The Role of Education on Disaster Preparedness: Case Study of 2012 Indian Ocean Earthquakes and Tsunami Warnings on Thailand's Andaman Coast

Raya Muttarak[1] and Wiraporn Pothisiri[2]

Abstract

This paper investigates the preparedness for earthquakes and tsunami of residents living along the Andaman coast in Phang Nga province, Thailand. A survey of 557 households located in the areas that received tsunami warnings following the Indian Ocean earthquakes on 11 April 2012 was conducted. The fieldwork was carried out during the period of numerous aftershocks which put residents in the region on high alert thus allowing the survey to capture individuals' emergency responses to natural hazards that might occur. The respondents were asked what emergency preparedness measures they have done following the 11 April earthquakes. Using the partial proportional odds model, the paper investigates determinants of personal disaster preparedness measured as the number of preparedness actions being taken. Controlling for village effects, we find that formal education – measured at the individual, household and community levels – has positive relationships with preparedness actions. Being affected by the 2004 tsunami increases emergency preparedness but for the group without such disaster experience, education of household members is found to be positively related with taking preparedness actions. Formal education may also enhance individual cognitive and learning skills as our findings show that disaster-related training is the most effective among individuals with high educational attainment. Besides, living in a community with higher proportion of women with at least secondary education increases the likelihood of disaster preparedness. This study suggests that formal education can increase disaster preparedness and consequently play a role in reducing vulnerability to natural hazards.

Keywords: disaster preparedness; education; earthquake; tsunami; Thailand; partial proportional odds model

[1] Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/ÖAW, WU), International Institute for Applied Systems Analysis
[2] College of Population Studies, Chulalongkorn University

INTRODUCTION

Although it remains impossible to predict when and where an earthquake will occur, the impacts of earthquake disasters can be reduced by taking a variety of personal safety measures (Turner et al. 1986, Lehman and Taylor 1987). For example, the catastrophic loss of the Indian Ocean Tsunami of December 2004 was largely due to the absence of warning systems, lack of knowledge and lack of preparedness among the populations at risk (Rachmalia et al. 2011). On the other hand, in the case of the Tohoku earthquake in Japan on 11 March 2011, despite little time between the quake and the tsunami, the effectiveness of local emergency warning systems and preparedness for earthquakes and tsunamis among Japanese citizens had saved many lives. These examples show that personal disaster preparedness is critical to mitigate the disaster impacts.

Getting prepared for a major disaster is the most effective way to minimize the damage suffered by the population (Banerjee and Gillespie 1994). It has been widely recognized among emergency management officials and disaster planners that for the first 72 hours after an earthquake or other disaster strikes, individuals and families should be prepared for self-sufficiency since services and supplies can be disrupted and emergency assistance might not be reached in time (Russell et al. 1995, Basolo et al. 2009). Preparedness has also been reported to be associated with successful evacuation during a hurricane (Howell and Bonner 2005, Dash and Gladwin 2007) and improve individuals' resilience to trauma (Bravo et al. 1990). Accordingly the US government has put resources and efforts to improve individual emergency preparedness for both natural and man-made disasters (Eisenman et al. 2006).

Since preparedness behavior varies considerably across social groups, it is important to identify subpopulation differences in order to design appropriate preparedness and emergency campaigns to improve awareness and preparedness among different subgroups (Eisenman et al. 2006). Socioeconomic and demographic characteristics including gender, age, race and ethnicity, income, education, home ownership, duration at a residence and presence of children are commonly found to be associated with preparedness behaviors although the direction of association is not always consistent (Lindell and Perry 2000, Tierney et al. 2001). Social capital, social networks and trust in government are also reported to be related to preparedness (Heller et al. 2005, Basolo et al. 2009, Bihari and Ryan 2012). Likewise, disaster-related factors such as prior disaster experience (Russell et al. 1995, Sattler et al. 2000, Horney et al. 2008, Tekeli-Yeşil et al. 2010), higher perceived risk and exposure to information (Basolo et al. 2009, Murphy et al. 2009) are found to be associated with greater preparedness. These studies were predominantly carried out in the US and mostly focus on disaster preparedness for hurricanes. Consequently, due to inconsistencies in the measurement of preparedness, different types of disasters as well as different locations studied, the associations between various characteristics and disaster preparedness found may not apply to all contexts (Kohn et al. 2012).

Using the Indian Ocean earthquakes on 11 April 2012 as a case study, this paper aims to investigate determinants of emergency disaster preparedness among residents living along the Andaman coast in Phang Nga province, Thailand. In particular, the paper rigorously investigates the association between educational attainment and disaster preparedness taking into account relevant demographic, socioeconomic and community characteristics that could influence preparedness actions. The paper focuses on examining how disaster preparedness varies by education both at the individual, household and community levels and how education interacts with other characteristics in shaping preparedness behaviors. In addition, assuming that people in a given community interact and exchange information, we argue that living in a community with high average level of education could be beneficial in improving preparedness levels.

This paper adds to the literature on disaster preparedness and vulnerability in three important ways. First, there have not been many studies that focus on investigating the relationship between educational attainment and disaster preparedness and the extant ones generally do not consider how education can influence preparedness. This paper extends the analysis to explore plausible explanations how formal education can influence preparedness actions. Second, while most studies investigate the influence of individual- or household-level education on disaster preparedness, arguing that community characteristics could also influence personal preparedness, this paper also considers the influence of community-level education and demographic factors. Third, extant studies on disaster preparedness were predominantly conducted in the US. There are much fewer studies on other countries especially developing countries (Mishra and Suar 2007, Mishra et al. 2010, Ferdinand et al. 2012). This paper provides new empirical evidence on Thailand where disaster preparedness has not yet been investigated.

In the following, we discuss the link between disaster preparedness and education. The next section describes the 2012 Indian Ocean earthquakes and the study area. Then the data and methods employed for the analysis are reported. Next results are presented and the final sections discuss the findings and conclude.

DISASTER PREPAREDNESS AND EDUCATION

Extant literature on vulnerability and disaster preparedness generally treat education as an indicator of socioeconomic status whereby education is included as one dimension of a vulnerability indicator (Kuhlicke et al. 2011). Accordingly, it is assumed that disaster preparedness increases with education because highly educated individuals have better economic resources to undertake preparedness actions. We further argue that formal schooling may promote preparedness behaviors because education may influence cognitive elements and shape how individuals perceive and assess risks as well as process risk-minimizing information (Menard et al. 2011).

Preparedness action is closely related to how individuals perceive and act on risk information (Tierney et al. 2001). Likewise, educated individuals might have greater awareness of risks since

they are more likely to have greater access to information sources and are more able to evaluate the information received (Jamison and Moock 1984, Rogers 1995, Asfaw and Admassie 2004). There is also evidence that education increases the acquisition of general knowledge that could influence values, priorities, capacity to plan for the future and improve allocation of resources (Thomas et al. 1991, Glewwe 1999, Burchi 2010). The knowledge and competence gained through education thus could be useful in times of crisis such as when a disaster strikes.

Empirical evidence on the relationship between educational level and preparedness behaviors however has not yet been adequately established. While some studies find that higher educational attainment enhances disaster preparedness (Edwards 1993, Norris et al. 1999, Murphy et al. 2009, Baker 2011, Menard et al. 2011), numerous other studies report no association between the two factors (Jackson 1981, Faupel et al. 1992, Siegel et al. 2003, Heller et al. 2005, Spittal et al. 2008, Kim and Kang 2010). Generally education is treated as a control variable and not much emphasis is put on understanding how education may influence preparedness behaviors. An exception is the recent study by Menard et al (2011) which explicitly focuses on establishing the relationship between having post-secondary degree and disaster preparedness. It is found that individuals with a college degree are more likely to have an emergency plan and know where to get additional information. It is explained that going to college in the US expose individuals with university emergency systems and education may influence how individuals process risk-minimizing information. Although this study provides evidence on the influence of higher education on disaster preparedness, with the absence of multivariate analysis, the study fails to consider confounding factors that can influence both education and preparedness.

Apart from formal schooling, disaster-related education has been promoted as a key approach to build disaster-resilient societies (UNISDR 2007). There is evidence that disaster educational interventions can be influential in raising awareness and knowledge on disasters which in turn can enhance disaster preparedness actions (Faupel and Styles 1993, Tanaka 2005, Page et al. 2008). The link between formal schooling and disaster educational interventions has been recognized (UNISDR 2007, Selby and Kagawa 2012) but there are not many empirical studies that consider the interplay between formal education and disaster education in shaping preparedness behaviors. This paper aims to explore this issue further.

