International Institute for
Applied Systems Analysis
IIASA www.iiasa.ac.at

Social Participation and Disaster Risk Reduction Behaviours: Case Study of Tsunami-risk Areas in Southern Thailand

Witvorapong, N., Muttarak, R. and Pothisiri, W.

IIASA Interim Report
December 2013

International Institute for
Applied Systems Analysis
Schlossplatz 1
A-2361 Laxenburg, Austria

Tel: +43 2236 807 342
Fax: +43 2236 71313
E-mail: publications@iiasa.ac.at
Web: www.iiasa.ac.at

Interim Report IR-13-019

Social Participation and Disaster Risk Reduction Behaviours: Case Study of Tsunami-risk Areas in Southern Thailand

Nopphol Witvorapong (nopphol@gmail.com)

Raya Muttarak (muttarak@iiasa.ac.at)

Wiraporn Pothisiri (wiraporn.p@chula.ac.th)

Approved by

Wolfgang Lutz (lutz@iiasa.ac.at)
Program Leader, World Population Program

December 10, 2013

International Institute for Applied Systems Analysis
Registration number: ZVR 524808900

Contents

Abstract

This paper aims to examine the relationships between social participation and disaster reduction actions. A survey of 557 households in tsunami-prone areas in Phang Nga, Thailand was conducted following the 2012 Indian Ocean earthquakes. We use a multivariate probit model to jointly estimate the likelihood of three responses to earthquake hazards, including keeping close watch of news, preparing survival kits and/or having a family evacuation plan, having an intention to migrate, and community participation. We find that those who experienced losses from the 2004 tsunami are more likely to participate in community activities and respond to earthquake hazards. Compared to men, women are more likely to prepare survival kits and/or have an emergency plan as well as have a greater intention to migrate. Individuals living in a community with a higher proportion of women with tertiary education also have a greater propensity to engage in community activities and carry out disaster reduction measures. The conditional probabilities of carrying out all three risk reduction actions for individuals who have participated in village-based activities are 5.2% higher compared to those not engaging in community activities. This implies that encouraging participation in community activities can have externalities in disaster mitigation, providing opportunities for community members to exchange information and experiences that may impact disaster responses at the individual level.

Acknowledgments

Funding for this work was made possible by an Advanced Grant of the European Research Council, “Forecasting Societies Adaptive Capacities to Climate Change” (grant agreement ERC-2008-AdG 230195-FutureSoc) and Ratchadaphiseksomphot Endowment Fund of Chulalongkorn University for the project “Understanding Social Barriers to Coping with and Adapting to Extreme Climate Events” (Grant agreement number: RES560530150-CC).

About the Authors

Nopphol Witvorapong is a lecturer at the Faculty of Economics, Chulalongkorn University, Bangkok.

Raya Muttarak is a Research Scholar with the World Population (POP) Program at the Wittgenstein Centre (IIASA, VID/ÖAW, WU), International Institute for Applied Systems Analysis. Raya is also a research scientist at the Vienna Institute of Demography.

Wiraporn Pothisiri is a lecturer at the College of Population Studies, Chulalongkorn University, Bangkok.

Social Participation and Disaster Risk Reduction Behavious: Case Study of Tsunami-risk Areas in Southern Thailand

Nopphol Witvorapong
Raya Muttarak
Wiraporn Pothisiri

1 Introduction

Following the Indian Ocean Tsunami of December 2004, there has been an increased awareness of the potentially destructive impacts of tsunamis and other extreme natural events. Coastal communities are becoming increasingly vulnerable to natural hazards partially due to an increase in extreme natural events, global environmental change, and in part due to population growth and development in coastal areas. Accordingly, disaster risk reduction has become a central theme of many international development agencies.

Minimising disaster damages can be done on a variety of scales. At the level of the national or local government, examples of disaster mitigation measures include improving forecasting and warning systems, enhancing community resilience through promoting awareness of potential disaster risks, and disseminating knowledge about disaster preparedness (Huppert & Sparks 2006). Other measures include more sensible management of environmental and natural resources, all of which are non-excludable public goods. At the individual level, protective measures are important, particularly when one lives in high-risk zones. Common protective measures range from storing emergency food and water supplies and attending a first-aid course to purchasing insurance against natural disasters and preparing a household emergency plan. Emergency preparedness allows households to carry out appropriate responses if/when a disaster strikes (Tierney et al. 2001) and strengthens their capabilities to cope with the aftermath (Henry et al. 2004).

Disaster risk reduction is not a completely individualistic effort as it can also be fostered by social networks. Efforts to promote disaster risk reduction often emphasise the importance of community involvement. While external agencies such as governmental or non-governmental organisations may initiate disaster management and risk reduction programmes, the sustainability of such activities primarily depends on partnership, participation, and ownership of local communities (Shaw 2012). At the same time, community involvement in hazard mitigation also includes community empowerment in negotiating with and engaging supra-local actors such as local and central government agencies to support community-driven processes. This suggests that local resilience to natural hazards can be promoted through collective action that supports effective responses.

Accordingly, recent literature has introduced social capital as a key element in disaster risk reduction. Social capital, when seen as embeddedness in social networks

(Lin 2008) or the social structure composed of individuals and organisations, can be useful in prevention, preparation, and coping with disasters in many ways. Social networks have a diversity of functions, from sharing of expertise and resources (Crabbé & Robin 2006) and transmission of information to supporting policies and practices that contribute to greater preparedness and effective responses (Ford et al. 2006; Tompkins 2005). In this sense, social capital can be deemed as a public resource that enhances the well-being of the community.

The degree of social capital can also be considered as an individual level attribute. There is a quasi-private component of social capital that can be invested in, exchanged and inherited (Adger 2003). Similar to human capital, social capital is an important determinant of human well-being as noted by Dasgupta (1999, p.325) "social capital is a private good that is nonetheless pervaded by externalities, both positive and negative". It has been shown across different national contexts that social capital can contribute to disaster prevention and risk reduction. For example, it was reported that residents in Charleston, North Carolina who had stronger social support were more likely to evacuate before Hurricanes Hugo and Andrew than those with weaker social support (Riad et al. 1999). Likewise, membership in a social organisation is found to increase support received following a hazard event (Beggs et al. 1996; Nakagawa & Shaw 2004). On the other hand, isolated individuals are less likely to be rescued, evacuate, or receive assistance (Dynes 2005) and have a greater mortality risk (Klinenberg 2002). It can be expected that well-connected individuals should benefit from their social ties in preparation for and response to emergencies.

Regardless of the definition or the level of social capital in consideration, it is clear that social capital is positively related with disaster preparedness (Chamlee-Wright 2010; Reininger et al. 2013; Yamamura 2010). Social networks provide channels through which a perception of risk and motivations to take preventative action can be transferred. Cohesive communities are generally more prepared for hazard events since members are more willing to collaborate on solving common problems (Agrawal & Monroe 2006). At the individual level, those who participate regularly in social activities can benefit from an exchange of useful information and warnings, especially in times of emergency.

