Title	Trust and distrust of tsunami vertical evacuation buildings: Extending protection motivation theory to examine choices under social influence
Author(s)	McCaughey, Jamie W.; Mundir, Ibnu; Daly, Patrick; Mahdi, Saiful; Patt, Anthony
Citation	McCaughey, J. W., Mundir, I., Daly, P., Mahdi, S., & Patt, A. (2017). Trust and distrust of tsunami vertical evacuation buildings: Extending protection motivation theory to examine choices under social influence. International Journal of Disaster Risk Reduction, 24, 462-473.
Date	2017
URL	http://hdl.handle.net/10220/43982
Rights	

International Journal of Disaster Risk Reduction 24 (2017) 462–473

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

Trust and distrust of tsunami vertical evacuation buildings: Extending protection motivation theory to examine choices under social influence

Jamie W. McCaughey[a,b,*,1], Ibnu Mundir[c], Patrick Daly[a], Saiful Mahdi[c,d], Anthony Patt[b]

[a] Earth Observatory of Singapore, Nanyang Technological University, Singapore
[b] Institute for Environmental Decisions, Dept. of Environmental Systems Science, ETH Zürich, Switzerland
[c] International Centre for Aceh and Indian Ocean Studies, Aceh, Indonesia
[d] Statistics Department, Syiah Kuala University, Banda Aceh, Indonesia

ARTICLE INFO

Keywords:
Tsunami
Evacuation
Protection motivation theory
Trust
Social influence
Social norms

ABSTRACT

Tsunami vertical evacuation (TVE) buildings have the potential to save many lives. Yet whether TVE buildings actually save lives depends critically on whether people trust and evacuate to them, a question that has not previously been researched. We examine the case of the city of Banda Aceh, Indonesia, where a M8.6 earthquake on 11-April-2012 caused a spontaneous mass evacuation but no tsunami. Our survey of residents living near TVE buildings (n = 202) shows that they clearly prefer horizontal evacuation: in the 2012 earthquake, only 26% evacuated to a TVE building, while 74% evacuated horizontally; if a similar earthquake happened in the future, only 32% intend to evacuate to a TVE building, while 68% intend to evacuate horizontally. To investigate the reasons for this, we extend protection motivation theory to examine people's choices among protective actions under social influence. Those who prefer to evacuate horizontally do not trust the safety of the TVE building and think they can reach a safe inland destination in time, while those who prefer to evacuate to a TVE building think they cannot reach a safe inland destination in time. Encouragement from friends and family influences people's evacuation destinations but official information and training do not. These findings suggest that more attention to the social context is crucial for the effectiveness of TVE buildings. Our extension of protection motivation theory to include choices among protective actions under social influence can be broadly useful in research on self-protective behavior in natural hazards, public health, and other contexts.

1. Introduction

Locally generated tsunamis can strike nearby coastlines in just tens of minutes following an earthquake (Appendix A). This is especially the case in the subduction zones of the world, including the Pacific 'ring of fire'. For cities in flat coastal areas in such regions, tsunami vertical evacuation (TVE) structures (buildings or mounds) may provide the only means of escape for many coastal residents, as tsunamis can travel many kilometres inland and traffic jams impede horizontal evacuation [1,2]. TVE structures saved many lives in the 2011 Great East Japan earthquake, but studies of that evacuation do not establish the proportions of nearby populations that evacuated to TVE buildings or horizontally to inland destinations, nor people's reasons for these evacuation choices [3–5]. Therefore while we know that TVE structures have the potential to save lives, we do not know the degree to which people actually trust and use them in evacuations.

Whether TVE structures substantially reduce loss of life in a tsunami depends on three critical factors. The first factor is whether TVE structures remain safe in both the earthquake and the tsunami. This has been a focus of research in geoscience and engineering [6]. The second factor is whether people are able to reach a TVE structure in time and find space when they get there. This has been a focus of research using evacuation simulation modelling [1,2]. The third factor is whether people actually trust and use TVE structures in an evacuation. This question that has not previously been researched and is the subject of this paper.