CASE STUDY OF 2012 INDIAN OCEAN EARTHQUAKES

2012 Indian Ocean earthquakes

We use the 2012 Indian Ocean earthquakes as a case study of personal emergency preparedness. Earthquakes are not so frequent in Thailand. The country has experienced mid-sized earthquakes (M5.0-5.9) only 8 times over the past 40 years (CICC 2012).Thus in general preparedness for earthquakes has not been given a priority neither at the national level nor individual level. The 2012 Indian Ocean earthquakes which struck on 11 April 2012 were followed by tsunami

warnings and numerous other quakes. The 11 April earthquakes thus put people in the region on high alert and may have triggered preparedness actions among the residents.

Here we briefly describe the 2012 Indian Ocean earthquakes.

On 11 April 2012 at 15:38 local time a large undersea earthquake with a magnitude of 8.6 struck offshore, 434km southwest from the Indonesian province of Banda Aceh in northern Sumatra. It was followed by another major shock (M8.2) at 17:43 local time 200km to the south, as well as numerous aftershocks (USGS 2012). The Pacific Tsunami Warning Center had issued the watch i.e. potential for a tsunami for countries all along the Indian Ocean, from Australia and India to as far off as Africa. In Thailand, the Department of the Disaster Prevention and Mitigation (DDPM) issued an urgent tsunami warning and evacuation order for people living on the Andaman coast of six southern provinces which were hit by the 2004 Indian Ocean Tsunami. Fortunately devastating tsunami did not occur since both the initial earthquake and the M8.2 aftershock were a slip-strike earthquake where two tectonic plates – Indian and Australian plates – slid against one another horizontally and this lateral movement did not lead to a vertical displacement of water. The tsunami warnings were then lifted several hours later (Pacific Tsunami Warning Center 2012).

Although a devastating tsunami did not occur, the quakes sparked fear among locals and tourists especially in the areas previously damaged by the 2004 tsunami. This panic was exacerbated by the earthquake of 4.3 magnitude which struck Phuket with its epicenter at Thalang district on 16 April 2012 at 16:44 local time. This was followed by a series of more than 26 aftershocks between 16 – 22 April 2012. The Phuket earthquakes might have been triggered by the Indonesian earthquake as the recent study reports a significant increase in the occurrence of sizable quakes in the six days following 11 April (Pollitz et al. 2012). The Indonesian and the Phuket earthquakes put people living in the southern Andaman coast on high alert due to the fear of the tremors that occurred many times and the repeat of the 2004 tsunami.

Study area

Phang Nga province is chosen for the study of disaster preparedness since the province suffered the greatest human losses and massive economic impact from the 2004 tsunami among the six Thai provinces being affected (Nidhiprabha 2010). Phang Nga alone experienced 5,880 live losses accounting for 72% of the total number of deaths and missing persons in the 2004 tsunami in Thailand. With a coastline of 240 km, Phang Nga's coastal area was strongly affected by the tsunami. Takua Pa District, a popular area for holidaymakers with numerous beach resorts was the most severely hit with run-up heights varies between 5 to 10m (FAO 2005, Römer et al. 2012). Inundation distances went up to two kilometers inland in some areas. The devastation extended well inland from the coast in many areas (Thanawood et al. 2006).

Given the large-scale impacts from the 2004 tsunami experienced by the residents of Phang Nga, this experience might improve personal disaster preparedness initiatives. In this study, we assess

disaster preparedness in the areas that were issued tsunami warnings on 11 April 2012 by the DDPM. A sample of 9 villages was randomly selected for an interview. The selected villages vary considerably in terms of the number of population and level of disaster preparedness as presented in Figure 1.

[FIGURE 1: ABOUT HERE]

DATA AND METHODS

Data sources

The analysis is based on two data sources. The data for personal preparedness is obtained from a survey of households located in tsunami high-risks area in Phang Nga province conducted by the College of Population Studies, Chulalongkorn University and the Wittgenstein Center for Demography and Global Human Capital between 17 April – 13 May 2012. Note that the survey was conducted almost right after the Indonesian earthquakes and during the period of the Phuket earthquakes or immediately after, allowing us to observe disaster preparedness in the moment of high disaster awareness.

The survey was a face-to-face interview carried out by trained interview staffs and local researchers in Thai language. For each village, 30% of the households were selected for an interview through systematic random sampling. In total 563 households were interviewed whereby the head of household was first approached; if not presented, the spouse or one of the household members aged 15 years and older was asked for the interview.

The questionnaire contains questions on basic demographic and socio-economic characteristics of the respondent and the household. A set of questions related to awareness of, response to and preparedness for the 2012 Indian Ocean earthquakes are also included. Besides, information on experience of the 2004 tsunami, social activities engaged and channels of information received is also asked. The final sample consists of 557 households with valid responses to all questions used in the analysis.

The data on basic demographic and education data at the village-level is obtained from the 2010 Population and Housing Census, supplied in an aggregated form by the National Statistical Office, Thailand.

Variables

The empirical analysis explores determinants of disaster preparedness actions based on characteristics that have been found to be associated with preparedness behaviors in previous literature. In particular, we investigate the relationships between formal education and disaster preparedness. The variables used in our analytic models are described below.

Dependent variable

Given the fact that Thailand's southern Andaman coast was on high alert due to the Indonesian and subsequent Phuket earthquakes during the period of the survey, the outcome of interest is whether people living in the tsunami high-risk areas were taking any measures to prepare for the earthquakes and the hazards that might have followed. The dependent variable is taken from the question which asks: "Have you or your family taken any preparedness actions after the 11 April 2012 Indonesian earthquake?" Response categories were: 1) no preparation; 2) keeping close watch of the situation; 3) preparation of survival kits; 4) planning evacuation procedure and emergency plan with household members; 5) inspection of house structure; and 6) other preparations.

Explanatory variables

1) Education

Given our hypothesis that education might enhance awareness and preparedness for disasters, we measure the relationships between education and preparedness after the Indian Ocean earthquakes at three levels.

- Individual level – the highest level of education of the respondents divided into four categories: 1) no education and elementary; 2) lower secondary; 3) upper secondary; and 4) tertiary
- Household level – the number of household members with at least secondary education
- Village level – proportion of men and women with at least secondary education in the village

2) Disaster-related variables

We include disaster-related variables previously found to be associated with disaster preparedness (Mileti and Fitzpatrick 1992, Faupel and Styles 1993, Heller et al. 2005, Mishra and Suar 2007). These variables are measured at the individual level including:

- Tsunami experience – coded 1if the respondent was affected by the 2004 tsunami; 0 otherwise
- Participation in tsunami drills and disaster education – code 1 if the respondent has participated in tsunami drills and/or disaster education; 0 otherwise
- Number of information sources – a continuous variable measuring the number of sources of information where the respondents obtained the news about the 11 April 2012 earthquakes and tsunami warnings

Control variables

Control variables include individual, household and village characteristics.

- Individual level – age, sex, occupation, marital status, years of residence in a house

- Household level – household income, number of usual residents, number of members aged 0-5 years, number of household members aged ≥ 60 years, number of disabled members, whether household located on the coast
- Village level – village dummy, proportion of women, proportion of people aged ≥ 65 years

Statistical techniques

In order to investigate the determinants of personal preparedness, we perform chi-square analysis comparing the number of preparedness activities undertaken by demographic and socioeconomic characteristics. In the case where the determinants are continuous variables, one-way analysis of variance (ANOVA) is performed to compare means of the relevant variables by number of preparedness activities.

Subsequently, positing that an individual's disaster preparation outcome is likely to be a product of both their individual and household characteristics as well as the characteristics of the village in which they live, we perform multivariate analysis in order to explore the influence of different factors on disaster preparedness actions at the same time.

Since the outcome variable – number of preparedness measures taken – is not normally distributed, ordinary least squares regression cannot be used because the normality assumption would be violated. We then group the number of preparation activities into three ordinal categories: no preparation, one preparation measure, two or more preparation measures. Although ordered logistic regression is an appropriate method for an ordinal response variable, the model is only valid for the data that meet the proportional odds assumption, that is the coefficients that describe the relationship between any two pairs of outcome groups are statistically the same. For our data, the likelihood-ratio test shows that the proportional odds assumption is violated (Wolfe and Gould 1998). Thus we decided to adopt the partial proportional odds model, which allows the coefficients that violate the proportional odds assumption to vary across logistic equations i.e. to have different effects on the dependent variable (Peterson and Harrell 1990, Fullerton and Xu 2012).

