. The experience and perception of natural hazards, participation in voluntary organizations, and hazard preparedness behavior.

	Adopting any preparedness behavior				Number of adopted preparedness behaviors			
Preparedness behavior	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Participation in any organization								
Having membership	0.071***				0.293***			
	(0.015)				(0.035)			
Active participation		0.053**				0.260***		
		(0.024)				(0.053)		
Number of participating organizations								
Having membership			0.041***				0.163***	
			(0.011)				(0.024)	
Active participation				0.035**				0.147***
				(0.017)				(0.033)
Natural hazard experience								
Damage from floods	0.084***	0.087***	0.084***	0.086***	0.224***	0.237***	0.217***	0.230***
	(0.029)	(0.029)	(0.029)	(0.029)	(0.077)	(0.076)	(0.074)	(0.075)
Damage from landslides	−0.016	−0.021	−0.024	−0.024	0.049	0.028	0.017	0.024
	(0.070)	(0.071)	(0.073)	(0.073)	(0.135)	(0.137)	(0.136)	(0.139)
Damage from earthquakes	0.025	0.028	0.026	0.029	0.112*	0.121*	0.105*	0.128**
	(0.030)	(0.031)	(0.029)	(0.030)	(0.063)	(0.064)	(0.064)	(0.064)
Perceptions of natural hazards								
Perceived risk	0.056***	0.057***	0.056***	0.056***	0.185***	0.188***	0.183***	0.184***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.037)	(0.037)	(0.035)	(0.036)
Perceived controllability	0.013	0.013	0.012	0.013	0.122***	0.125***	0.117***	0.125***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.039)	(0.040)	(0.040)	(0.040)
Demographic factors								
Age	0.0002	0.0003	0.0001	0.0003	0.001	0.001	0.0003	0.001
	(0.0009)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Education	0.006**	0.006**	0.006**	0.006**	0.023***	0.023***	0.022***	0.023***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)	(0.005)	(0.006)
Gender	−0.017	−0.019	−0.017	−0.019	−0.036	−0.044	−0.033	−0.043
	(0.014)	(0.014)	(0.014)	(0.014)	(0.048)	(0.047)	(0.046)	(0.045)
Social Status	0.008	0.008	0.007	0.008	0.029	0.029	0.027	0.029
	(0.007)	(0.007)	(0.007)	(0.007)	(0.019)	(0.019)	(0.020)	(0.020)
Urbanization	−0.021	−0.020	−0.020	−0.019	−0.084*	−0.080*	−0.081*	−0.078*
	(0.021)	(0.020)	(0.020)	(0.020)	(0.050)	(0.049)	(0.048)	(0.047)
Duration of residence	−0.006**	−0.006**	−0.006**	−0.006**	−0.024*	−0.024	−0.023	−0.023
	(0.003)	(0.003)	(0.002)	(0.002)	(0.014)	(0.015)	(0.014)	(0.015)
County dummies								
Observations	1,916	1,916	1,916	1,916	1,916	1,916	1,916	1,916
Log Likelihood	−1,057.6	−1,061.2	−1,057.0	−1,061.0	−3.105.3	−3.110.3	−3,101.4	−3,109.2
AIC	2,175.2	2,182.5	2.174.0	2.181.9	6.270.6	6,280.7	6,262.8	6,278.3
Theta (std.err)	0.191	0.187	0.192	0.187	12.501***	11.735***	13.201***	11.922***
Pseudo r^2 (Nagelkerke)	0.137	0.133	0.137	0.134	(3.875)	(3.447)	(4.291)	(3.552)
Pseudo r^2 (CoxSnell)					0.222	0.217	0.225	0.218
					0.215	0.211	0.218	0.212

Notes: *p < 0.1; **p < 0.05; ***p < 0.01; (1) through (4) are logistic regression models, and (5) through (8) are negative binomial regression models; coefficients are marginal effects at the means; standard errors are clustered by region; county dummies as fixed-effects were included but not reported in the table.

be more proper to learn about indigenous people's preparedness behavior. Table 2 summarizes the list of variables with their labels, means, and standard deviations.