Using the case of a mass evacuation in the city of Banda Aceh, Indonesia, we investigate determinants of people's decisions to evacuate to a TVE building or horizontally to an inland destination. A strong (M8.6) earthquake on 11-April-2012 caused a spontaneous mass evacuation in Banda Aceh, but ultimately no tsunami. This provides a realistic test of use of TVE buildings that had been built as part of the

Abbreviations: PMT, Protection motivation theory; TVE, Tsunami vertical evacuation; OR, Odds ratio

* Corresponding author at: Earth Observatory of Singapore, Nanyang Technological University, Singapore.
E-mail address: jmccaughey@ntu.edu.sg (J.W. McCaughey).
[1] ORCID 0000-0003-1490-5022.

http://dx.doi.org/10.1016/j.ijdrr.2017.06.016
Received 20 April 2017; Received in revised form 12 June 2017; Accepted 12 June 2017
Available online 20 June 2017

reconstruction following the 26-Dec-2004 tsunami. One of the authors of this paper (I.M.) personally evacuated to a TVE building in the 11-April-2012 earthquake. He observed that most people in nearby communities avoided the TVE buildings and instead evacuated horizontally to inland destinations. This observation motivated us to field a larger study in order to (1) quantify evacuation destinations for this population, (2) investigate trust and other determinants of people's choices to evacuate to a TVE building or horizontally to inland destinations, and (3) assess whether the 2012 experience has changed people's intentions to use the TVE buildings in a future evacuation.

In this paper we examine how infrastructure intended to reduce societal vulnerability can be ineffective if people do not trust that infrastructure. We also propose a new tool for analyzing self-protective behaviors, based on protection motivation theory.

1.1. Theoretical approach: extending protection motivation theory to examine choices among protective actions under social influence

We use protection motivation theory (PMT) to examine why people choose to evacuate to a TVE building or horizontally to an inland destination. PMT was initially developed to investigate why people do or do not engage in health-promoting behaviors [7]. PMT has since been revised and widely used to gain insights into self-protection intentions and behaviors in health, natural hazards, and other contexts [8–10]. For example, PMT has been used to understand why people do or do not take protective actions in the contexts of flooding [11–13] and adaptation to climate change [14]. PMT is not the only theory of self-protective behaviors: among others, the theory of reasoned action [15] and the protective action decision model [16] have also provided important insights. For our purposes, however, the advantage of PMT over alternative frameworks lies in its emphasis on whether people think a protective action is effective ('response efficacy') and is something that they could do ('self-efficacy'). In our view, these constructs are directly relevant to how people may choose one evacuation destination over another.

In essence, PMT proposes that the greater the perceived threat and the greater the perceived efficacy of protective actions, the greater the motivation to carry out those protective actions. Key components of PMT include a threat appraisal and coping appraisal. The threat appraisal includes perceived likelihood (how likely is the threat to materialize?) and perceived severity (if the threat does materialize, how badly would I be affected?). The coping appraisal includes perceived response efficacy (is the protective action effective?) and self-efficacy (can I actually carry out the protective action?). For example, people are more likely to protect their house with sandbags (protective action) the more they think that floods are likely to happen (perceived likelihood), that their house is likely to be affected by floods (perceived severity), that using sandbags is effective against floods (response efficacy) and that they themselves are able to effectively use sandbags to protect their house (self-efficacy). Together these constructs influence protection motivation; whether this leads to protective actions depends also on other constraining and enabling factors (such as the availability of sandbags).

However, we identified two gaps in PMT that are relevant to our study. First, PMT examines *whether* people take protective actions (for example, to evacuate or not), whereas our study also examines *which* protective action people take (horizontal vs. vertical evacuation). This gap is especially important as many studies have found that the coping appraisal (response efficacy and self-efficacy) is a stronger predictor of intentions and actions than the threat appraisal [10]. Second, PMT does not consider how social influence affects protective actions (such as whether others carry out or encourage the protective actions), whereas we wished to test whether official information, training, and encouragement from family and friends were determinants of evacuation destinations. Our systematic review shows that both of these gaps are also present in most empirical studies based on PMT. These studies tend to neglect choices among protective actions and social influence (review methodology and findings reported in Appendix B).