The partial proportional odds model (PPOM) can be expressed as a generalized ordered logit model:

$$P(Y_i > j) = \mathrm{g}(\mathrm{X}\beta_j) = \frac{\exp(\propto_j + X_i\beta_j)}{1 + [\exp(\propto_j + X_i\beta_j)]} \text{ with } j = 1,2 \ldots, M-1$$

where M is the number of categories of the ordinal dependent variable (3 in our case) and β_j is unique for each j for the coefficients that the proportional odds assumption is violated otherwise $\beta_j=\beta$. For our analysis, M=3 thus the PPOM is equivalent to a series of binary logistic regressions where categories of the dependent variable are combined. The dependent variable is defined over

an increasing number of preparation measures taken: *Y*=1 for no preparation, *Y*=2 for one preparation measure taken and *Y*=3 for two or more preparation measures taken. In our case, *M*=3, then for *J*=1 category *Y1* is contrasted with *Y2* and *Y3* (logit 1); and for *J*=2 the contrast is between *Y1* and *Y2* versus *Y3* (logit 2). This way each group is compared to groups with higher number of preparation measures.

All statistical analyses are carried out in the statistical software STATA, version 11 and the PPOM is estimated using *gologit2*, a user written program (Williams 2006).

RESULTS

In this section, we first describe summary statistics of our sample as well as present binary relationships between these characteristics and disaster preparedness actions (Table 1). This gives us a first overview of characteristics that can influence preparedness. Next in the multivariate analysis (Table 2), village dummies are included to control for village heterogeneity. We use a forward stepwise method starting with the inclusion of individual demographic characteristics, followed by individual disaster-related characteristics, household characteristics and village characteristics. The final analysis in Tables 3 and 4 further explore if the determinants of disaster preparedness vary by individual education and previous tsunami experience respectively.

Binary relationships between disaster preparedness and individual, household and village characteristics

[TABLE 1: ABOUT HERE]

Table 1 describes demographic characteristics of the sample at the individual, household and village levels. Binary relationships between these characteristics and the number of preparedness measures taken are also presented. As shown in Table 1, the number of preparedness actions carried out differs notably by age and occupation: 28.6% of individuals in youngest age group, 34.7% of those in the oldest age group and 44% of those engaged in agriculture did not take any preparedness actions. Disaster-related variables are significantly associated with disaster preparedness. Respondents who were affected by the 2004 tsunami and participated in evacuation drills and disaster education are more likely to be prepared and more likely to undertake more than just one preparedness measure. Individuals with higher number of sources of information on tsunami and earthquakes news are also more likely to be prepared.

Considering household characteristics, demographic composition in a household is related to disaster preparedness whereby household with a higher number of members aged $\geq$ 60 years (0.72) and a lower number of members with disability (0.02) are more likely to be unprepared. Note that on the average the number of elderly and disabled household members is less than one in most households. Preparedness is significantly related with household location: only 14.3% of those living on the coast were not prepared as compared to 38.9% of those whose house located

≥1 km from the shore. With respect to village characteristics, respondents living in a village with higher proportion of women have lower rates of preparation.

Regarding disaster preparedness and education, there is a weak relationship between individual education and the number of preparedness measures taken. Those with no education or with only elementary education are less likely to be prepared (29.4%). Respondents with tertiary education are more likely to be prepared as well as are more likely to have taken more than one preparedness action (41.2%). The average education level in a village is also highly correlated with disaster preparedness whereby the respondents with higher number of preparation activities are more likely to live in a village with higher proportion of men and women with at least secondary education.

Disaster preparedness considering village effects

[TABLE 2: ABOUT HERE]

In Table 2, we apply the partial proportional odds model (PPOM) to estimate the factors associated with disaster preparedness taking into account the differences between villages. Models 1,2 and 3 thus include a village dummy variable to control for the possibility that disaster preparedness outcome can vary with a village one lives in. In Model 4, we explore the relationships between village demographic characteristics and disaster preparedness. Note that the village dummies are not included in Model 4 since the models with village dummies are equivalent to fixed effects estimator where village-level covariates are treated as nuisances and cannot be estimated (Paul et al. 2010). We also exclude the two villages in our original sample where all respondents have taken preparedness actions (see Figure 1). The analysis in Tables 2- 4 thus include the sample of 544 subjects.

Before moving to result discussion, here we explain the interpretation of the parameter estimates. The results can be interpreted in the same way as traditional ordered logit models, that is the change in the log odds of the response variable per unit change in the predictor. Positive coefficients indicate an increase in the likelihood of preparation and negative coefficients a decrease. Unlike the ordered logit models, in the PPOM, multiple coefficients are estimated for each variable that violates the proportional odds assumption. Accordingly, for these variables, two different coefficients are listed. The first coefficient (not shaded) predicts responses for the first logit equation (Logit 1) while the second coefficient (shaded in gray) predicts responses for the second logit equation (Logit 2). In Logit 1 the reference group is no preparation; while in Logit 2 the reference group is individuals who have not done any preparation or have taken only one preparedness measure.

The model estimates in Table 2 are presented in a forward stepwise manner. Model 1 investigates the relationships between individual demographic characteristics and disaster preparedness. Individual education and marital status appear to be a key determinant of disaster preparedness. Generally speaking, higher levels of education are strongly associated to a higher

number of disaster preparedness activities. Likewise, individuals who are married are more likely to be prepared. Model 2 includes disaster-related variables. Here the experience of tsunami in 2004 and participation in evacuation drills and disaster education are not significantly associated with disaster preparedness unlike in the binary statistics. The number of sources of information is positively related with the number of preparedness actions taken. An increase in one source of information increases the odds of preparation by 1.35 time ($e^{0.303}$). Model 3 includes household characteristics. Household income has no significant relationship with disaster preparedness. Consistent with the binary statistics, the greater the number of household members aged $\geq$ 60 years, the lower the likelihood of preparation but this applies only to the first logit equation. Likewise, the greater the number of disabled members, the greater the odds of preparation. We find a weak positive relationship between education of household members and the number of preparedness activities taken. Model 4 includes village characteristics. It is found that while 1% increase in the proportion of women in a village reduces the likelihood of preparation by 26% ($e^{-0.180}$), 1% increase in the proportion of women with at least secondary education increases the odds of preparation by 10% ($e^{0.08}$).

Variation of determinants of disaster preparedness by individual education and previous tsunami experience

[TABLES 3 AND 4: ABOUT HERE]

It is also of interest to compare whether the effects of the determinants of disaster preparedness vary by individual education and tsunami experience. In Table 3 we estimate the PPOM models splitting the sample into two groups: individuals with less than secondary education and individuals with at least secondary education. Similarly in Table 4, the sample is divided into those who were not affected by the 2004 tsunami and those who were.

Table 3 shows that the predictors of the likelihood of preparation vary considerably by individual education. For respondents with low educational attainment, the main factors influencing disaster preparedness are the number of sources of information and some household demographic characteristics i.e. the number of elderly and disabled members. Living in a village with high proportion of women with at least secondary education also increases the likelihood of preparation for the lower educated subjects but not necessarily increase the number of preparedness measures taken (Logit 2). On the other hand for individuals with higher education, it is evident that being affected by tsunami in 2004 and participation in evacuation drills and disaster education increase their likelihood of taking preparedness actions. For this group the number of household members with at least secondary education further increases their likelihood of preparation. The odds of undertaking preparatory activities significantly increase by 3.7 ($e^{1.298}$) and 5.8 ($e^{1.752}$) times for highly educated individuals living in a household with one and two or more members with at least secondary education respectively.

Table 4 compares the factors associated with disaster preparedness by tsunami experience. For individuals not being affected by the 2004 tsunami, evidently education of the household members is a key driver for taking up preparedness actions. Likewise, the number of sources of information significantly increases the likelihood of preparing for this group. Village-level education is also associated with the odds of preparation whereby 1% increase in the proportion of men with at least secondary education reduces the odds of preparation by 24% ($e^{-0.278}$) whereas 1% increase in the proportion of women with at least secondary education increases the odds of preparation by almost 50% ($e^{0.401}$). For individuals who were affected by the 2004 tsunami, the likelihood of being prepared is associated with household characteristics. The greater the number of people and the elderly in household (applied only to Logit 1), the lower the odds of preparation. The likelihood of preparation however increases significantly with the number of disabled members. For this group, we also find that the odds of taking preparedness actions increases slightly by 9% ($e^{0.094}$) with a 1% increase in the proportion of women with at least secondary education and reduces significantly by 26% ($e^{-0.307}$) with a 1% increase in the proportion of female population.

DISCUSSION

The results show that personal disaster preparedness varies considerably by a community they live in. Geophysical characteristics and social organization of the community can influence how individuals were affected by the 2004 tsunami and also their opportunities to participate in local evacuation drills and disaster education. In this sense, individual disaster-related characteristics which can affect disaster preparedness are also determined by where they live. We have shown in our analysis that the strong relationships between these characteristics and disaster preparation disappear once village effects are controlled for.