2 Determinants of Risk Reduction Actions

Preparedness actions vary considerably with personal characteristics and circumstances. Socio-demographic characteristics including age, gender, marital status, number of children, and education are reported to be associated with disaster preparedness (Dooley et al. 1992; Heller et al. 2005; Lindell & Whitney 2000; Muttarak & Pothisiri 2013; Russell et al. 1995; Turner et al. 1986). The level of preparedness is also found to increase with economic circumstances such as income and home ownership (Edwards 1993; Mulilis et al. 2000; Russell et al. 1995).

Disaster experience, as an important psychological factor, can change response activities. It may alter the understanding and perception of risk and encourage that precautionary measures be undertaken. The extent to which disaster experience has an impact on self-protective behaviour varies according to different components such as the number of disasters experienced (Russell et al. 1995), how recent the experience was (Mileti & Fitzpatrick 1992), and whether losses were incurred from the disaster (Jackson 1981; O'Brian & Mileti 1992).

Disaster experience may also influence social capital. Social capital may be eroded following a disaster, as network members may be dislocated or lost through injury or death and network resource capacity can be overwhelmed (Kaniasty & Norris 1993; Varda et al. 2009). However, disaster experience may renew or enhance social capital in a community during the disaster period. In "normal" times, citizenship obligations are modest; whereas, in times of natural disasters, as community members share the same experience, they may feel more attached to each other, in which case a sense of belonging is generated and gains from cooperation are better realised (Dynes 2002). In high risk areas, being regularly exposed to natural disasters induces communities to diffuse information concerning preventive measures and enables them to cope with risks through collective learning (Yamamura 2010). The experience reinforces social trust and community participation (Yamamura 2010; Yamamura 2013), which in turn becomes useful in risk reduction.

The above-mentioned literature suggests that disaster risk reduction actions are determined by several factors. Figure 1 summarises determinants of risk reduction behaviours and relationships among them. Social capital is associated with risk reduction actions. At the same time, both social capital and risk reduction behaviours are determined by individual characteristics and previous disaster experience, which are observable. However, there could be unobserved characteristics of an individual such as risk aversion, attitudes or beliefs that influence both social capital investment, and undertaking risk reduction actions. If this is the case, social capital and risk reduction actions are jointly determined and should be estimated simultaneously.

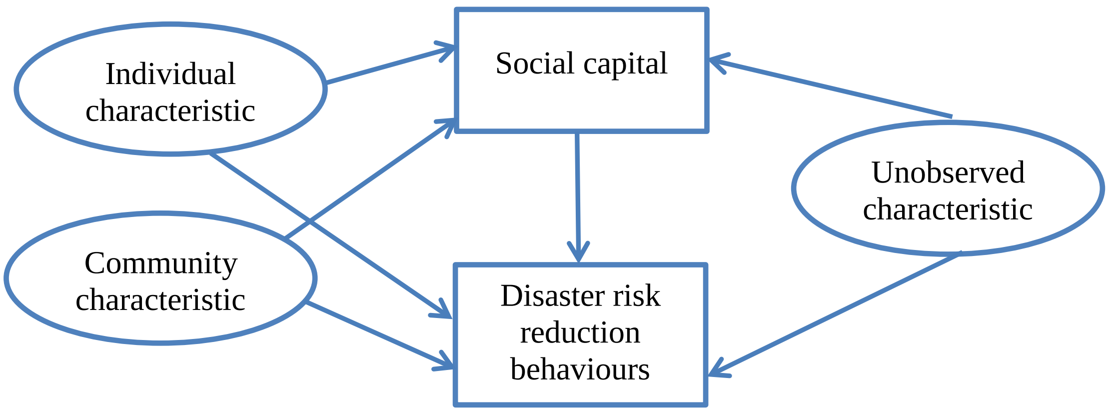

Figure 1. Relationships among individual and community characteristics, social capital and disaster reduction behaviours

While previous studies have investigated the role of social capital on disaster prevention, preparedness, and recovery (Aldrich 2011a; Aldrich 2011b; Bihari & Ryan 2012; Reininger et al. 2013), few studies have considered the possibility that the investment in social capital and risk reduction behaviours can be jointly influenced by the same underlying characteristics. This paper aims to explore determinants of disaster risk reduction behaviours (measured as disaster preparedness and migration intention) and social capital (measured as social participation), and examine the relationships between the two actions. It uses a survey of 557 households located along the western coastline of Southern Thailand in Phang Nga province, conducted immediately after the 11 April 2012 Indian Ocean earthquakes. Controlling for individual and community characteristics and accounting for unobserved heterogeneity, we hypothesise that disaster experience influences both social participation and an undertaking of actions to reduce disaster risk and that social participation positively influences the level of disaster preparedness.

3 Study Area and Context of Disaster Risks

Phang Nga province was chosen for the study because the province was the worst affected area of the six tsunami-affected provinces in Thailand in 2004. The province suffered the greatest human loss and incurred a massive economic impact due to damages to buildings and basic infrastructure (Nidhiprabha 2010). Relying on its own resources for reconstruction, five years later, the affected areas were seen as having fully recovered (Willroth et al. 2011). Following the 2004 Indian Ocean tsunami, tsunami warning systems were installed and regular drills were introduced. Tsunami experience together with various campaigns for disaster risk reduction were expected to have raised awareness and encouraged risk reduction actions among Phang Nga residents.

The 2012 Indian Ocean earthquake provides a unique opportunity to investigate risk reduction behaviours of households residing in tsunami-risk areas in Phang Nga. On 11 April 2012, a powerful magnitude 8.6 undersea earthquake struck 434km southwest of the Indonesian province of Banda Aceh in northern Sumatra. It was followed by another major shock (M8.2) as well as numerous aftershocks (USGS 2012). This triggered a tsunami warning for countries along the Indian Ocean rim including six provinces located along the western coastline of Southern Thailand. Although a massive tsunami did not occur because the tectonic plates shifted horizontally rather than vertically like in 2004, the event was seen an actual test of the warning system and evacuation procedures (Natural Sciences Sector 2012; Singh 2012).

The April 2012 Indian Ocean quake triggered numerous earthquakes of M4.5 and greater worldwide (Pollitz et al. 2012). In particular, on 16 April 2012, an earthquake of 4.3 magnitude struck Phuket with its epicentre at Thalang district, 22km away from Phang Nga. This quake was followed by a series of more than 26 aftershocks between 16 and 22 April 2012. During that period, both the 11 April Indian Ocean quake and Phuket quakes sparked fear among locals and tourists especially in the areas previously damaged by the 2004 tsunami. Rumours were spread that Phuket could be submerged due to the quakes. Residents in the region were put on high alert for fear of a disaster similar to that of 2004.

4 Data

The analysis is based on two data sources. The data at the individual level are obtained from a survey of households located on a tsunami high-risks area that was conducted immediately after the Indian Ocean earthquakes and during and just after the period of the minor earthquakes between 17 April and 13 May 2012 by the College of Population Studies, Chulalongkorn University. The period of the survey was timely as risk reduction behaviours could be observed in the moment when preparedness was being tested by real events.