These gaps in PMT are also of broader interest in research on self-protective decisions in natural hazards, public health, public safety, and other contexts. First, perceived efficacy of a particular protective action may differ substantially from the objective efficacy of that action: people do not necessarily protect themselves in the most effective ways. One clear and tragic example is the many excess road deaths in the US in the months after the 9–11 terrorist attacks as people avoided flying and instead travelled by car [17]. To improve public safety, then, it is critical to identify where perceived and objective efficacy diverge, and why this occurs.

Second, whether someone takes a specific protective action may depend on the other protective actions that are possible. Outside of PMT, studies have found a single-action bias: once people take a single action to counter a threat, they may consider this sufficient and do nothing further [18]. This is problematic if a combination of actions would be more effective. For PMT studies, one implication is that a count of the number of distinct protective actions intended or taken may not be an appropriate analytical approach. Furthermore, situational factors may encourage or hinder some protective actions but not others. For example, residents in high-risk areas may be unable to find an insurance company willing to cover them, yet they can still take other protective actions [13].

Third, outside of PMT, many lines of research have shown that social norms and other forms of social influence substantially influence behavior in a wide range of contexts [see ref. 19 for a recent review]. Studies using the theory of planned behavior [20] have found normative beliefs to be significant predictors of behavior [21]. Incorporating measures of social influence should therefore add explanatory power to PMT.

We propose two extensions to address these gaps in PMT. First, instead of a single coping appraisal and a single protection motivation (Fig. 1a), we include distinct coping appraisals, each leading to a distinct protection motivation, for each protective action or type of protective action considered (Fig. 1b). Second, we include social influence within each coping appraisal (Fig. 1b). We include social influence here in a general form, acknowledging that research on social influence has shown distinct influences from injunctive norms (directives from others), descriptive norms (observing what others do), as well as a complex interplay between individual and group levels in attitudes, behaviors, and social cohesion [19,22,23]. While Fig. 1 shows the core components of PMT, our extensions could easily be applied to variants of PMT that have been developed for particular purposes.

In summary, the main theoretical contribution of this paper is to extended PMT to include social influence and differences among protective actions. This provides a useful analytical tool for researchers and practitioners interested in how people respond to risks, including natural hazards. This can be useful in diverse contexts for comparing which factors may encourage or hinder specific protective actions, for examining whether single-action bias may suppress multiple protective actions, for examining whether perceived response efficacies may differ from objectively determined efficacies of protective actions, and for examining social influence on protective actions. Below we demonstrate how this extended PMT model provides important insights in the context of natural hazards.

2. Methods

We test our extended PMT model using the case of a mass evacuation following the 11-April-2012 earthquake in the city of Banda Aceh, Indonesia. We examine two distinct coping appraisals: one coping appraisal for vertical evacuation, and another coping appraisal for horizontal evacuation. Within each coping appraisal, we include social influence and the standard PMT constructs specific to each evacuation destination.