Meanwhile, we also find that individual disaster preparedness differs by demographic composition of the village. In general, the higher proportion of female population in the village reduces personal disaster preparedness but the higher proportion of women with at least secondary education increases the likelihood of undertaking preparedness actions. This raises a question why gender and educational composition in the community could affect individual emergency preparedness behaviors. One explanation is that women are more likely to have denser social ties comprising of higher proportion of kin and neighbors than men (Moore 1990, Renzulli et al. 2000) so they might be more likely to exchange information and mutual assistance but on the other hand women usually have less socioeconomic resources and lower access to formal emergency planning organizations (Fothergill 1996). A community with higher proportion of female population thus could translate into lower disaster preparedness because women might have lower access to information channels (Enid et al. 2008) so they could not pass around useful information. However, living in a community with high proportion of highly educated women increases personal disaster preparedness because education increases access to socioeconomic resources and this can benefit other members in a community through strong female social networks.

With respect to education and emergency preparedness, formal education appears to be positively related to preparedness actions at the individual, household and village levels. We also observe a strong interaction between individual educational attainment and informal education on disaster preparedness. Participating in evacuation drills and disaster education increases the likelihood of undertaking preparedness actions but only among the respondents with at least secondary education. It is plausible that highly educated individuals have better learning skills and are better in processing abstract thinking e.g. in a hypothetical situation like tsunami drills so they benefit more from disaster educational interventions.

Similarly we find that education of household members enhances disaster preparedness especially among the individuals who were not affected by the 2004 tsunami. Previous studies reported that disaster experience increases disaster awareness and preparedness actions (Russell et al. 1995, Sattler et al. 2000, Horney et al. 2008, Tekeli-Yeşil et al. 2010) hence it is not surprising that education does not play much role in the group who were affected by the 2004 tsunami. For those without previous tsunami experience, though, education of household members together with the number of information sources are key factors that drive disaster preparedness. Since information is processed through multiple stages – hearing the information, understanding it and perceiving its relevance (Nigg 1982)–, education might shape the degree to which individuals accurately perceive and assess risks and make a decision to take on preparedness actions.

This current study is not without limitations. Since the individual-level data is obtained from the household survey with one respondent per household, we cannot distinguish who actually initiated emergency preparedness actions in a household. We thus control for whether the respondent is a head of household in the analysis as a proxy for decision making power. A future study should attempt to identify who actually implemented preparation measures in a household to better understand how individual and household characteristics influence disaster preparedness.

CONCLUSION

This study provides evidence that education – measured at the individual, household and village-levels – has significant relationships with disaster preparedness. We distinguish between the effects of formal schooling and disaster-related trainings on preparedness actions and find that disaster education is effective particularly in the context where participants have high educational attainment. Formal education may enhance cognitive ability, information processing and learning skills so individuals with higher education respond better in hard times such as when the disaster strikes. Indeed in the absence of past disaster experience, we find that households with highly educated members are better prepared for the disasters. There is also a spill-over effect of education possibly through communication and information exchange among village members as evident that living in a village with higher proportion of highly educated female members increases the number of preparedness activities undertaken by an individual.

This paper shows that disaster-related education can enhance personal preparedness which is crucial in mitigating the disaster risks. However, the effectiveness of such education might be limited only to a subgroup of population such as highly educated individuals. Thus, policies that ensure universal access to formal education at least at the secondary level can be beneficial in reducing vulnerability and mitigating disaster impacts.

LITERATURE CITED

Asfaw, A. and A. Admassie. 2004. The role of education on the adoption of chemical fertiliser under different socioeconomic environments in Ethiopia. *Agricultural Economics* 30 (3):215-228.

Baker, E. J. 2011. Household preparedness for the Aftermath of Hurricanes in Florida. *Applied Geography* 31 (1):46-52.

Banerjee, M. M. and D. F. Gillespie. 1994. Strategy and organizational disaster preparedness. *Disasters* 18 (4):344-354.

Basolo, V., L. J. Steinberg, R. J. Burby, J. Levine, A. M. Cruz, and C. Huang. 2009. The effects of confidence in government and information on perceived and actual preparedness for disasters. *Environment and Behavior* 41 (3):338-364.

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

Bravo, M., M. Rubio-Stipec, G. J. Canino, M. A. Woodbury, and J. C. Ribera. 1990. The psychological sequelae of disaster stress prospectively and retrospectively evaluated. *American Journal of Community Psychology* 18 (5):661-680.

Burchi, F. 2010. Child nutrition in Mozambique in 2003: the role of mother's schooling and nutrition knowledge. *Economics and Human Biology* 8 (3):331-345.

CICC, (Chula International Communication Center). 2012. Likelihood of Earthquakes in Thailand.[online] URL: http://www.cicc.chula.ac.th/en/2012-04-26-04-31-26/203-likelihood-of-earthquakes-in-thailand.html

Dash, N. and H. Gladwin. 2007. Evacuation decision making and behavioral responses: Individual and household. *Natural Hazards Review* 8 (3):69-77.

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., C. Wold, J. Fielding, A. Long, C. Setodji, S. Hickey, and L. Gelberg. 2006. Differences in individual-level terrorism preparedness in Los Angeles County. *American Journal of Preventive Medicine* 30 (1):1-6.

Enid, K., E. Svetlana, and S. Melinda. 2008. Gender, social capital and information exchange in rural Uganda. *Journal of International Development* 20 (1):35-52.

FAO, (Food and Agriculture Organization of the United Nations). 2005. Report of Joint FAO/MOAC Detailed Technical Damages and Needs Assessment Mission in Fisheries and Agriculture Sectors in Tsunami Affected Six Provinces in Thailand. FAO, Bangkok.[online] URL: http://www.apfic.org/apfic_downloads/tsunami/FAO_MOAC_thai.pdf

Faupel, C. E., S. P. Kelly, and T. Petee. 1992. The impact of disaster education on household preparedness for Hurricane Hugo. *International Journal of Mass Emergencies and Disasters* 10 (1):5-24.

Faupel, C. E. and S. P. Styles. 1993. Disaster education, household preparedness, and stress responses following Hurricane Hugo. *Environment and Behavior* 25 (2):228-249.

Ferdinand, I., G. O'Brien, P. O'Keefe, and J. Jayawickrama. 2012. The double bind of poverty and community disaster risk reduction: A case study from the Caribbean. *International Journal of Disaster Risk Reduction* 2 (0):84-94.

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

Fullerton, A. S. and J. Xu. 2012. The proportional odds with partial proportionality constraints model for ordinal response variables. *Social Science Research* 41 (1):182-198.

Glewwe, P. 1999. Why does mother's schooling raise child health in developing countries? Evidence from Morocco. *Journal of Human Resources* 3 (1):124-159.

Heller, K., D. B. Alexander, M. Gatz, B. G. Knight, and T. Rose. 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.

Horney, J., C. Snider, S. Malone, L. Gammons, and S. Ramsey. 2008. Factors associated with hurricane preparedness: Results of a pre-hurricane assessment. *Journal of Disaster Research* 3 (2):143-149.

Howell, S. E. and D. E. Bonner. 2005. Citizen Hurricane Evacuation Behavior in Southeastern Louisiana: A Twelve Parish Survey. University of New Orleans, Louisiana.[online] URL: https://hazdoc.colorado.edu/bitstream/handle/10590/318/C008010.pdf?sequence=1

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

Jamison, D. T. and P. R. Moock. 1984. Farmer education and farm efficiency in Nepal: The role of schooling, extension services, and cognitive skills. *World Development* 12 (1):67-86.

Kim, Y.-C. and J. Kang. 2010. Communication, neighbourhood belonging and household hurricane preparedness. *Disasters* 34 (2):470-488.

Kohn, S., J. L. Eaton, S. Feroz, A. A. Bainbridge, J. Hoolachan, and D. J. Barnett. 2012. Personal disaster preparedness: An integrative review of the literature. *Disaster Medicine and Public Health Preparedness* 6 (3):217-231.

Kuhlicke, C., A. Scolobig, S. Tapsell, A. Steinführer, and B. De Marchi. 2011. Contextualizing social vulnerability: findings from case studies across Europe. *Natural Hazards* 58 (2):789-810.

Lehman, D. R. and S. E. Taylor. 1987. Date with an Earthquake: Coping with a Probable, Unpredictable Disaster. *Personality and Social Psychology Bulletin* 13 (4):546-555.

Lindell, M. K. and R. W. Perry. 2000. Household Adjustment to Earthquake Hazard: A Review of Research. *Environment and Behavior* 32 (4):461-501.

Menard, L. A., R. O. Slater, and J. Flaitz. 2011. Disaster preparedness and educational attainment. *Journal of Emergency Management* 9 (4):45-52.