The process of collecting the individual-level data can be described as follows. First, seven sub-districts that had been issued tsunami warnings on 11 April 2012 by the Department of the Disaster Prevention and Mitigation (DDPM) were selected. Then, nine villages within the seven sub-districts were randomly selected as interview sites. Interviews were face-to-face and carried out in the Thai language by trained interview staff and local researchers. In each village, 30% of the households were selected for interview through systematic random sampling. The interviewers first approached the head of household; in the head of household's absence, the spouse or a household member aged 15 years or older was asked to participate. The questions asked ranged from basic demographic and socio-economic characteristics of the respondent and the household to awareness of, response to, and preparedness for the 2012 Indian Ocean earthquakes. Questions regarding experience with the previous 2004 tsunami, social activities engaged in, and channels of information received were also included. The final sample consists of 557 households with valid responses to all questions used in the analysis.

The other source of data comes from the 2010 Population and Housing Census, supplied in an aggregated form by the National Statistical Office, Thailand. It contains a basic demographic profile and education at the village level.

4.1 Outcome Variables

The outcomes of interest are disaster reduction behaviours and social capital. Since the survey was carried out during the period of aftershocks, we treat the Indian Ocean earthquake as a trigger that prompted individuals to react to potential disaster risks. Three actions of disaster reduction are considered: 1) close watching of the news; 2) preparation of survival kits or a household evacuation plan; and 3) migration intention. The first two activities are derived from a specific question in the survey which asks: "Have you or your family taken any preparedness actions after the 11 April 2012 Indian Ocean earthquake?". Migration intention is derived from a question which asks: "Have you or your family thought about moving to other areas after the 2012 Indian Ocean earthquake?". Moving away from disaster-prone areas is one way to reduce exposure to disaster risks. Migration intention is shown to be a powerful predictor of actual mobility (Bradley et al. 2008; Lu 1998). Here, intention to migrate is considered to be one indicator of risk reduction behaviour.

Social capital is measured in terms of social participation. Participation in community activities such as volunteering, religious involvement, or membership in an association allows people to interact and provides a venue to create trust among group members (Putnam 1995a; Putnam 1995b). Social participation creates networks to disseminate information and allows social trust to ossify. There is evidence that risky health behaviours is lower among those who engage in social and club activities (Hyyppä & Mäki 2003). We thus hypothesise that social participation may promote risk reduction behaviours likewise. Social participation is derived from the question asking how often the respondent participates in community activities in the past 12 months. Individuals who participate in community activities sometimes or regularly are code 1; those who do not are coded 0.

Determinants of Risk Reduction Behaviours and Social Participation

Individual Characteristics

Individual characteristics that can influence risk reduction behaviours and social participation include age, gender, marital status, employment status, health, and status in household. Experience of the 2004 tsunami is also considered. Experience is measured as the degree of impacts received from the 2004 tsunami, i.e. whether the individual experienced loss of life, injury, or loss/damage of property.

Household Characteristics

Risk reduction actions and social participation can be associated with household characteristics including number of household members, proportion of dependent members (those aged <5 years and those aged >60 years and over), whether a household has a disabled member, household income, and years of household settlement in the community. We also consider household location, i.e. whether the house is situated on a coastline.

Village Characteristics

Given that risk reduction and social participation often take the form of collective action, demographic characteristics of the village, namely, the number of households, percentage of female population, and percentage of women with tertiary education are considered.

Table 1. Dependent Variables

Disaster Preparedness Measures	**Percentage**
Whether the person followed news about the earthquake	
Yes	59.78%
No	40.22%
Whether the person had prepared evacuation kits or formed an evacuation plan	
Yes	36.80%
No	63.20%
Whether, after the earthquake, the individual expressed desire to move	
Yes	19.21%
No	80.79%
Whether the individual participated in village-based social events	
Yes	74.15%
No	25.85%
Number of observations	557

Table 1 shows the distribution of the four dependent variables. Almost two-thirds of the respondents reported having kept a close watchof the news while about one-third mentioned that their households had prepared emergency kits and/or formed an evacuation plan. One-fifth of the respondents expressed an intention to migrate from tsunami-risk areas. For a given individual, keeping close watch of news presumably takes the least effort, followed by stockpiling emergency supplies or forming an evacuation plan, while migrating out of the area requires the most effort. The frequencies seem to reflect the effort level involved in each disaster reduction action.

74.15% of the sample reported having participated in social events at the village level, suggesting a close-knitted network, consistent with what is usually observed in disaster-prone areas.

Table 2. Descriptive Statistics of the Sample

Variables	Mean	Standard Deviation
Personal Characteristics		
Head of household = 1	0.603	0.489
Female = 1	0.549	0.498
Age between 15 - 29 = 1	0.126	0.332
Age between 30 - 39 = 1	0.190	0.393
Age between 40 - 49 = 1	0.242	0.429
Age between 50 - 59 = 1	0.219	0.414
Married = 1	0.702	0.458
Having primary education = 1	0.345	0.476
Having secondary education = 1	0.242	0.429
Having tertiary education = 1	0.092	0.289
Economically inactive = 1	0.203	0.402
Bad subjective health = 1	0.099	0.299
Having lost a family member or had an injured family member in the 2004 tsunami = 1	0.458	0.498
Household Characteristics		
Number of household members	3.865	1.984
Percentage of members with more than secondary education	28.659	0.293
Percentage of dependent members	35.337	0.308
Having a disabled family member = 1	0.043	0.203
Monthly income between 10,000 - 19,000 THB = 1	0.400	0.490
Monthly income more than 20,000 THB = 1	0.244	0.429
Length of settlement in the area of the family relative to the respondent's age	0.563	0.342
Whether the household sits on a coastline = 1	0.126	0.332
Village Characteristics		
Percentage of female population	45.193	2.499
Percentage of female population with tertiary education	4.067	1.535
Number of households	623.011	459.047
Number of Observations	557	

Table 2 contains summary statistics of explanatory variables. At the individual level, 60% of the 557 responses came from the head of the household. Most respondents were female (54.9%) and almost 70% were middle-aged (aged between 30 – 60 years). The majority was married (approximately 70%) and had only primary education (34.5%). The reference education group was no formal education, accounting for over 30% of the sample. Approximately 80% of the sample was engaged in some form of work and about 90% reported having good or average subjective health. 45.8% had experienced a loss in the 2004 tsunami. The average household size of the sample was 3.9 members, of which about 29% had more than secondary education (as the younger generations have been subjected to compulsory secondary education (9 years) since 2003). The combination of young children (under 5) and elderly individuals made up approximately 35% for an average household while only 4.3% of the sampled households had a disabled family member. About 40% of the households had an income between 10,000 and 19,000 THB (approximately 330 – 660 USD) per month and 24.4% had more than 20,000 THB per month. The rest earned less than 10,000 THB. An average respondent reported that their families had lived in the area for over half of his/her life. Only 12.6% of the households lived in a house that was on the coastline. For an average village in the sample, the number of households was around 623 and there were more males than females (55% versus 45%), with only 4% of all females having tertiary education.