The output variables were either binary or count variables. For binary variables (i.e. participation in any organizations or adopting any preparedness behavior), logistic regression models were utilized. For count variables (i.e. number of participating organizations or number of adopted preparedness behaviors), negative binomial regression models were used, because negative binomial regression is better for dealing with overdispersion (c-hat > 1) in count data (Lindén and Mäntyniemi 2011). The standard errors were clustered by county-level administrative division to net out regional variations and manage heteroscedasticity. The variance inflation factor for all the models was below 2.5, which is acceptable for most social science research. In all the models, dummy variables for the county-level administrative divisions of Taiwan were included as fixed effects; however, their coefficients and standard errors are not reported in the Tables.

Results

Table 3 illustrates the statistical associations between the experiences and perceptions of natural hazards and participation in voluntary organizations. Models 1 and 2 were logistic regression models structured for the binary output variables, and Models 3 and 4 were negative binomial regression models for the count variables. The coefficients are shown as marginal effects at the means, indicating the change in the predicted probability of participation for a one-unit change in an explanatory variable. First, experience of natural hazards showed different results according to

hazard types. Damage from floods had no significant association with participation in voluntary organizations for any of the four models; however, damage from landslides and earthquakes tended to have a positive relationship with participation in voluntary organizations. Specifically, damage from landslides increased the probability of respondents' active participation in a voluntary organization (Model 2) by 14% ($b = 0.140$, $p < 0.05$), membership in a large number of voluntary organizations (Model 3) by 26.2% ($b = 0.262$, $p < 0.10$), and active participation in a large number of voluntary organizations (Model 4) by 26.3% ($b = 0.263$, $p < 0.05$); however, damage from landslides had no significant relationship with membership in a voluntary organization (Model 1). Furthermore, damage from earthquakes increased the probability of membership in a voluntary organization by 11.0% ($b = 0.110$, $p < 0.01$), active participation in a voluntary organization by 9.1% ($b = 0.091$, $p < 0.01$), membership in a large number of voluntary organizations by 20.2% ($b = 0.202$, $p < 0.01$), and active participation in a large number of voluntary organizations by 7.3% ($b = 0.073$, $p < 0.10$). These results suggested that landslides and earthquakes, which are relatively rare (but more destructive) hazards had a stronger relationship with both the depth and breadth of participation in voluntary organizations; however, damage from landslides appeared to be more closely associated with active participation than merely being a member.

Residents' perceived risk had no significant association with participation in voluntary organizations in any of the four models, but perceived controllability had a significant relationship: perceived controllability increased the chances of being a member of a voluntary organization by 2.9% ($b = 0.029$, $p < 0.01$), active participation in a voluntary organization by 1.9% ($b = 0.019$, $p < 0.01$), membership of a large number of voluntary organizations by 7.0% ($b = 0.070$, $p < 0.01$), and active participation in a large number of voluntary organizations by 3.3% ($b = 0.033$, $p < 0.05$). This result possibly indicated that people's membership of a voluntary organization was more closely associated with self-efficacy, and their perceptions of how to deal with hazard situations, than simply thinking of them as potential risks.