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., S. Mazumdar, and D. Suar. 2010. Place attachment and flood preparedness. *Journal of Environmental Psychology* 30 (2):187-197.

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

Moore, G. 1990. Structural determinants of men's and women's personal networks. *American Sociological Review* 55 (5):726-735.

Murphy, S. T., M. Cody, L. B. Frank, D. Glik, and A. Ang. 2009. Predictors of emergency preparedness and compliance. *Disaster Medicine and Public Health Preparedness*.

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

Nigg, J. M. 1982. Communication under conditions of uncertainty: Understanding earthquake forecasting. *Journal of Communication* 32 (1):27-36.

Norris, F. H., T. Smith, and K. Kaniasty. 1999. Revisiting the experience–behavior hypothesis: The effects of Hurricane Hugo on hazard preparedness and other self-protective acts. *Basic and Applied Social Psychology* 21 (1):37-47.

Pacific Tsunami Warning Center. 2012. Tsunami Watch: Tsunami Bulletin Number 007.[online] URL: http://ptwc.weather.gov/ptwc/index.php?region=3&id=indian.TSUIOX.2012.04.11.1318

Page, L., J. Rubin, R. Amlot, J. Simpson, and S. Wessely. 2008. Are Londoners prepared for an emergency? A longitudinal study following the London bombings. *Biosecur Bioterror* 6 (4):309-319.

Paul, C., C. Claire, S. Fiona, and V. Anna. 2010. The choice between fixed and random effects models: Some considerations for educational research. Department of Economics, University of Bristol, UK.[online] URL: http://ideas.repec.org/p/bri/cmpowp/10-240.html

Peterson, B. and F. Harrell. 1990. Partial proportional odds models for ordinal response variables. *Applied Statistics* 39 (2):205-217.

Pollitz, F. F., R. S. Stein, V. Sevilgen, and R. Burgmann. 2012. The 11 April 2012 east Indian Ocean earthquake triggered large aftershocks worldwide. *Nature* 490 (7419):250-253.

Rachmalia, U. Hatthakit, and A. Chaowalit. 2011. Tsunami preparedness of people living in affected and non-affected areas: A comparative study in coastal area in Aceh, Indonesia. *Australasian Emergency Nursing Journal* 14 (1):17-25.

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

Rogers, E. M. 1995. *Diffusion of Innovations*. 4th edition. The Free Press, New York, NY.

Römer, H., P. Willroth, G. Kaiser, A. T. Vafeidis, R. Ludwig, H. Sterr, and J. Revilla Diez. 2012. Potential of remote sensing techniques for tsunami hazard and vulnerability analysis – a case study from Phang-Nga province, Thailand. *Natural Hazards and Earth System Sciences* 12 (6):2103-2126.

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.

Sattler, D. N., C. F. Kaiser, and J. B. Hittner. 2000. Disaster preparedness: Relationships among prior experience, personal characteristics, and distress. *Journal of Applied Social Psychology* 30 (7):1396-1420.

Selby, D. and F. Kagawa. 2012. Disaster Risk Reduction in School Curricula: Case Studies from Thirty Countries. United Nations Educational, Scientific and Cultural Organization and United Nations Children Fund Geneva.[online] URL: http://www.unicef.org/education/files/DRRinCurricula-Mapping30countriesFINAL.pdf

Siegel, J. M., K. I. Shoaf, A. A. Afifi, and L. B. Bourque. 2003. Surviving two disasters: Does reaction to the first predict response to the second? *Environment and Behavior* 35 (5):637-654.

Spittal, M. J., J. McClure, R. J. Siegert, and F. H. Walkey. 2008. Predictors of two types of earthquake preparation: Survival activities and mitigation activities. *Environment and Behavior* 40 (6):798-817.

Tanaka, K. 2005. The impact of disaster education on public preparation and mitigation for earthquakes: a cross-country comparison between Fukui, Japan and the San Francisco Bay Area, California, USA. *Applied Geography* 25 (3):201-225.

Tekeli-Yeşil, S., N. Dedeoğlu, M. Tanner, C. Braun-Fahrlaender, and B. Obrist. 2010. Individual preparedness and mitigation actions for a predicted earthquake in Istanbul. *Disasters* 34 (4):910-930.

Thanawood, C., C. Yongchalermchai, and O. Densrisereekul. 2006. Effects of the December 2004 tsunami and disaster management in southern Thailand. *Science of Tsunami Hazards* 24 (3):206-217.[online] URL: http://tsunamisociety.org/243thana.pdf

Thomas, D., J. Strauss, and M.-H. Henriques. 1991. How does mother's education affect child height? *Journal of Human Resources* 26 (2):183-211.

Tierney, K. J., M. K. Lindell, and R. W. Perry. 2001. *Facing Hazards and Disasters: Understanding Human Dimensions*. Joseph Henry Press.

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

UNISDR, (United Nations International Strategy for Disaster Reduction). 2007. Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. UNISDR, Geneva.[online] URL: http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf

USGS, (U.S. Geological Survey). 2012. Magnitude 8.6 - Off the West coast of Northern Sumatra.[online] URL: http://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/usc000905e.php#details

Williams, R. 2006. Generalized ordered logit/partial proportional odds models for ordinal dependent variables. *Stata Journal* 6 (1):58-82.

Wolfe, R. and W. Gould. 1998. An approximate likelihood-ratio test for ordinal response models. *Stata Technical Bulletin* 7 (42).

Table 1: Summary statistics of individual-, household- and village-level characteristics and binary relationships between these characteristics and disaster preparedness

	No preparation	One preparation	Two or more preparations	N	Total
Individual characteristics					
Educational attainment+					
no & elementary education	29.4%	43.4%	27.2%	371	66.6%
lower secondary	23.7%	56.6%	19.7%	76	13.6%
upper secondary	23.7%	40.7%	35.6%	59	10.6%
tertiary	17.6%	41.2%	41.2%	51	9.2%
Status in household					
head of household	28%	44.9%	27.1%	336	60.3%
not head of household	25.3%	44.3%	30.3%	221	39.7%
Years of residence in household	27.93(20.21)	25.33(15.42)	25.58(16.32)	557	26.1(17.09)
Sex					
men	27.9%	47%	25.1%	251	45.1%
women	26.1%	42.8%	31%	306	54.9%
Age*					
<30 years	28.6%	32.9%	38.6%	70	12.6%
30 - 39 years	20.8%	50.9%	28.3%	106	19%
40 - 49 years	25.2%	53.3%	21.5%	135	24.2%
50 - 59 years	25.4%	41%	33.6%	122	21.9%
60 years and over	34.7%	40.3%	25%	124	22.3%
Marital status					
divorced/separated/widowed	24.1%	51.9%	24.1%	79	14.2%
married	26.2%	44.7%	29.1%	409	73.4%
single	34.8%	36.2%	29%	69	12.4%
Occupation**					
fishery	23.1%	50%	26.9%	52	9.3%
agriculture	44%	44%	12%	75	13.5%
laborer	27.6%	37.9%	34.5%	87	15.6%
general trade/own business	24.2%	44.8%	30.9%	194	34.8%
private employee/civil servant	13.9%	55.6%	30.6%	36	6.5%
economically inactive	25.7%	44.2%	30.1%	113	20.3%
Experience of 2004 tsunami***					
not affected	40.7%	38.9%	20.4%	216	38.8%
affected	18.2%	48.4%	33.4%	341	61.2%
Participated in evacuation drills and disaster education***					
not participated	38%	40.7%	21.4%	332	59.6%
participated	10.7%	50.7%	38.7%	225	40.4%
Number of sources of information***	2.41(1.02)	2.94(1.44)	3.2(1.48)	557	2.87(1.38)

Household characteristics					
Number of members with at least secondary education					
none	29.3%	43.8%	26.9%	283	50.8%
one person	23.8%	46.4%	29.8%	168	30.2%
two or more persons	25.5%	44.3%	30.2%	106	19%
Number of persons in household	3.98(2.21)	3.73(1.95)	3.96(1.80)	557	3.87(1.98)
Number of children aged ≤ 5 years	0.37(0.67)	0.36(0.63)	0.39(0.67)	557	0.37(0.65)
Number of members aged ≥ 60 years***	0.72(0.98)	0.39(0.66)	0.52(0.82)	557	0.52(0.81)
Number of members with disability**	0.02(0.14)	0.03(0.18)	0.08(0.28)	557	0.04(0.20)
Household income					
< ฿ 10,000	27.8%	46.5%	25.8%	198	35.5%
฿10,000 - 19,999	26%	46.2%	27.8%	223	40%
฿20,000 - 29,999	26.4%	42.5%	31%	87	15.6%
฿30,000 and over	28.6%	34.7%	36.7%	49	8.8%
House location***					
house located on the coast	14.3%	50%	35.7%	70	12.6%
house located <1 km from the shore	19.9%	48.3%	31.8%	261	46.9%
house located ≥ 1km from the shore	38.9%	38.9%	22.1%	226	40.6%
Village characteristics					
Percentage of men with at least secondary education***	20.39(6.21)	23.19(6.22)	24.65(7.63)	557	22.85(6.83)
Percentage of women with at least secondary education***	24.9(6.61)	30.39(6.59)	31.23(6.43)	557	29.15(7.04)
Percentage of members aged 60 years and over	5.67(2.41)	5.52(1.79)	5.24(1.74)	557	5.48(1.97)
Percentage of women***	46.14(2.79)	45.13(2.32)	44.4(2.17)	557	45.19(2.50)

Note: Standard deviations are in parentheses. For categorical variables, chi-square tests are performed to test the relationship between that particular variable and disaster preparedness. For continuous variables, ANOVA is applied.