5 Empirical Model

Four binary outcomes of interest are jointly estimated: whether or not an individual i followed news about the earthquakes ($NEWS_i$), prepared any survival kits and/or formed any evacuation plans ($EVAC_i$), expressed the desire to move from the area after the earthquakes ($MOVE_i$), and participated in village-based social events (SOC_i). Given that the four outcomes may not be independent to one another, we estimate a multivariate probit model with four dependent variables. Under this framework, the following latent variable models are assumed:

$$NEWS_i^* = X_i'\beta_N + \varepsilon_{Ni} \quad (1)$$

$$EVAC_i^* = X_i'\beta_E + \varepsilon_{Ei} \quad (2)$$

$$MOVE_i^* = X_i'\beta_M + \varepsilon_{Mi} \quad (3)$$

$$SOC_i^* = X_i'\beta_S + \varepsilon_{Si} \quad (4)$$

The observed outcome takes the value of 1 when its associated latent variable exceeds the value of zero. In other words, where $y_{id} \in \{NEWS_i, EVAC_i, MOVE_i, SOC_i\}, y_{id} = 1$ if $y_{id}^* > 0$ and $y_{id} = 0$ otherwise. β represents a vector of coefficients to be estimated and ε is the error term for each equation.

The four error terms are assumed to be correlated according to a multivariate normal distribution such that

$$\begin{bmatrix} \varepsilon_{Ni} \\ \varepsilon_{Ei} \\ \varepsilon_{Mi} \\ \varepsilon_{Si} \end{bmatrix} \sim N \left[\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho_{NE} & \rho_{NM} & \rho_{NS} \\ \rho_{NE} & 1 & \rho_{EM} & \rho_{ES} \\ \rho_{NM} & \rho_{EM} & 1 & \rho_{MS} \\ \rho_{NS} & \rho_{ES} & \rho_{MS} & 1 \end{bmatrix} \right] = N(0, \Omega)$$

where Ω is the variance-covariance matrix of the error terms. The variance-covariance matrix is notably symmetric. Each rho (ρ) represents the conditional tetrachoric correlation for each pair of outcomes, measuring the extent to which the two outcomes would covary if unobserved characteristics of an individual were indeed observed.

The cumulative distribution function of the above model is given by

$$\Pr(NEWS_i = 1, EVAC_i = 1, MOVE_i = 1, SOC_i = 1)$$
$$= \int_{-\infty}^{\varepsilon_{Ni}} \int_{-\infty}^{\varepsilon_{Ei}} \int_{-\infty}^{\varepsilon_{Mi}} \int_{-\infty}^{\varepsilon_{Si}} \phi_4(X_i'\beta_N, X_i'\beta_E, X_i'\beta_M, X_i'\beta_S;\ \rho_{NE}, \rho_{NM}, \rho_{NS}, \rho_{EM}, \rho_{ES}, \rho_{MS})d\,\varepsilon_{Ni}d\,\varepsilon_{Ei}d\varepsilon_{Mi}d\varepsilon_{Si}$$
$$= \Phi_4(X_i'\beta_N, X_i'\beta_E, X_i'\beta_M, X_i'\beta_S;\ \rho_{NE}, \rho_{NM}, \rho_{NS}, \rho_{EM}, \rho_{ES}, \rho_{MS})$$

where ϕ_4 is the joint probability density function of the fourth order. Conditional upon the empirical significance of the ρ's above, the log likelihood function becomes

$$\ln L = \sum_{i=1}^{N} NEWS_i * EVAC_i * MOVE_i * SOC_i * \ln \Phi_4(X_i'\beta_N, X_i'\beta_E, X_i'\beta_M, X_i'\beta_S;\ \rho_{NE}, \rho_{NM}, \rho_{NS}, \rho_{EM}, \rho_{ES}, \rho_{MS}).$$

The fact that the regular maximum likelihood method would require four integrals makes the method computationally burdensome. Instead, when the number of integrals is higher than two, following Cappellari and Jenkins (2003), the model is estimated using the simulated maximum likelihood (SML) method based on the Geweke-Hajivassiliou-Keane recursive simulator. The use of a multivariate probit here mirrors the conceptual framework where all outcomes of interest take place simultaneously.

6 Results

Table 3. Coefficient Estimates from Multivariate Probit Regression Model

Variables	Close Watch of News	Evacuation Kits/ Plans	Intention to Move	Social Participation
Personal Characteristics				
Head of household	-0.101	0.017	-0.228	0.055
	(0.145)	(0.150)	(0.183)	(0.168)
Female	-0.076	0.345*	0.417*	-0.057
	(0.135)	(0.141)	(0.166)	(0.152)
Age between 15 - 29	0.282	0.095	-0.628+	0.056
	(0.274)	(0.270)	(0.354)	(0.279)
Age between 30 - 39	0.229	-0.184	0.129	0.261
	(0.222)	(0.232)	(0.283)	(0.244)
Age between 40 - 49	0.153	-0.287	0.135	0.283
	(0.210)	(0.226)	(0.258)	(0.218)
Age between 50 - 59	0.173	0.067	0.0312	0.430+
	(0.205)	(0.223)	(0.264)	(0.222)
Married	0.227+	0.234	-0.042	0.018
	(0.136)	(0.143)	(0.165)	(0.151)
Having primary education	-0.319*	0.133	0.267	-0.173
	(0.153)	(0.158)	(0.179)	(0.162)
Having secondary education	-0.307	0.228	0.203	0.197
	(0.211)	(0.207)	(0.276)	(0.210)
Having tertiary education	-0.230	0.543*	0.412	-0.0068

Variables	Close Watch of News	Evacuation Kits/ Plans	Intention to Move	Social Participation
	(0.268)	(0.276)	(0.352)	(0.276)
Economically inactive	-0.003	0.141	0.099	0.193
	(0.162)	(0.163)	(0.191)	(0.164)
Bad subjective health	0.175	0.364	0.258	-0.264
	(0.190)	(0.222)	(0.253)	(0.206)
Bad experience in the 2004 tsunami	0.296*	-0.017	0.393**	0.517***
	(0.123)	(0.130)	(0.151)	(0.130)
Household Characteristics				
Number of household members	-0.014	-0.011	0.050	-0.004
	(0.031)	(0.032)	(0.038)	(0.034)
% with > secondary education	0.480+	0.169	0.258	-0.212
	(0.250)	(0.268)	(0.344)	(0.269)
% of dependents	-0.304	0.106	0.119	0.219
	(0.243)	(0.253)	(0.295)	(0.253)
Presence of disabled member	0.446	0.675*	0.312	0.561
	(0.322)	(0.288)	(0.312)	(0.381)
Income 10,000 - 19,000 THB	-0.205	0.203	-0.061	-0.214
	(0.138)	(0.146)	(0.165)	(0.149)
Income > 20,000 THB	-0.119	0.068	-0.348	-0.070
	(0.164)	(0.172)	(0.219)	(0.179)
Length of settlement	0.128	-0.126	0.109	0.002
	(0.188)	(0.190)	(0.246)	(0.204)
House on a coastline	-0.084	0.195	0.716***	-0.114
	(0.177)	(0.173)	(0.193)	(0.184)
Village Characteristics				
% female population	-0.106***	-0.165***	-0.183***	-0.058+
	(0.032)	(0.032)	(0.047)	(0.032)
% females with tertiary education	0.167***	0.216***	0.369***	0.115**
	(0.039)	(0.042)	(0.056)	(0.041)
Number of households	-0.0006***	0.0002	-0.0004**	-0.0001
	(0.0002)	(0.0001)	(0.0002)	(0.0002)
Constant	4.603**	5.410***	5.025*	2.537
	(1.514)	(1.481)	(2.117)	(1.553)
$\boldsymbol{\rho}$ (Evacution & News)		0.094		
		(0.075)		
$\boldsymbol{\rho}$ (Evacuation & Move Intention)		0.130		
		(0.091)		
$\boldsymbol{\rho}$ (News & Move Intention)		0.061		
		(0.088)		
$\boldsymbol{\rho}$ (News & Social Participation)		0.418***		