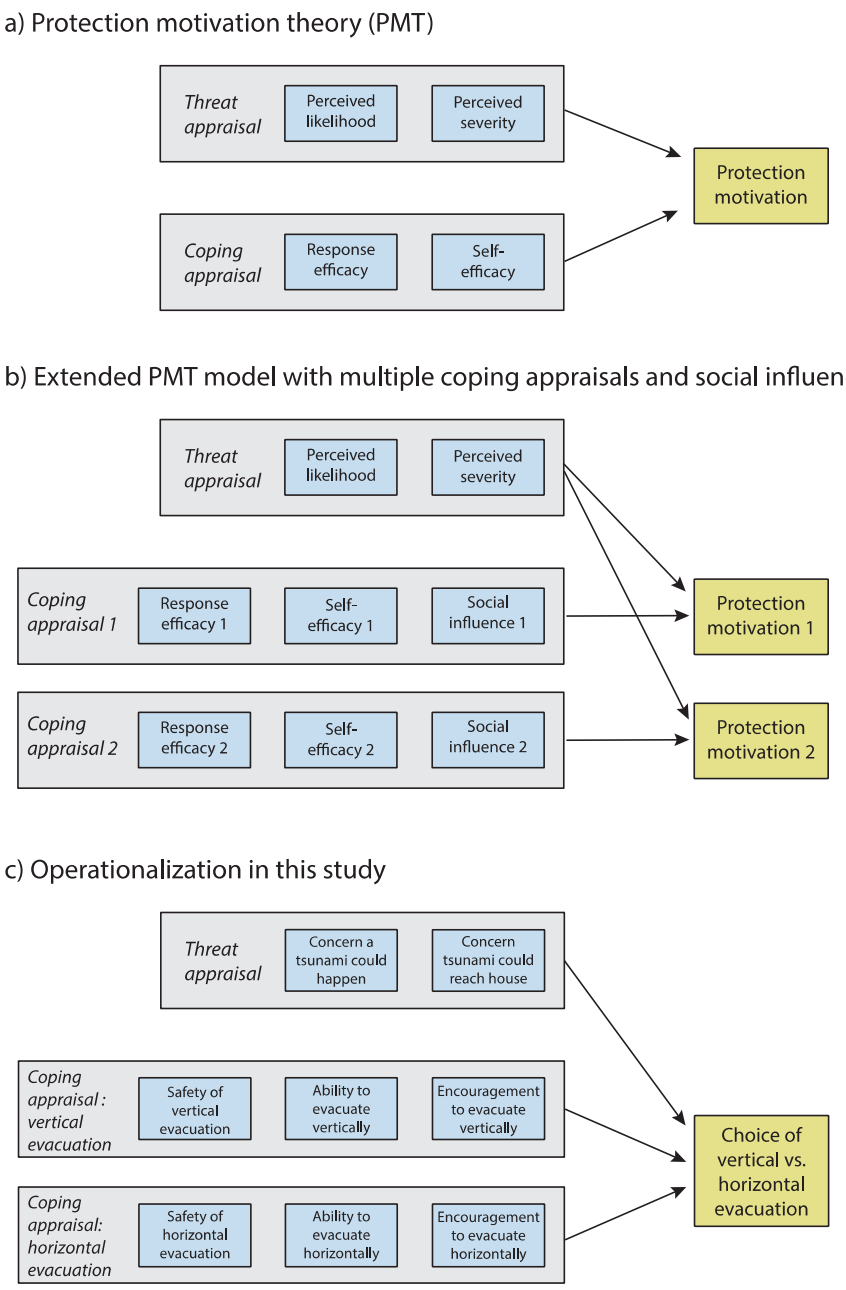

Fig. 1. (a) Key components of the cognitive mediating process in protection motivation theory (PMT). (b) Our extensions of PMT to include social influence in distinct coping appraisals and distinct protection motivations for each of two or more protective actions. (c) Operationalization of our extended PMT model for this study of tsunami evacuation decisions.

2.1. Study area

The 26-Dec-2004 tsunami reached the city of Banda Aceh ~40 min after the M9.2 earthquake, with waves up to 10–15 m in height causing widespread destruction across roughly half of the city reaching up to the city centre (Fig. 2 and Refs. [24,25]). Across Aceh province the tsunami killed an estimated ~160,000 people [26]. As the tsunami was not anticipated, there were no specifically designed tsunami vertical evacuation (TVE) structures, early warning systems, or evacuation procedures at that time. Nearly all of the post-disaster reconstruction of the city of Banda Aceh was done within the tsunami-affected area, putting tens of thousands of people back into areas that are exposed to future tsunamis [27]. Specifically designed tsunami vertical evacuation (TVE) buildings were built in just a few of the coastal communities that suffered near-total devastation in 2004 and would be the most difficult to evacuate in case of a future tsunami. This type of structure was new to Aceh [28].