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1.

Table 2: Partial proportion odds ordered logit models predicting disaster preparedness with village fixed effects

	Model 1		Model 2		Model 3		Model 4	
	β	s.e.	*β*	s.e.	*β*	s.e.	*β*	s.e.
Individual characteristics								
Education (ref: no & elementary)								
lower secondary	-0.112	(0.267)	-0.060	(0.270)	-0.024	(0.286)	-0.067	(0.284)
upper secondary	0.652*	(0.306)	0.633*	(0.310)	0.559+	(0.330)	0.496	(0.326)
tertiary	0.892**	(0.336)	0.845*	(0.338)	0.750*	(0.371)	0.686+	(0.368)
Head of household	-0.089	(0.224)	-0.103	(0.226)	-0.121	(0.236)	-0.067	(0.233)
Years of residence in household	0.009	(0.006)	0.003	(0.006)	0.005	(0.007)	0.006	(0.007)
Women	0.370+	(0.215)	0.308	(0.219)	0.344	(0.225)	0.299	(0.223)
Age (ref: <30 years)								
30 - 39 years	-0.347	(0.335)	-0.243	(0.338)	0.165	(0.420)	0.173	(0.415)
	-0.758*	(0.376)	-0.830*	(0.383)	-1.136**	(0.407)	-0.629	(0.386)
40 - 49 years	-0.088	(0.379)	-0.092	(0.385)	-0.065	(0.411)	0.042	(0.402)
					-1.136**	(0.407)	-1.048**	(0.400)
50 - 59 years	-0.028	(0.369)	-0.077	(0.373)	-0.161	(0.392)	-0.089	(0.385)
60 years and over	-0.406	(0.414)	-0.363	(0.419)	0.431	(0.536)	0.472	(0.525)
					-0.889	(0.547)	-0.917+	(0.540)
Marital status (ref: single)								
divorced/separated/widowed	0.124	(0.396)	0.084	(0.402)	-0.005	(0.429)	0.097	(0.424)
married	0.629*	(0.305)	0.636*	(0.312)	0.675*	(0.330)	0.651*	(0.328)
Occupation (ref: agriculture)								
fishery	-0.223	(0.406)	-0.535	(0.418)	-0.452	(0.437)	-0.362	(0.431)
laborer	0.227	(0.349)	0.089	(0.355)	-0.527	(0.414)	-0.309	(0.405)
							0.610	(0.394)
general trade/own business	-0.085	(0.310)	-0.157	(0.316)	-0.174	(0.329)	0.037	(0.321)
private employee/civil servant	0.397	(0.429)	0.084	(0.441)	0.079	(0.464)	0.296	(0.455)
economically inactive	0.339	(0.331)	0.209	(0.339)	0.152	(0.353)	0.268	(0.347)
Affected by tsunami in 2004			0.371+	(0.217)	0.354	(0.228)	0.159	(0.218)
Participated in evacuation drills and disaster education			0.382	(0.245)	0.380	(0.253)	0.293	(0.249)
Number of sources of information			0.303***	(0.068)	0.494***	(0.110)	0.499***	(0.108)
					0.240**	(0.080)	0.244**	(0.078)
Household characteristics								
Number of members with at least secondary education (ref: none)								
one person					0.274	(0.220)	0.413+	(0.214)
two or more persons					0.510+	(0.277)	0.599*	(0.274)
Household income (ref: < ฿10,000)								
฿10,000 - 19,999					0.063	(0.380)	0.098	(0.377)
฿20,000 - 29,999					0.022	(0.365)	0.112	(0.358)

฿30,000 and over					-0.123	(0.396)	-0.056	(0.391)
Number of persons in household					-0.063	(0.064)	-0.074	(0.063)
Number of children aged ≤ 5 years					-0.094	(0.165)	-0.051	(0.164)
Number of members aged ≥ 60 years					-0.774***	(0.186)	-0.680***	(0.173)
					0.346+	(0.191)	0.368*	(0.182)
Number of members with disability					1.336**	(0.473)	1.331**	(0.461)
House location (ref: house located on the coast)								
house located <1 km from the shore					-0.273	(0.284)	-0.306	(0.284)
house located ≥ 1km from the shore					-0.147	(0.340)	-0.292	(0.326)
Village characteristics								
% men with at least secondary education							0.024	(0.023)
% women with at least secondary education							0.108***	(0.029)
							0.023	(0.030)
% members aged 60 years and over							-0.022	(0.069)
% of women							-0.180**	(0.062)
Village dummies included	yes		yes		yes		no	
Constant_1	0.965	(0.623)	-0.145	(0.673)	-0.052	(0.840)	3.629	(2.691)
Constant_2	-1.565	(0.614)	-2.758	(0.676)	-2.364	(0.846)	4.376	(2.747)
Log likelihood	-509.204		-495.931		-469.953		-477.579	
DF	26		29		45		42	
Pseudo R^2	0.13		0.15		0.20		0.18	

Note: Coefficients not highlighted indicate the estimate under the proportional odds assumption while coefficients shaded are variables that violate the proportional odds assumption. The non-shaded coefficients are for the first logit equation contrasting *no preparation* versus *one preparation* and *two preparations or higher*. The shaded coefficients are for the second logit equation contrast *no preparation* and *one preparation* versus *two preparations or higher*.

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1.

Table 3: Partial proportion odds ordered logit models predicting disaster preparedness with village fixed effects: samples split by respondents' level of education

	Less than secondary education				At least secondary education			
	Model 1		Model 2		Model 1		Model 2	
	β	s.e.	β	s.e.	β	s.e.	β	s.e.
Individual characteristics								
Affected by tsunami in 2004	0.261	(0.278)	0.134	(0.273)	0.743+	(0.395)	0.467	(0.410)
Participated in evacuation drills and disaster education	0.245	(0.304)	0.260	(0.308)	0.898*	(0.450)	0.764	(0.487)
Number of sources of information	0.295***	(0.084)	0.302***	(0.087)	0.417**	(0.135)	0.533***	(0.145)
Household characteristics								
Number of members with at least secondary education (ref: none)								
one person			0.160	(0.270)			1.298**	(0.425)
two or more persons			0.274	(0.331)			1.752**	(0.585)
Number of children aged ≤ 5 years			0.008	(0.205)			-1.201**	(0.430)
							0.094	(0.346)
Number of members aged ≥ 60 years			-0.659***	(0.190)			0.725+	(0.426)
			0.203	(0.213)				
Number of members with disability			1.390**	(0.524)			0.850	(1.160)
Village characteristics								
% men with at least secondary education			0.032	(0.031)			-0.001	(0.039)
% women with at least secondary education			0.111**	(0.035)			0.041	(0.055)
			0.029	(0.037)				
% members aged 60 years and over			0.019	(0.089)			-0.294*	(0.131)
% of women			-0.187*	(0.080)			-0.096	(0.118)
Village dummies included	yes		no		yes		no	
Constant_1	0.441	(0.930)	3.795	(3.444)	-1.009	(1.144)	2.763	(5.061)
Constant_2	-2.164	(0.931)	3.920	(3.535)	-4.304	(1.174)	1.632	(5.012)
Log likelihood	-329.480		-320.159		-153.109		-145.606	
DF	27		36		24		38	
Pseudo R^2	0.15		0.18		0.21		0.25	
N	360		360		184		184	

Note: Model 1 control for individual characteristics including head of household status, years of residence, sex, age, marital status and occupation. Model 2 further adds household characteristics including household income and household location. Full results are available in Table 1, Appendix 1. Coefficients not highlighted indicate the estimate under the proportional odds assumption while coefficients shaded are variables that violate the proportional odds assumption. The non-shaded coefficients are for the first logit equation contrasting *no preparation* versus *one preparation* and *two preparations or higher*. The shaded coefficients are for the second logit equation contrast *no preparation* and *one preparation* versus *two preparations or higher*.