Among the demographic factors, age showed a positive and significant association with participation in voluntary organizations: respondents older by a year had a 0.5% higher probability of being members of voluntary organizations ($b = 0.005$, $p < 0.01$), a 0.4% higher probability of actively participating in voluntary organizations ($b = 0.004$, $p < 0.01$), a 1.1% higher probability of being members of a large number of voluntary organizations ($b = 0.011$, $p < 0.01$), and a 0.7% higher probability of active participation in a large number of voluntary organizations ($b = 0.007$, $p < 0.01$). The level of education also showed a positive and significant association with participation in a voluntary organization. A one-year increase in education increased the probability of membership of a voluntary organization by 0.6% ($b = 0.006$, $p < 0.01$), the probability of active participation in a voluntary organization by 0.6% ($b = 0.006$, $p < 0.01$), the probability of membership of a large number of voluntary organizations by 1.2% ($b = 0.012$, $p < 0.05$), and the probability of active participation in a large number of voluntary organizations by 0.9% ($b = 0.009$, $p < 0.01$). Gender, however, had no significant relationship with any aspect of participation in voluntary organizations. Social status affected the probability of participation in voluntary organizations. A one-unit increase in social status increased the probability of membership of a voluntary organization by 2.0% ($b = 0.020$, $p < 0.01$), active participation in a voluntary organization by 2.4% ($b = 0.024$, $p < 0.01$), membership of a large number of voluntary organizations by 4.4% ($b = 0.044$, $p < 0.01$), and active participation in a large number of voluntary organizations by 3.2% ($b = 0.032$, $p < 0.01$). Furthermore, urbanization was not significantly associated with participation in voluntary organizations, and duration of residence had no significant relationship with membership of a voluntary organization, but significantly increased the probability of active participation in a voluntary organization by 1.2% ($b = 0.012$, $p < 0.05$).

In Table 4, the four variables of participation in voluntary organizations were used as explanatory variables. Two sets of regression models were structured on residents' adoption of preparedness behaviors. Again, Models 1 through 4 were logistic regression models structured for a binary variable (respondents' adoption of any preparedness behavior regardless of the number of actions), and Models 5 through 8 were negative binomial models structured for a count variable (the number of preparedness behaviors adopted by the respondents). First, the respondents' participation in voluntary organizations was positively associated with their preparedness behaviors across all models; for example, Models 1 and 5 showed that membership of a voluntary organization increased the probability of adoption of any preparedness behavior by 7.1% ($b = 0.071$, $p < 0.01$) and the number of adopted preparedness behaviors by 29.3% ($b = 0.293$, $p < 0.01$). This not only supported previous studies reporting a positive relationship between social capital and hazard preparedness behaviors (e.g. Allen 2006; Hausman, Hanlon, and Seals 2007; Reininger et al. 2013), but also showed

that social capital was positively associated with both the depth and breadth of hazard preparedness behaviors.

In Table 3, respondents who experienced landslides and earthquakes showed higher rates of participation in voluntary organizations than those who experienced floods; however, with regard to the adoption of preparedness behaviors, respondents who experienced damage from floods consistently showed higher rates of adoption across models. In Models 1 and 5, damage from floods increased the probability of adoption of any preparedness behavior by 8.4% ($b = 0.084$, $p < 0.01$) and the number of adopted preparedness actions by 22.4% ($b = 0.224$, $p < 0.01$). By contrast, damage from landslides had no strong relationship. Damage from an earthquake only increased the probability of a higher number of adopted preparedness behaviors (b = 0.112, p < 0.10), but did not have a significant relationship with adopting any preparedness behavior. These results suggested that damage from floods may enhance individuals' hazard preparedness without affecting their participation in voluntary organizations; however, their experiences of earthquakes and landslides may enhance hazard preparedness through participation in voluntary organizations.

Perceived risk increased the probability of adopting any preparedness behavior by 5.6% ($b = 0.056$, $p < 0.01$) and the number of adopted preparedness behaviors by 22.4% ($b = 0.224$, $p < 0.01$). Perceived controllability had a positive association only with the number of preparedness behaviors ($b = 0.122$, $p < 0.01$). Compared with the previous results presented in Table 3, these results suggested that perceived risk and hazard preparedness were closely associated with each other, while perceived controllability was more closely associated with participation in voluntary organizations than with hazard preparedness behaviors.