Variables	Close Watch of News	Evacuation Kits/ Plans	Intention to Move	Social Participation
		(0.079)		
ρ (Evacuation & Social Participation)		0.135+		
		(0.081)		
ρ (Move Intention & Social Participation)		0.183+		
		(0.103)		
LR Joint Test of *ρ*'s		33.258***		
Wald Test: Overall Significance		87.810***		
Log Psuedolikelihood		-1125.59		
Observations		557		

Notes: Coefficient estimates are based on 25 GHK draws with the (default) seed value of 123456789.
Robust standard errors are in parentheses.
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Coefficient estimates from a multivariate probit model are provided in Table 3. The four binary outcomes are jointly estimated using the simulated maximum likelihood approach that is based on the seed value of 123456789 and the fact that each (simulated) error term is drawn 25 times. It should be noted that the number of draws here is larger than the recommended value of the square root of the sample size (i.e. $\sqrt{557}$) (Cappellari & Jenkins 2003). Not all pairwise ρ's are statistically significant individually. In particular, the correlation between the error term of each of the three disaster responses i.e. 1) keeping close watch of news (ρ =0.418), 2) preparing survival kits or having family evacuation plan (ρ =0.135), or 3) having intention to migrate (ρ =0.183), and that of social participation is statistically significant, but among the three disaster responses themselves, it is not. Nevertheless, the use of the multivariate probit model is justified by the joint significance of ρ's at the 0.1% level under the likelihood ratio test.

Table 4. Marginal Effects from Multivariate Probit Model

Variables	Close Watch of News	Evacuation Kits/ Plans	Intention to Move	Social Participation
Personal Characteristics				
Head of household	-0.035	0.005	-0.047	0.016
	(0.051)	(0.048)	(0.037)	(0.050)
Female	-0.026	0.109***	0.086**	-0.017
	(0.047)	(0.044)	(0.034)	(0.045)
Age between 15 - 29	0.098	0.030	-0.129+	0.017
	(0.095)	(0.086)	(0.072)	(0.082)
Age between 30 - 39	0.080	-0.058	0.026	0.077
	(0.077)	(0.074)	(0.058)	(0.072)
Age between 40 - 49	0.053	-0.091	0.028	0.084
	(0.073)	(0.071)	(0.053)	(0.064)
Age between 50 - 59	0.060	0.021	0.006	0.127**

Variables	Close Watch of News	Evacuation Kits/ Plans	Intention to Move	Social Participation
	(0.071)	(0.071)	(0.054)	(0.065)
Married	0.079+	0.074+	-0.009	0.005
	(0.047)	(0.045)	(0.034)	(0.045)
Primary education	-0.111**	0.042	0.055	-0.051
	(0.053)	(0.050)	(0.036)	(0.048)
Secondary education	-0.107	0.072	0.042	0.058
	(0.073)	(0.065)	(0.056)	(0.062)
Tertiary education	-0.080	0.172*	0.084	-0.002
	(0.093)	(0.087)	(0.072)	(0.081)
Economically inactive	-0.001	0.045	0.020	0.057
	(0.056)	(0.052)	(0.039)	(0.048)
Bad subjective health	0.061	0.115+	0.053	-0.078
	(0.066)	(0.070)	(0.052)	(0.061)
Bad experience in the 2004 tsunami	0.103**	-0.005	0.081***	0.153***
	(0.042)	(0.041)	(0.030)	(0.037)
Household Characteristics				
Household members	-0.005	-0.004	0.010	-0.001
	(0.011)	(0.010)	(0.008)	(0.010)
% with > secondary education	0.167*	0.054	0.053	-0.063
	(0.087)	(0.085)	(0.071)	(0.079)
% of dependents	-0.106	0.034	0.024	0.065
	(0.084)	(0.080)	(0.061)	(0.075)
Presence of disabled member	0.156	0.214*	0.064	0.166
	(0.112)	(0.090)	(0.064)	(0.112)
Income 10,000 - 19,000 THB	-0.071	0.064	-0.012	-0.063
	(0.048)	(0.046)	(0.034)	(0.044)
Income> 20,000 THB	-0.041	0.021	-0.071	-0.021
	(0.057)	(0.054)	(0.044)	(0.053)
Length of settlement	0.045	-0.040	0.022	0.001
	(0.065)	(0.060)	(0.050)	(0.060)
House on a coastline	-0.029	0.062	0.147***	-0.034
	(0.062)	(0.055)	(0.038)	(0.054)
Village Characteristics				
% female population	-0.037***	-0.052***	-0.038***	-0.017*
	(0.011)	(0.009)	(0.009)	(0.009)
% females with tertiary education	0.058***	0.068***	0.076***	0.034***
	(0.013)	(0.012)	(0.010)	(0.012)
Number of households	-0.0002***	0.00007	-0.0001***	-0.00004
	(0.00005)	(0.00005)	(0.00003)	(0.00005)

Notes: Standard errors are in parentheses and they are calculated using the delta method.
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

To be able to interpret the results in terms of the probability, for each equation, marginal effects of all explanatory variables are given in Table 4. At the individual and household level, being female is associated with 10.9% and 8.6% higher probabilities of having evacuation kits and/or an emergency plan, and having an intention to migrate. Older individuals, especially those between 50 and 59 years of age, are more likely to participate in social events. Being married is linked with a 7.9% and a 7.4% increase in the probabilities of keeping close watch of news and forming an evacuation plan. Respondents with tertiary education and those having a disabled person in the household have a greater propensity to prepare for survival kits and/or establishing a family evacuation plan. The most important predictor is, as hypothesised, whether the individual was affected by the 2004 tsunami in terms of loss of property or life; this characteristic is a key driver of the likelihood of keeping close watch of news (10.3%), intention to migrate (8.1%), and social participation (15.3%).

Some village characteristics are also associated with the four outcomes. In general, an increase in the proportion of women in the village leads to a reduction in both disaster responses and social participation. However, the opposite is true with respect to the proportion of women with tertiary education. The greater the proportion of women with tertiary education in the village, the greater the likelihood of keeping close watch of news, preparing survival kits and/or initiating a family evacuation plan, and intending to migrate as well as participating in village-based activities.