Our study area includes 7 villages in Meuraxa district in the city of Banda Aceh, Indonesia (Fig. 2). These study villages are at or near the coast and suffered extensive damage and loss of life in the 2004 tsunami. The Japan International Cooperation Agency built tsunami vertical evacuation (TVE) buildings [29] in Alue Deah Teungoh (pop. 1142), Deah Glumpang (pop. 546), and Lambung (pop. 510) villages (population data from Badan Pusat Statistik / Potensi Desa, 2011). The Rehabilitation and Reconstruction Agency for Aceh and Nias (BRR) built one TVE building on the border between Gampong Pie (pop. 436) and Ulee Lheue (pop. 504) villages. The remaining two villages in our study, Cot Lamkuweh (pop. 872) and Deah Baro (pop. 422), are immediately adjacent to one or more villages that have a TVE building. In Appendix C we provide a KML file with the locations of these four TVE buildings. This shows the TVE building locations in the context of these communities through imagery spanning the pre-tsunami to present time.

Each of the four TVE buildings has a design capacity of 243 persons at 10 m height on the third floor and 294 persons at 14 m height on the roof [29]. This total estimated capacity (2148) is 48% of the total 2011

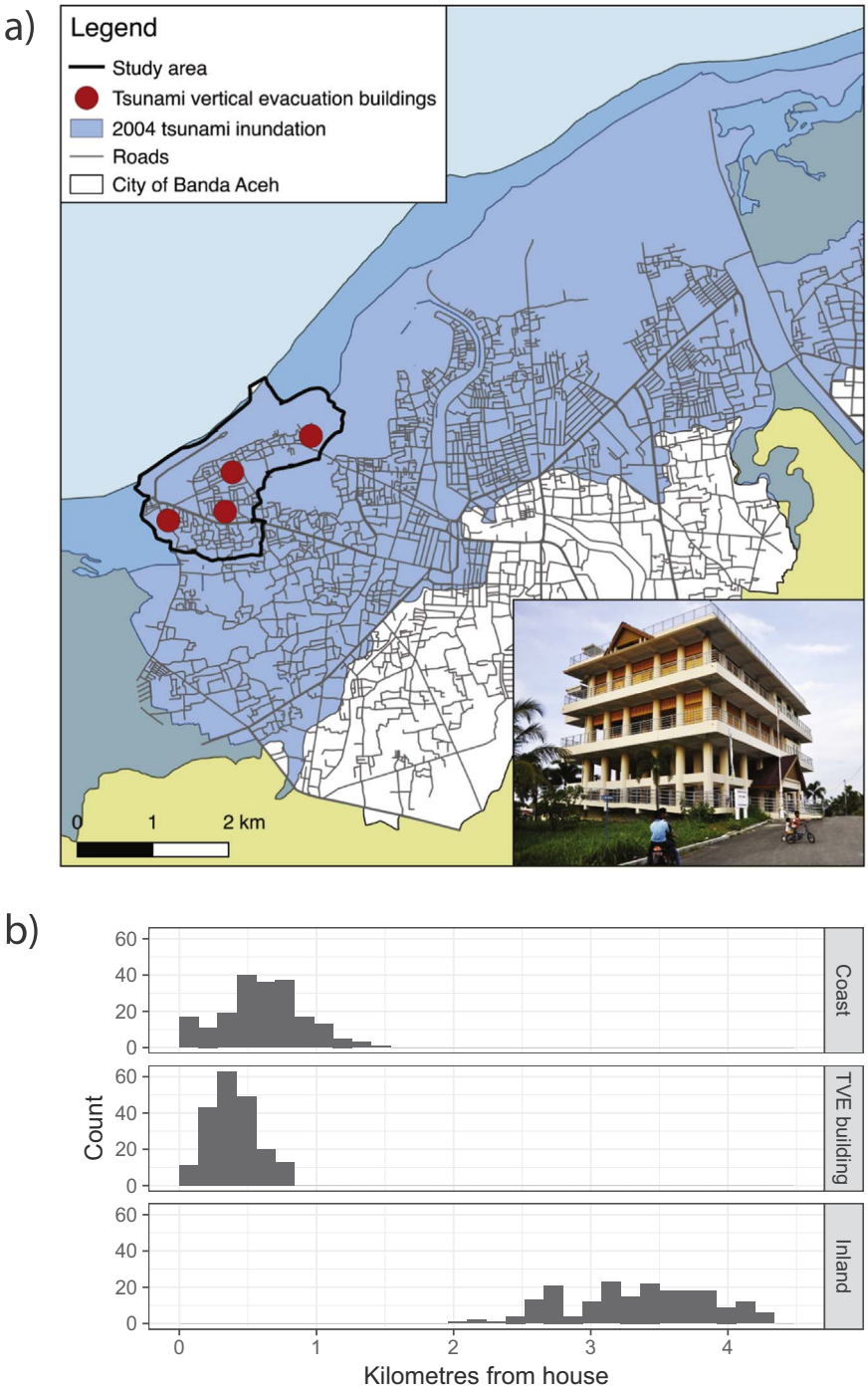

Fig. 2. (a) Location of tsunami vertical evacuation (TVE) buildings and household sampling area examined in this study, relative to area inundated by the 2004 tsunami. Inset: photo of TVE building in Alue Deah Teungoh village (photo by Maida Irawani). (b) Histograms of spatial variables for the homes of each of 202 interviewed residents. Top: straight-line distance from the house to the nearest point on the coastline. Centre: shortest distance along roads from the house to the nearest TVE building. Bottom: shortest distance along roads from the house to the nearest inland edge of the area inundated by the 2004 tsunami.

population of these 7 villages (4432). To investigate the TVE building design process, we reviewed project documents and interviewed two former members of the JICA/JICS project team and 14 village leaders from the 7 study villages. Each TVE building site depended on the ability and willingness of the host villages to donate communal land. Because of this, only one of the four TVE buildings is sited directly on a main road. Community consultations led to two main design inputs. First, the TVE buildings were oriented to face Mecca, so that the prayer rooms within them would be correctly aligned. Second, interior layout of each TVE building was designed to accommodate activities that community members wished to carry out there. At the time of our study, however, residents and village leaders reported ongoing management challenges and only occasional community use of the TVE buildings. The lower floors of the TVE building on the border of Gampong Pie and Ulee Lheue currently houses the Tsunami and Disaster Mitigation Research Centre, a research institute of Syiah Kuala University; the other three TVE buildings are not permanently occupied.