Of the demographic factors, only education consistently showed a significant positive relationship with the adoption of preparedness behaviors: education increased the probability of both adoption of any preparedness behavior ($b = 0.006$, $p < 0.05$) and the number of adopted preparedness behaviors ($b = 0.023$, $p < 0.01$). Although this finding for education was consistent with previous studies (e.g. Muttarak and Pothisiri 2013), age, gender, and social status had no statistically significant relationship with preparedness behaviors. Urbanization decreased the number of adopted preparedness behaviors ($b = 0.084$, $p < 0.10$), meaning that urban residents were more reluctant to engage in hazard preparedness. In addition, duration of residence was negatively associated with preparedness behaviors ($b = -0.006$, $p < 0.05$), which was inconsistent with a previous study (Dooley et al. 1992).

Finally, the R-squared values in both tables indicate limited explanatory power of the statistical models. Although the low R-square does not invalidate the model results, it means there are other important factors that are not captured in this study. Those omitted factors may include geography, disaster history, government disaster policies, cultural characteristics, and media exposure.

Discussion

This study set out with two goals, the first of which was to determine how participation in voluntary organizations, as a measure of behavioral aspect of social capital, was associated with hazard preparedness behaviors. The results showed that individuals' participation in voluntary organizations was positively associated with their adoption of hazard preparedness behaviors. This result was consistent with previous studies, but a contribution this study made was to test the intensity and breadth of participation for different dimensions of participation: the four different measures of participation in voluntary organizations were significantly positively related to the adoption of preparedness behaviors. The difference between the coefficients was not particularly large; therefore, no noticeable differences were found between the intensity and breadth of participation. Moreover, it was interesting to note that, regardless of the types of organizations (i.e. political, residential, religious etc.), participating in a larger number of organizations was positively associated with the adoption of preparedness behaviors, indicating that people's various social networks may enhance their hazard preparedness behaviors. Similarly, two dimensions of preparedness behaviors – one being the adoption of any preparedness behavior, and the other being the number of adopted preparedness behaviors – were not noticeably different. Although this result reinforced the strong positive relationship between social capital and hazard preparedness, further studies could investigate why people's more 'active' participation in the same voluntary organizations, compared to simply having membership, did not further improve their hazard preparedness.

The second goal of this study was to examine the potential role of social capital as a mediator between people's perceptions and experiences of natural hazards and their preparedness behaviors (see Hausman, Hanlon, and Seals 2007); therefore, the study focused on the degree to which individuals' experiences and perceptions of natural hazards were associated with their participation in voluntary organizations and, in turn, their adoption of preparedness behaviors. First, it was evident that people's

experiences of floods were different from those of landslides and earthquakes. People who had sustained damage from floods did not participate more actively in voluntary organizations, but they adopted more preparedness behaviors than people who did not sustain such damage. It is possible that Taiwanese people were generally familiar with situations caused by flooding and did not need to develop specific networks for dealing with such situations. By contrast, people who experienced damage from landslides and earthquakes tended to be engaged in various social organizations, which in turn had a positive relationship with their preparedness behaviors. It is possible that experiencing certain infrequently occurring but highly destructive hazards, such as earthquakes, landslides, or volcanic eruptions, may make people feel that the risk cannot be mitigated by individual actions (Paton 2003; Spedden 1998); in other words, damage from landslides and earthquakes may encourage people to rely on their connections and networks with others, which requires further studies.

The role of participation in voluntary organizations (as a partial indicator of social capital) may explain some conflicting results in previous studies. A few studies showed that people's hazard experiences enhanced their preparedness (e.g. Russell, Goltz, and Bourque 1995; Tekeli-Yeşil et al. 2010), while other studies argued that this was not the case (e.g Halpern-Felsher et al. 2001; Spittal et al. 2005; Trumbo et al. 2014). This study suggested that the inconsistent results in previous studies may have been due to the existence or lack of social capital, which may mediate between hazard experience and preparedness behaviors; however, the examination of only three types of hazards in one society does not confirm this postulation. Further studies must be conducted regarding various types of natural hazards in different contexts.