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1.

Table 4: Partial proportion odds ordered logit models predicting disaster preparedness with village fixed effects: samples split by experience of tsunami in 2004

	Not affected by 2004 tsunami				Affected by 2004 tsunami			
	Model 1		Model 2		Model 1		Model 2	
	β	s.e.	β	s.e.	β	s.e.	β	s.e.
Disaster-related factors								
Participated in evacuation drills and disaster education	0.438	(0.439)	-0.074	(0.518)	0.324	(0.292)	0.347	(0.313)
Number of sources of information	0.626***	(0.118)	0.772***	(0.152)	0.143+	(0.082)	0.180*	(0.092)
Education								
Individual education (ref: no & elementary)								
lower secondary	0.264	(0.401)	0.921+	(0.558)	-0.337	(0.324)	-0.352	(0.395)
			-0.496	(0.661)				
upper secondary	0.533	(0.434)	0.590	(0.541)	0.572	(0.388)	0.312	(0.459)
tertiary	0.120	(0.491)	0.379	(0.641)	0.930*	(0.408)	0.989+	(0.509)
Number of members with at least secondary education (ref: none)								
one person	0.866*	(0.341)	0.793*	(0.393)	-0.180	(0.259)	0.007	(0.291)
two or more persons	0.985*	(0.400)	1.094*	(0.504)	-0.184	(0.282)	0.443	(0.367)
Other demographic and socioeconomic characteristics								
Number of persons in household			-0.117	(0.137)			-0.182*	(0.086)
			0.236	(0.145)				
Number of children aged ≤ 5 years			0.011	(0.291)			-0.067	(0.219)
Number of members aged ≥ 60 years			-0.243	(0.345)			-0.417*	(0.202)
							0.439*	(0.211)
Number of members with disability			0.742	(1.117)			1.715**	(0.584)
Village characteristics								
% men with at least secondary education			-0.278*	(0.132)			0.028	(0.028)
			0.351	(0.230)				
% women with at least secondary education			0.401***	(0.114)			0.094*	(0.041)
			-0.138	(0.163)			-0.009	(0.041)
% members aged 60 years and over			-0.032	(0.150)			0.119	(0.102)
% of women			0.035	(0.178)			-0.307***	(0.083)
			-0.744*	(0.315)				
Village dummies included	yes		no		yes		no	
Constant_1	-0.505	(0.548)	-9.942	(7.476)	1.485	(0.438)	11.79**	(3.739)
Constant_2	-2.848	(0.579)	23.73+	(13.260)	-1.254	(0.427)	11.99**	(3.803)
Log likelihood	-184.710		-157.301		-307.897		-279.889	
DF	13		42		14		43	
Pseudo R^2	0.19		0.31		0.09		0.18	

N	216	216	328	328

Note: Model 2 control for other individual characteristics including head of household status, years of residence, sex, age, marital status and occupation as well as household characteristics including household income and household location. Full results are available in Table 2, Appendix 1. Coefficients not highlighted indicate the estimate under the proportional odds assumption while coefficients shaded are variables that violate the proportional odds assumption. The non-shaded coefficients are for the first logit equation contrasting *no preparation* versus *one preparation* and *two preparations or higher*. The shaded coefficients are for the second logit equation contrast *no preparation* and *one preparation* versus *two preparations or higher*.

Table A1.1: Partial proportion odds ordered logit models predicting disaster preparedness with village fixed effects: samples split by respondents' level of education

	Less than secondary education				At least secondary education			
	Model 1		Model 2		Model 1		Model 2	
	β	s.e.	β	s.e.	β	s.e.	β	s.e.
Individual characteristics								
Affected by tsunami in 2004	0.261	(0.278)	0.134	(0.273)	0.743+	(0.395)	0.467	(0.410)
Participated in evacuation drills and disaster education	0.245	(0.304)	0.260	(0.308)	0.898*	(0.450)	0.764	(0.487)
Number of sources of information	0.295***	(0.084)	0.302***	(0.087)	0.417**	(0.135)	0.533***	(0.145)
Head of household	-0.167	(0.282)	-0.117	(0.289)	0.355	(0.412)	-0.046	(0.462)
Years of residence in household	0.002	(0.008)	0.005	(0.008)	-0.005	(0.015)	0.009	(0.016)
Women	0.302	(0.275)	0.329	(0.281)	0.056	(0.393)	0.407	(0.416)
Age (ref: <30 years)								
30 - 39 years	-0.226	(0.600)	-0.312	(0.617)	-0.003	(0.470)	-0.428	(0.511)
40 - 49 years	-0.072	(0.602)	-0.035	(0.625)	-0.332	(0.539)	-0.624	(0.596)
	-0.957	(0.610)	-1.176+	(0.638)				
50 - 59 years	-0.052	(0.582)	-0.007	(0.599)	0.145	(0.654)	-0.311	(0.723)
60 years and over	-0.220	(0.616)	0.684	(0.717)	-2.876*	(1.163)	-4.821**	(1.509)
			-0.537	(0.737)				
Marital status (ref: single)								
divorced/separated/widowed	-0.006	(0.607)	-0.148	(0.623)	0.004	(0.768)	3.162*	(1.416)
							-1.031	(1.276)
married	0.453	(0.545)	0.482	(0.557)	0.747+	(0.425)	1.616**	(0.578)
							0.325	(0.559)
Occupation (ref: agriculture)								
fishery	-0.380	(0.499)	-0.222	(0.509)	-1.212	(0.879)	-1.109	(0.910)
laborer	0.208	(0.429)	0.286	(0.443)	-0.026	(0.710)	0.339	(0.780)
general trade/own business	-0.088	(0.382)	0.043	(0.378)	-0.215	(0.622)	0.232	(0.656)
private employee/civil servant	0.045	(0.721)	0.326	(0.731)	-0.154	(0.704)	0.204	(0.750)
economically inactive	0.0678	(0.397)	0.113	(0.400)	0.826	(0.770)	1.050	(0.801)
Household characteristics								
Number of members with at least secondary education (ref: none)								
one person			0.160	(0.270)			1.298**	(0.425)
two or more persons			0.274	(0.331)			1.752**	(0.585)
Household income (ref: < ฿10,000)								
฿10,000 - 19,999			0.047	(0.544)			0.871	(0.788)
							-0.772	(0.697)
฿20,000 - 29,999			0.023	(0.532)			1.009	(0.637)
							-0.383	(0.589)
฿30,000 and over			0.007	(0.583)			0.998	(0.743)

							-0.872	(0.684)
Number of persons in household			-0.037	(0.078)			-0.183	(0.131)
Number of children aged ≤ 5 years			0.008	(0.205)			-1.201**	(0.430)
							0.094	(0.346)
Number of members aged ≥ 60 years			-0.659***	(0.190)			0.725+	(0.426)
			0.203	(0.213)				
Number of members with disability			1.390**	(0.524)			0.850	(1.160)
House location (ref: house located on the coast)								
house located <1 km from the shore			0.071	(0.360)			-1.053+	(0.543)
house located ≥ 1km from the shore			-0.016	(0.415)			-0.614	(0.608)
Village characteristics								
% men with at least secondary education			0.032	(0.031)			-0.001	(0.039)
% women with at least secondary education			0.111**	(0.035)			0.041	(0.055)
			0.029	(0.037)				
% members aged 60 years and over			0.019	(0.089)			-0.294*	(0.131)
% of women			-0.187*	(0.080)			-0.096	(0.118)
Village dummies included	yes		no		yes		no	
Constant_1	0.441	(0.930)	3.795	(3.444)	-1.009	(1.144)	2.763	(5.061)
Constant_2	-2.164	(0.931)	3.920	(3.535)	-4.304	(1.174)	1.632	(5.012)
Log likelihood	-329.480		-320.159		-153.109		-145.606	
DF	27		36		24		38	
Pseudo R^2	0.15		0.18		0.21		0.25	
N	360		360		184		184	

Note: Coefficients not highlighted indicate the estimate under the proportional odds assumption while coefficients shaded are variables that violate the proportional odds assumption. The non-shaded coefficients are for the first logit equation contrasting *no preparation* versus *one preparation* and *two preparations or higher*. The shaded coefficients are for the second logit equation contrast *no preparation* and *one preparation* versus *two preparations or higher*.

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1.