It is beyond the scope of this study to determine the objective efficacy of horizontal vs. vertical evacuation: to do so would require an engineering inspection of the TVE buildings as well as integrated and geospatially explicit tsunami and evacuation modelling. The available information is inconclusive. It is clear that complete evacuation of the tsunami-affected area of Banda Aceh before the arrival of a locally generated tsunami is not possible: one study [30] found that in the 11-April-2012 earthquake, 78% of evacuees were stuck in traffic. Just ~22% of those who evacuated from areas near the coast reached their destination within 20 min of the earthquake (this rises only to ~43% by

40 min). This survey also found that vertical evacuation reduces evacuation times: ~71% of those who evacuated to a high building or mosque reached this destination within 20 min (this rises to ~91% by 40 min), while only ~15% of those who evacuated horizontally reached their destination within 20 min (this rises only to 35% by 40 min). However, vertical evacuation may be problematic for large tsunamis: the TVE buildings are 14 m tall [29], but the 2004 tsunami was 10–15 m tall in these areas [31]. Indeed, the many deaths at designated evacuation shelters in the 11-March-2011 tsunami in Japan [32] stand as a stark reminder that structural mitigation measures offer no guarantee of safety.

2.2. Sample

We took a sample (n = 202) proportional to village population among our 7 study villages. Within each village we used systematic random sampling of houses. If no-one was present after two contact attempts, or if the occupants of the house declined to participate, the field researcher moved to the next house in the sequence. We completed 202 interviews (63%), had 94 unsuccessful contact attempts (29%), and had 27 cases where a resident declined to participate (8%). The field researchers worked during regular working days, thus our sample is 78% female. Though unbalanced, this is broadly representative of the situation at the time of the 2012 earthquake, which occurred mid-afternoon on a Wednesday (3:38 p.m. local time). The future evacuation intentions reported here would thus be more valid for a future earthquake if that earthquake occurred during a working day, and potentially less valid if that earthquake occurred at a time when more adult males are likely to be at home.