Furthermore, along with people's experiences of natural hazards, this study investigated people's perceptions of hazards. Individuals with higher levels of perceived risk tended to show higher levels of hazard preparedness. Previous studies disputed the gap between people's risk perceptions and actual preparedness behaviors, attributing this to the victims' emotions (Siegrist and Gutscher 2008; Slovic et al. 2007), while other studies attributed it to individuals' cognitive and affective processes, (Paton 2003; Terpstra 2011). The findings of this study indicated no such gap among Taiwanese people. People who thought that they could deal with situations caused by hazards tended to be more engaged with voluntary organizations, which in turn was positively related to hazard preparedness. This suggested that social capital can potentially or partially mediate perceived controllability and preparedness behaviors. Although perceived controllability is not a widely used variable in disaster studies, it was included as a form of self-efficacy. Godin and Kok (1996) indicated that self-efficacy has a significant influence on preparedness behavior when dealing with issues perceived as largely uncontrollable. Perceived controllability was not directly associated with an individual's adoption of any preparedness behavior but had a significant association with the number of adopted preparedness behaviors. This implied that perceived controllability may not encourage people to prepare for natural hazards but can enhance preparedness behaviors among those who have already taken certain hazard preparedness actions.

The results for Taiwanese demographic factors were not as expected, based on previous studies, with the exception of education, which warrants further studies. Education level consistently showed a significant positive association with hazard preparedness, which was consistent with previous studies emphasizing the role of education. For other demographic factors, previous studies generally found that those who were wealthy, older, female, and members of majority groups were more likely to take preventive action than those who were not (Enarson and Morrow 1998; Fothergill 1996; Fothergill and Peek 2004; Mishra and Suar 2007; Murphy et al. 2009; Sattler, Kaiser, and Hittner 2000); however, none of them showed a statistically significant effect. This inconsistency may reflect Taiwan's social or cultural characteristics, which require further studies. Finally, urbanization and duration of residence showed negative associations with preparedness behaviors, which also contrasted with the results of previous studies (Dooley et al. 1992). The duration of residence was included based on the assumption that people who live in a community for a long time tend to have long-term relationships with neighbors, thereby increasing the possibility of them being involved in voluntary organizations and adopting preparedness behaviors; however, in Taiwanese society, the duration of residence is not strongly associated with social capital, and may even be negatively associated with hazard preparedness. This unexpected result, as a study on another East Asian society pointed out, may be due to rapid economic development and urbanization, which have encouraged people to relocate to newly developed areas, while older areas are left underdeveloped and impoverished. Further studies are required in this regard.

Conclusion

This paper sought to draw attention to individuals' hazard preparedness, which is important in mitigating the impact of natural hazards and examined how it might be associated with their experiences and perceptions of natural hazards and their participation in voluntary organizations. The key finding of this study

was that experiences of natural hazards were positively associated with preparedness behaviors, but the association differed according to the type of natural hazard: individuals' who experienced earthquakes and landslides tended to participate more actively in voluntary organizations than individuals who had no such experiences, and their participation in voluntary organizations, in turn, was positively associated with their preparedness behaviors; individuals who experienced floods tended to adopt preparedness behaviors without actively participating in voluntary organizations.

However, it must be noted that participation in voluntary organizations is only one of various indicators of social capital. Further studies could use other measures or examine other aspects of social capital that can play a mediating role between experiences/perceptions of natural hazards and preparedness behaviors. Moreover, this study relied on a single year's survey data; therefore, the results did not capture how people's perceptions change over time or indicate any causal relationships between variables. Further studies should be designed in ways to compare these results with surveys conducted in different years. Furthermore, this study's findings reflect the cultural characteristics of Taiwan and, thus, may not be generalizable to other social contexts. Further comparative studies may help to deepen understanding of the different natural events that affect social behaviors. We can also benefit from more qualitative approaches to the preparedness behaviors of various social and ethnic groups within Taiwan (e.g. Fortun et al. 2017; Huang 2018; Revet 2020).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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