Table 5. Fit of the Model: Prediction of Univariate and Joint Probabilities

Events	Predicted	Actual	Difference
News = 1	0.594	0.598	-0.004
	(0.171)		
Evac = 1	0.370	0.368	0.002
	(0.207)		
Move = 1	0.192	0.192	-0.001
	(0.192)		
Soc = 1	0.740	0.741	-0.001
	(0.135)		
News = 0, Evac = 0, Move = 0, Soc = 0	0.116	0.127	-0.011
	(0.103)		
News = 1, Evac = 0, Move = 0, Soc = 0	0.058	0.052	0.005
	(0.039)		
News = 0, Evac = 1, Move = 0, Soc = 0	0.036	0.029	0.007
	(0.032)		
News = 0, Evac = 0, Move = 1, Soc = 0	0.008	0.002	0.006
	(0.009)		
News = 0, Evac = 0, Move = 0, Soc = 1	0.138	0.135	0.003
	(0.092)		
News = 1, Evac = 1, Move = 0, Soc = 0	0.025	0.025	0.000
	(0.022)		
News = 1, Evac = 0, Move = 1, Soc = 0	0.006	0.007	-0.001
	(0.008)		
News = 1, Evac = 0, Move = 0, Soc = 1	0.230	0.230	0.000

Events	Predicted	Actual	Difference
	(0.105)		
News = 0, Evac = 1, Move = 1, Soc = 0	0.006	0.007	-0.001
	(0.009)		
News = 0, Evac = 1, Move = 0, Soc = 1	0.062	0.056	0.007
	(0.048)		
News = 0, Evac = 0, Move = 1, Soc = 1	0.020	0.016	0.003
	(0.020)		
News = 1, Evac = 1, Move = 1, Soc = 0	0.006	0.009	-0.003
	(0.009)		
News = 1, Evac = 1, Move = 0, Soc = 1	0.144	0.154	-0.010
	(0.089)		
News = 1, Evac = 0, Move = 1, Soc = 1	0.056	0.063	-0.007
	(0.062)		
News = 0, Evac = 1, Move = 1, Soc = 1	0.021	0.031	-0.010
	(0.025)		
News = 1, Evac = 1, Move = 1, Soc = 1	0.070	0.057	0.012
	(0.085)		

Notes: Predicted probabilities are calculated based on 25 pseudorandom draws and the (default) seed value of 123456789. An actual proportion of a given event is equal to the frequency of such event occuring divided by the total number of observations (i.e. 557). Both predicted joint probabilities and actual proportions add up to 1.
Standard deviations are in parentheses.

Predicted single-variable and joint probabilities of the four binary outcomes are shown in Table 5. The first column represents the four binary outcomes and all their possible combinations (i.e. $2^4 = 16$). The second column contains predicted probabilities and the third column actual frequencies of the events. The final column shows the difference between predicted and actual probabilities, indicating, albeit informally, the fit of the model. The actual frequency of a given event is calculated as the frequency of such an event divided by the total number of observations (557). The predicted single-variable probabilities are calculated by substituting the linear prediction from each latent variable equation into the standard normal cumulative distribution function. Following Capellari and Jenkins (2006), the calculation of joint (multivariate) probabilities is based on a simulation method with 25 pseudorandom draws from the standard uniform density, using linear predictions and Cholesky factorisation of the variance-covariance matrix of the error terms obtained from the multivariate probit regression. Since the table comprises all possible joint events, in each column, all probabilities from the fifth row onwards add up to 1. Overall, the model provides quite a good fit. The largest difference between the predicted and the actual probabilities is around 1.2 percentage point and most differences are less than a 0.5 percentage point.

Table 6. Conditional Probabilities of Risk Reduction Behaviours

Events	Conditional on Soc = 1	Conditional on Soc = 0	Paired Difference	T-Test Statistics
News = 1	0.660	0.401	0.259	195.119***
	(0.151)	(0.153)	(0.001)	
Evac = 1	0.388	0.308	0.079	72.043***
	(0.207)	(0.191)	(0.001)	
Move = 1	0.204	0.139	0.065	31.475***
	(0.197)	(0.155)	(0.002)	
News = 0, Evac = 0, Move = 0	0.203	0.386	-0.183	-61.235***
	(0.152)	(0.204)	(0.003)	
News = 1, Evac = 1, Move = 1	0.085	0.033	0.052	22.398***
	(0.099)	(0.047)	(0.002)	

Notes: a) Under the second and third columns (i.e. conditional probabilities), standard deviations are given in parentheses. Under the fourth column (i.e. paired difference), standard errors are provided in parentheses and they are equal to standard deviations divided by the square root of the number of observations (557).
b) SOC refers to social participation. NEWS refers to keeping close watch of news. EVAC refers to preparation of emergency kits or having family emergency plan. MOVE refers to intention to migrate.
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

In order to determine the pathway in which social participation affects different types of disaster responses, drawing on the predicted joint probabilities explained earlier, conditional probabilities are provided in Table 6. The first three rows show conditional probabilities of undertaking each disaster response measure estimated with bivariate probit models using the same vector of independent variables as in the multivariate probit model. They are provided in order to show the relationship between social participation and a given disaster response more clearly, illustrating the impact of social participation on one disaster response, *irrespective* of the others. The last two rows display conditional probabilities estimated with the multivariate probit model containing possible joint events of carrying out three disaster reduction behaviours altogether. The first two columns illustrate the probabilities of carrying out disaster reduction measures conditional on having some social participation and having no social participation respectively. The subsequent column shows the paired difference between the two conditional probabilities and the final column shows results of the t-test performed on the paired difference.

It can be seen in Table 6 that with the absence of social participation, the propensities of undertaking each of the preparatory measures, i.e. keeping close watch of news, preparing survival kits and/or having a family evacuation plan, and intending to migrate are 40%, 30% and 14% respectively. Yet, conditional on social participation, the likelihood of each event increases to 66%, 39%, and 20% respectively. Likewise, the probability of pursuing three disaster reduction actions altogether is also higher (5.2% higher) given social participation. While the probability of not undertaking any of the risk reduction measures is almost 40% given no social participation, conditional on social participation, the likelihood of not doing anything reduces to only 20%.

7 Discussion

This paper examines the determinants of disaster risk reduction behaviours and social capital and the relationships between the two actions using the case study of disaster response during the Indian Ocean earthquakes in 2012 in Phang Nga province, Thailand. We investigate three disaster reduction behaviours, namely, keeping close watch of news, having emergency kits and/or a family evacuation plan, and having an intention to migrate. It is found that being badly affected by the 2004 Indian Ocean tsunami is the main driver of preventive actions, especially keeping close watch of news and having an intention to migrate. However, tsunami experience is not significantly associated with the likelihood of preparing emergency kits or having a family evacuation plan. Consistent with previous studies, while prior disaster experience is positively correlated with increased general preparedness (Heller et al. 2005; Mishra & Suar 2007), not all types of preparedness actions naturally increase with experience (Kohn et al. 2012).