Table A1.2: Partial proportion odds ordered logit models predicting disaster preparedness with village fixed effects: samples split by experience of tsunami in 2004

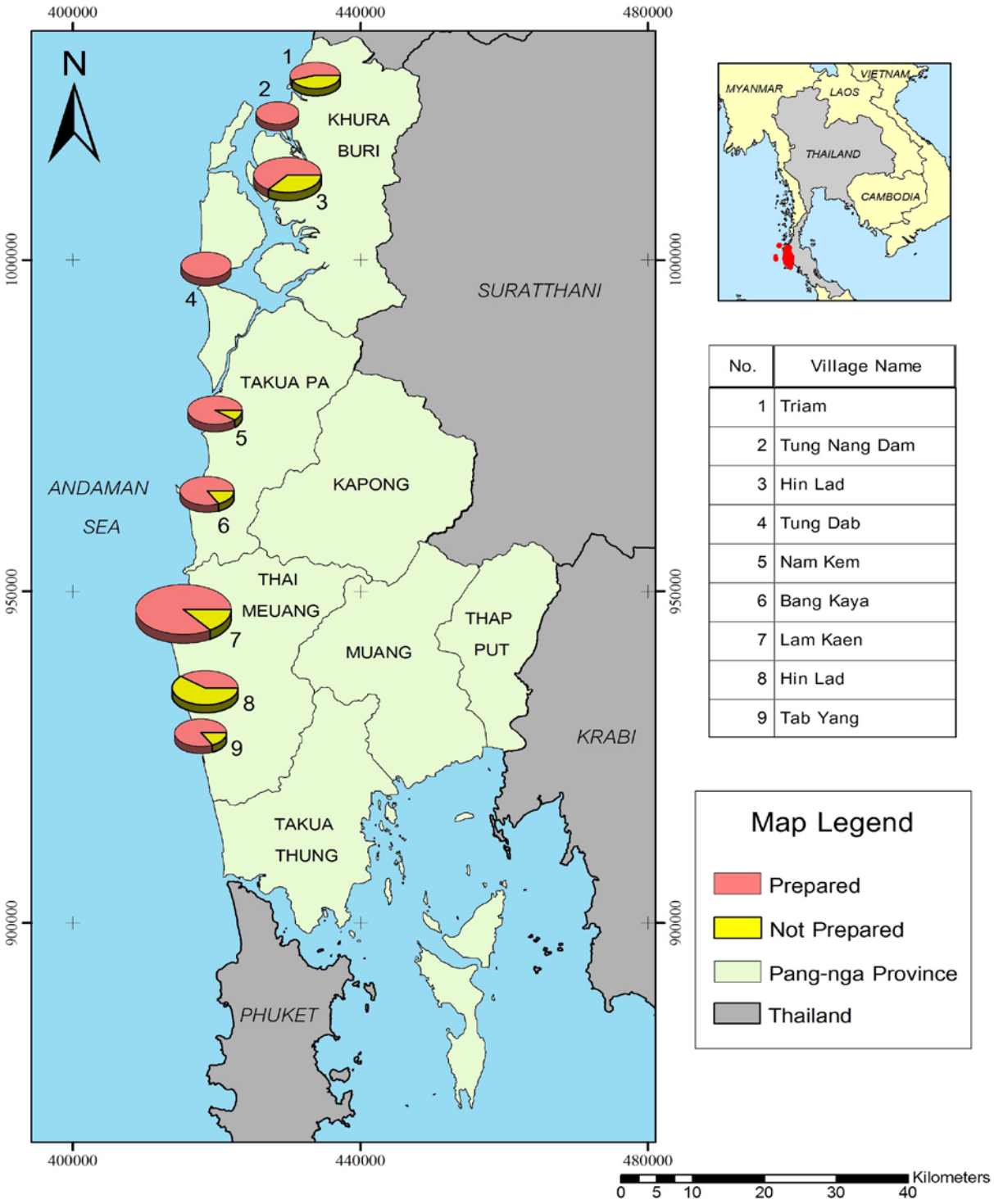
	Not affected by 2004 tsunami				Affected by 2004 tsunami			
	Model 1		Model 2		Model 1		Model 2	
	β	s.e.	β	s.e.	β	s.e.	β	s.e.
Disaster-related factors								
Participated in evacuation drills and disaster education	0.438	(0.439)	-0.074	(0.518)	0.324	(0.292)	0.347	(0.313)
Number of sources of information	0.626***	(0.118)	0.772***	(0.152)	0.143+	(0.082)	0.180*	(0.092)
Education								
Individual education (ref: no & elementary)								
lower secondary	0.264	(0.401)	0.921+	(0.558)	-0.337	(0.324)	-0.352	(0.395)
			-0.496	(0.661)				
upper secondary	0.533	(0.434)	0.590	(0.541)	0.572	(0.388)	0.312	(0.459)
tertiary	0.120	(0.491)	0.379	(0.641)	0.930*	(0.408)	0.989+	(0.509)
Number of members with at least secondary education (ref: none)								
one person	0.866*	(0.341)	0.793*	(0.393)	-0.180	(0.259)	0.007	(0.291)
two or more persons	0.985*	(0.400)	1.094*	(0.504)	-0.184	(0.282)	0.443	(0.367)
Other demographic and socioeconomic characteristics								
Head of household			0.216	(0.475)			0.190	(0.413)
							-0.703*	(0.354)
Years of residence in household			0.015	(0.011)			0.0004	(0.011)
Women			-0.052	(0.406)			-0.114	(0.406)
							1.030**	(0.343)
Age (ref: <30 years)								
30 - 39 years			0.810	(0.688)			-0.621	(0.502)
40 - 49 years			0.843	(0.678)			-0.880+	(0.517)
			-2.464**	(0.873)				
50 - 59 years			0.316	(0.729)			-1.291*	(0.613)
							-0.057	(0.542)
60 years and over			0.285	(0.988)			-0.965	(0.660)
Marital status (ref: single)								
divorced/separated/widowed			0.083	(0.740)			1.683*	(0.762)
							-0.826	(0.658)
married			0.701	(0.550)			1.973***	(0.568)
							0.337	(0.512)
Occupation (ref: agriculture)								
fishery			0.489	(1.096)			-0.525	(0.562)
laborer			-0.264	(0.677)			-0.841	(0.624)
			1.574*	(0.683)			0.376	(0.584)
general trade/own business			0.308	(0.570)			-0.544	(0.453)

private employee/civil servant			0.135	(0.915)			0.152	(0.607)
economically inactive			0.454	(0.579)			-0.172	(0.525)
Household characteristics								
Household income (ref: < ฿10,000)								
฿10,000 - 19,999			0.446	(0.752)			-0.271	(0.508)
฿20,000 - 29,999			1.098	(0.708)			-0.446	(0.483)
฿30,000 and over			0.047	(0.748)			-0.484	(0.527)
Number of persons in household			-0.117	(0.137)			-0.182*	(0.086)
			0.236	(0.145)				
Number of children aged ≤ 5 years			0.011	(0.291)			-0.067	(0.219)
Number of members aged ≥ 60 years			-0.243	(0.345)			-0.417*	(0.202)
							0.439*	(0.211)
Number of members with disability			0.742	(1.117)			1.715**	(0.584)
House location (ref: house located on the coast)								
house located <1 km from the shore			0.281	(0.716)			-0.966*	(0.444)
							-0.135	(0.361)
house located ≥ 1km from the shore			-0.189	(0.748)			-0.064	(0.417)
Village characteristics								
% men with at least secondary education			-0.278*	(0.132)			0.028	(0.028)
			0.351	(0.230)				
% women with at least secondary education			0.401***	(0.114)			0.094*	(0.041)
			-0.138	(0.163)			-0.009	(0.041)
% members aged 60 years and over			-0.032	(0.150)			0.119	(0.102)
% of women			0.035	(0.178)			-0.307***	(0.083)
			-0.744*	(0.315)				
Village dummies included	yes		no		yes		no	
Constant_1	-0.505	(0.548)	-9.942	(7.476)	1.485	(0.438)	11.79**	(3.739)
Constant_2	-2.848	(0.579)	23.73+	(13.260)	-1.254	(0.427)	11.99**	(3.803)
Log likelihood	-184.710		-157.301		-307.897		-279.889	
DF	13		42		14		43	
Pseudo R^2	0.19		0.31		0.09		0.18	
N	216		216		328		328	

Note: Coefficients not highlighted indicate the estimate under the proportional odds assumption while coefficients shaded are variables that violate the proportional odds assumption. The non-shaded coefficients are for the first logit equation contrasting *no preparation* versus *one preparation* and *two preparations or higher*. The shaded coefficients are for the second logit equation contrast *no preparation* and *one preparation* versus *two preparations or higher*.

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1.

Figure 1: Map of sampled 9 villages in Phang Nga province and percentage of respondents undertaking preparedness actions in village (shown in pie charts)



Note: The size of the pie charts vary according to village population size.