2.3. Measures

Interviews lasting ~30 min were conducted at participants' homes by a team of Acehnese field researchers; these field researchers were experienced with surveys and participated in training specific to this study. Interviews were conducted in Acehnese or Indonesian, depending on each participant's preference. The field researchers recorded and transcribed responses in Indonesian. The authors cleaned and analyzed the data in Indonesian. We include the interview protocol in Appendix D.

2.3.1. Dependent variables

We asked participants (1) for the 2012 earthquake, whether they evacuated, and if so what was their destination, and (2) if a similar earthquake happened in the future, would they intend to evacuate, and if so where is their intended destination. For analysis we categorise evacuation destinations as either a TVE building or an inland destination. Inland destinations included houses of relatives, locations that had served as refugee centres following the 2004 tsunami, and mosques.

2.3.2. Independent PMT variables

The threat appraisal includes perceived likelihood and severity, framed as levels of concern. Framing as a level of concern has been shown to be at least as good a predictor of behavior as framing as a likelihood [33]. In our study context, framing as a likelihood would have been culturally unacceptable, as people are not comfortable being asked to predict future acts of God (as they tend to view tsunamis). For perceived likelihood we asked, *'How concerned are you that a tsunami could recur?'* For perceived severity we asked, *'If a tsunami did recur, how concerned would you be that it would reach your house?'* Participants responded using a 4-point visual and verbal scale (*Not concerned, A little concerned, Concerned, Very concerned*). Pretesting indicated that this format was suitable for participants with limited literacy and numeracy.

We examine one coping appraisal for horizontal evacuation and another coping appraisal for vertical evacuation. These include measures of response efficacy, self-efficacy, and social influence specific to each evacuation destination. Response efficacy is problematic to measure: essentially we would like to know participants' perceived chances of survival for each evacuation destination. We did not ask this question directly for two reasons. First, this population has been traumatized by the 2004 tsunami, so such a direct question would be disturbing. Second, many in this population believe that although their actions have influence, whether they survive is ultimately in the hands of God; it is therefore uncomfortable for them to estimate the outcome. Instead, we asked open-ended questions about participants' reasons for their evacuation destination in 2012 and their intended destination in a future evacuation. We analyse these qualitatively and semi-quantitatively. We measured the other PMT constructs quantitatively. For self-efficacy for vertical evacuation we asked, *'If you evacuate from your house after an earthquake toward the vertical evacuation building, do you feel that you could reach there before a tsunami arrives?'* Participants answered using a 4-point visual and verbal scale (*No chance, Small chance, Good chance, Almost certain*). Using the same response scale, for self-efficacy for horizontal evacuation we asked, *'If you evacuate from your house after an earthquake toward an inland destination, do you feel that you could reach a safe place before a tsunami arrives?'* We note that this combines aspects of response efficacy. However, pre-testing indicated that this format made the most sense to participants. For social influence, we examine injunctive norms. We asked whether people had heard directions or encouragement to evacuate to a particular destination from official sources (government, media) and from closer social relations (family, friends, neighbors). We coded the destinations as either a TVE building or an inland destination.

Fear is sometimes included within PMT [9], while the risk-as-feelings approach [34,35] emphasizes how feelings interact with more deliberative processing to influence behaviors. We therefore asked, '*How afraid did you feel at the time of the 2012 earthquake?*'. Participants answered using a 4-point visual and verbal scale (*Not afraid, A little afraid, Afraid, Very afraid*).

We conducted our study only after the 2012 earthquake and mass evacuation. We therefore have no measures of pre-event perceptions related to PMT constructs. We regress 2012 behaviors on post-event perceptions with this caveat, acknowledging that this has less validity than if we had pre-event measures. However, this limitation is nearly unavoidable in any ecologically valid study of behaviors in large earthquakes, as large earthquakes are unpredictable and exceedingly rare.