Indeed some disaster preparedness tasks are easier to implement than others. Keeping close watch of news only requires an individual to turn on their television set or update the situation with their neighbours, whereas assembling an emergency kit and having a family evacuation plan require stockpiling of necessary supplies and coordination among family members respectively. The latter entails more efforts and strategic planning. This is consistent with the fact that we observe that individuals with tertiary education are more likely to gather supplies and/or implement a family plan while prior disaster experience does not contribute to such action.

Likewise, while previous empirical studies from the US report mixed evidence regarding disability status and disaster preparedness (Bethel et al. 2011; Eisenman et al. 2009; Uscher-Pines et al. 2009), we find that the presence of household members with a disability increases the likelihood of having disaster supplies or an emergency plan. Preparedness items can mitigate adverse impacts especially for persons with disability who are most vulnerable during the time of disasters. Our finding underlines the importance of promoting preparedness among vulnerable groups.

It is also found that women are both more likely to have stockpiled supplies or formed a family evacuation plan and have a higher intention to move away from tsunami-risk zones. One explanation for such gender difference is that women perceive disaster events or threats as more serious and hazardous compared to men (Cutter et al. 1992; Fothergill 1996) and this consequently translates into greater risk reduction actions. Nevertheless, at the community-level, we find that the propensities of undertaking preparedness measures and intention to migrate increase substantially only in a community with a greater proportion of women with tertiary education. Living in a community with a large proportion of highly educated women likely increases personal disaster preparedness because education increases access to disaster-related information and socioeconomic resources. Since women are more likely to have denser social ties comprising a higher proportion of kin and neighbours than men (Renzulli et al. 2000), having highly educated women in a community could result in a spillover effect on risk reduction behaviours.

Turning to the role of social capital in disaster mitigation, it is found that the likelihood of undertaking risk reduction actions is highly correlated with social participation. The propensity of keeping close watch of news, preparing for emergency supplies or having a family evacuation plan, and having an intention to migrate significantly increases for individuals who have engaged in community activities. Social participation may broaden one's social connections, facilitate exchange of information and increase encouragement/peer pressure. As evident in previous literature, social participation brings about positive externality such as increasing leisure-time physical activity (Lindström et al. 2001), smoking cessation (Lindström et al. 2000) and survival in old age (Maier & Klumb 2005). This suggests that promoting civic and social engagement can also be beneficial to disaster mitigation.

Jointly estimating outcomes of interest, we are able to account for the interdependence of the decision to undertake disaster preparedness measures, intention to migrate and social participation. In this study, which is based on cross-sectional data, we have to rely on the assumption that individuals make decisions on these actions *simultaneously*. A different timing assumption is plausible. Given that the survey was collected after the 2012 earthquakes, it is not unreasonable to think that disaster reduction measures were employed after the incident while engagement in community-based activities had previously been pursued. In this case, social participation should be modelled as an endogenous independent variable that explains disaster preparedness outcomes. Such modelling technique is probably more appropriate with panel data, nevertheless.

8 Conclusion

Without doubt, preparing for a natural disaster is an efficient way to minimize its adverse impact. It is therefore important to understand not only factors that may hinder risk reduction behaviours but also ones that promote them. While it is not possible or difficult to alter demographic characteristics associated with disaster risk reduction actions such as age and gender, certain social characteristics can be improved. Our finding that engagement in community-based activities increases disaster preparedness and intention to move away from disaster-risk areas suggests that promoting social participation may have a positive externality in reducing vulnerability and disaster risk.

9 References

Adger, W.N. 2003. Social capital, collective action, and adaptation to climate change. *Economic Geography* 79(4): 387–404.

Agrawal, S. and M.C. Monroe. 2006. Using and improving social capital to increase community preparedness for wildfire. Pages 163–167 in S. M. McCaffrey, ed., *The Public and Wildland Fire Management: Social Science Findings for Managers*. Newtown Square, PA: U.S. Department of Agriculture, Forest Service.

Aldrich, D.P. 2011a. The externalities of strong social capital: Post-tsunami recovery in southeast India. *Journal of Civil Society* 7(1): 81–99.

Aldrich, D.P. 2011b. The power of people: Social capital's role in recovery from the 1995 Kobe earthquake. *Natural Hazards* 56(3): 595–611.

Beggs, J.J., V.A. Haines, and J.S. Hurlbert. 1996. The effects of personal network and local community contexts on the receipt of formal aid during disaster recovery. 14(1): 57–78.

Bethel, J.W., A.N. Foreman, and S.C. Burke. 2011. Disaster preparedness among medically vulnerable populations. *American Journal of Preventive Medicine* 40(2): 139–143.

Bihari, M. and R. Ryan. 2012. Influence of social capital on community preparedness for wildfires. *Landscape and Urban Planning* 106(3): 253–261.

Bradley, D.E. et al. 2008. Actuation of mobility intentions among the young-old: An event-history analysis. *The Gerontologist* 48(2): 190–202.

Cappellari, L. and S.P. Jenkins. 2006. Calculation of multivariate normal probabilities by simulation, with applications to maximum simulated likelihood estimation. *Stata Journal* 6(2): 156–189.

Cappellari, L. and S.P. Jenkins. 2003. Multivariate probit regression using simulated maximum likelihood. *Stata Journal* 3(3): 278–294.

Chamlee-Wright, E. 2010. *The Cultural and Political Economy of Recovery: Social Learning in a Post-Disaster Environment*. New York: Routledge.

Crabbé, P. and M. Robin. 2006. Institutional adaptation of water resource infrastructures to climate change in eastern Ontario. *Climatic Change* 78(1): 103–133.

Cutter, S.L., J. Tiefenbacher, and W.D. Solecki. 1992. En-gendered fears: Femininity and technological risk perception. *Organization & Environment* 6(1): 5–22.

Dasgupta, P. 1999. Economic progress and the idea of social capital. Pages 325–424 in P. Dasgupta and I. Serageldin, eds., *Social Capital: A Multifaceted Perspective*. Washington D.C.: Wolrd Bank.

Dooley, D. et al. 1992. Earthquake preparedness: Predictors in a community survey. *Journal of Applied Social Psychology* 22(6): 451–470.

Dynes, R. 2005. *Community Social Capital as the Primary Basis for Resilience*. University of Delaware Disaster Research Center.

Dynes, R. 2002. *The Importance of Social Capital in Disaster Response*. Disaster Research Center, University of Delaware.

Edwards, M.L. 1993. Social location and self-protective behavior: Implications for earthquake preparedness. *International Journal of Mass Emergencies and Disasters* 11(3): 293–303.

Eisenman, D.P. et al. 2009. Variations in disaster preparedness by mental health, perceived general health, and disability status. *Disaster medicine and public health preparedness* 3(1): 33–41.

Ford, J.D., B. Smit, and J. Wandel. 2006. Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada. *Global Environmental Change* 16(2): 145–160.

Fothergill, A. 1996. Gender, risk and disaster. *International Journal of Mass Emergencies and Disasters* 14(1): 33–56.

Heller, K. et al. 2005. Social and personal factors as predictors of earthquake preparation: The role of support provision, network discussion, negative affect, age, and education. *Journal of Applied Social Psychology* 35(2): 399–422.

Henry, S., B. Schoumaker, and C. Beauchemin. 2004. The impact of rainfall on the first out-migration: A multi-level event-history analysis in Burkina Faso. *Population and Environment* 25(5): 423–460.

Huppert, H.E. and R.S.J. Sparks. 2006. Extreme natural hazards: population growth, globalization and environmental change. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 364(1845): 1875–1888.

Hyyppä, M.T. and J. Mäki. 2003. Social participation and health in a community rich in stock of social capital. *Health education research* 18(6): 770–779.

Jackson, E.L. 1981. Response to earthquake hazard: The west coast of North America. *Environment and Behavior* 13(4): 387–416.

Kaniasty, K. and F.H. Norris. 1993. A test of the social support deterioration model in the context of natural disaster. *Journal of personality and social psychology* 64(3): 395–408.

Klinenberg, E. 2002. *Heat Wave: A Social Autopsy of Disaster in Chicago*. Chicago and London: The University of Chicago Press.

Kohn, S. et al. 2012. Personal disaster preparedness: An integrative review of the literature. *Disaster Medicine and Public Health Preparedness* 6(3): 217–231.

Lin, N. 2008. A network theory of social capital. Pages 50–69 in Dario Castiglione, J. W. van Deth, and G. Wolleb, eds., *The Handbook of Social Capital*. London: Oxford University Press.

Lindell, M.K. and D.J. Whitney. 2000. Correlates of household seismic hazard adjustment adoption. *Risk Analysis* 20(1): 13–26.

Lindström, M. et al. 2000. Socioeconomic differences in smoking cessation: The role of social participation. *Scandinavian Journal of Public Health* 28(3): 200–208.

Lindström, M., B.S. Hanson, and P.-O. Östergren. 2001. Socioeconomic differences in leisure-time physical activity: The role of social participation and social capital in shaping health related behaviour. *Social Science & Medicine* 52(3): 441–451.

Lu, M. 1998. Analyzing migration decisionmaking: Relationships between residential satisfaction, mobility intentions, and moving behavior. *Environment & planning A* 30(8): 1,473–495.

Maier, H. and P.L. Klumb. 2005. Social participation and survival at older ages: Is the effect driven by activity content or context? *European Journal of Ageing* 2(1): 31–39.

Mileti, D.S. and C. Fitzpatrick. 1992. The causal sequence of risk communication in the Parkfield earthquake prediction experiment. *Risk Analysis* 12(3): 393–400.

Mishra, S. and D. Suar. 2007. Do lessons people learn determine disaster cognition and preparedness? *Psychology & Developing Societies* 19(2): 143–159.

Mulilis, J.-P., T.S. Duval, and K. Bovalino. 2000. Tornado preparedness of students, nonstudent renters, and nonstudent owners: Issues of PrE Theory. *Journal of Applied Social Psychology* 30(6): 1310–1329.

Muttarak, R. and W. Pothisiri. 2013. The role of education on disaster preparedness: case study of 2012 Indian Ocean earthquakes on Thailand's Andaman coast. *Ecology and Society* 18(4): 51.

Nakagawa, Y. and R. Shaw. 2004. Social capital: A missing link to disaster recovery. *International Journal of Mass Emergencies and Disasters* 22(1): 5–34.

Natural Sciences Sector. 2012. Indian Ocean Tsunami Warning System performed well, detailed assessment underway. *UNESCO and Intergovernmental Oceanographic Commission*.

Nidhiprabha, B. 2010. Thailand. Pages 171–224 in S. Jayasuriya and P. McCawley, eds., *The Asian Tsunami: Aid and Reconstruction after a Disaster*. Cheltenham: The Asian Development Bank Institute and Edward Elgar Publishing.

O'Brian, P. and D.S. Mileti. 1992. Citizen participation in emergency response following the Loma Prieta earthquake. *International Journal of Mass Emergencies and Disasters* 10(1): 71–89.

Pollitz, F.F. et al. 2012. The 11 April 2012 east Indian Ocean earthquake triggered large aftershocks worldwide. *Nature* 490(7419): 250–253.

Putnam, R.D. 1995a. Bowling alone: America's declining social capital. *Journal of Democracy* 6(1): 65–78.

Putnam, R.D. 1995b. Tuning in, tuning out: The strange disappearance of social capital in america. *PS: Political Science and Politics* 28(4): 664.

Reininger, B.M. et al. 2013. Social capital and disaster preparedness among low income Mexican Americans in a disaster prone area. *Social Science & Medicine* 83: 50–60.

Renzulli, L.A., H. Aldrich, and J. Moody. 2000. Family matters: Gender, networks, and entrepreneurial outcomes. *Social Forces* 79(2): 523–546.

Riad, J.K., F.H. Norris, and R.B. Ruback. 1999. Predicting evacuation in two major disasters: Risk perception, social influence, and access to resources. *Journal of Applied Social Psychology* 29(5): 918–934.

Russell, L.A., J.D. Goltz, and L.B. Bourque. 1995. Preparedness and hazard mitigation actions before and after two earthquakes. *Environment and Behavior* 27(6): 744–770.

Shaw, R. 2012. Overview of community-based disaster risk reduction. *Community, Environment and Disaster Risk Management* 10: 3–17.

Singh, D. 2012. Indian Ocean tsunami early warning systems pass test. *The United Nations Office for Disaster Risk Reduction (UNISDR).*

Tierney, K.J., M.K. Lindell, and R.W. Perry. 2001. *Facing the Unexpected: Disaster Preparedness and Response in the United States*. Joseph Henry Press.

Tompkins, E.L. 2005. Planning for climate change in small islands: Insights from national hurricane preparedness in the Cayman Islands. *Global Environmental Change* 15(2): 139–149.

Turner, R.H., J.M. Nigg, and D.H. Paz. 1986. *Waiting for Disasters: Earthquake Watch in California*. Berkeley: University of California Press.

Uscher-Pines, L. et al. 2009. Disaster preparedness of households with special needs in southeastern Pennsylvania. *American journal of preventive medicine* 37(3): 227–230.

USGS, (U.S. Geological Survey). 2012. Magnitude 8.6 - Off the West coast of Northern Sumatra.

Varda, D.M. et al. 2009. Social network methodology in the study of disasters: issues and insights prompted by post-katrina research. *Population Research and Policy Review* 28(1): 11–29.

Willroth, P., J.R. Diez, and N. Arunotai. 2011. Modelling the economic vulnerability of households in the Phang-Nga Province (Thailand) to natural disasters. *Natural Hazards* 58(2): 753–769.

Yamamura, E. 2010. Effects of interactions among social capital, income and learning from experiences of natural disasters: a case study from Japan. *Regional Studies* 44(8): 1019–1032.

Yamamura, E. 2013. Natural disasters and social capital formation: The impact of the Great Hanshin-Awaji earthquake.