2.3.3. Other independent variables

As this is the first study of trust in and use of TVE buildings, we asked a wide range of questions on potentially relevant determinants of evacuation destinations. We based these questions partly on focus-group discussions about responses to the 11-Apr-2012 earthquake that one of us (I.M.) conducted with residents in communities near TVE buildings two weeks following this earthquake. We also based these questions partly on previous research on people's choices to evacuate to cyclone shelters. Although this is not entirely analogous to tsunami vertical evacuation, people's decisions to evacuate to a cyclone shelter are associated with previous disaster experience [36], previous experiences in a cyclone shelter [37], trust in evacuation messages, proximity to a cyclone shelter, and higher level of education [38].

Questions in our survey included disaster experience and trauma, disaster education programs, familiarity with and visits to the TVE building, trust in warning systems, immediacy of evacuation, mobility, and demographics (further details of these measures are provided in Appendix E). We also investigated whether the geographical layout of escape routes and TVE buildings influenced evacuation choices and intentions. Using GIS we calculated distances from each surveyed house to the coast (straight-line) and to the nearest TVE building (along roads). We also calculated the distance (along roads) of the shortest route from each surveyed house to the inland edge of the 2004 tsunami inundation zone (Fig. 1b), as well as whether this route passed by a TVE

building.

2.3.4. Alternative TVE building designs

We sought to understand whether alternative TVE building designs might increase intentions to evacuate to the TVE building. We based these alternative scenarios in part on our focus-group discussions with residents in some of the study villages. Using the same response scale, we asked participants how likely they would be to evacuate to the existing TVE building as well as a series of hypothetical alternative TVE buildings. These hypothetical alternatives were: (b) if the TVE building were taller; (c) if the TVE building were stronger; (d) if the TVE building were closer to their house; (e) if the TVE building were farther from the sea; (f) if the TVE building were stocked with available food, water, and medicine ('supplies'); (g) if the TVE building served also as a school; or (h) if the TVE building served also as the village mosque. For each scenario, participants chose an evacuation intention from a 4-point visual and verbal scale (*I would not go there, Small chance I would go there, Likely I would go there, I would definitely go there*).

2.4. Analysis

We use a combination of quantitative and qualitative analyses to assess the relationships between independent variables and chosen and intended evacuation destinations. Studies that use PMT typically build regression models: the independent variables are PMT constructs in the threat and coping appraisals, while the dependent variables are whether protective actions are taken/intended or not. We follow this approach with two modifications. First, our regression models exclude response efficacy because we measured this qualitatively for reasons explained above. Second, our dependent variables are evacuation destination (0 = inland, 1 = TVE building), rather than whether people evacuated or not. This reflects our focus on *which* protective action people take, and the fact that these protective actions are mutually exclusive. Furthermore, the standard PMT approach would be analytically meaningless in this case. As we show below, there is no reference group of people who did not evacuate.

3. Results

3.1. Evacuation choices in 2012 earthquake and evacuation intentions in a future earthquake

We find that among those who were at home at the time of the 2012 earthquake, everyone (100%) in our sample evacuated. However, only 26% evacuated to a tsunami vertical evacuation (TVE) building, while the majority (74%) evacuated horizontally to inland destinations (Fig. 3). Our data suggest that a lack of TVE building capacity cannot explain this pattern. Among those who evacuated to a TVE building, 57% said it was full, whereas 43% said it was half full or less; these subjective estimates differed among people who went to the same TVE building. Furthermore, only 2% of those who evacuated horizontally in 2012 said that they did so because of a lack of available space in the TVE building (Section 4.2.2).

Our data also show that the experience of 2012 has generally not changed people's minds about evacuating to a TVE building if a similar earthquake happened in the future. Most people who evacuated to a TVE building in 2012 intend to do so again if a similar earthquake happened the future, while most people who evacuated horizontally intend to do so again if a similar earthquake happened in the future (Fig. 3). Including those who were not at home at the time of the 2012 earthquake, 32% of the entire sample intend to evacuate to a TVE building, 59% intend to evacuate horizontally to an inland destination, 9% intend to evacuate inland if they have a vehicle or to the TVE building if they do not, and just 1 person (< 1%) does not intend to evacuate.[2]

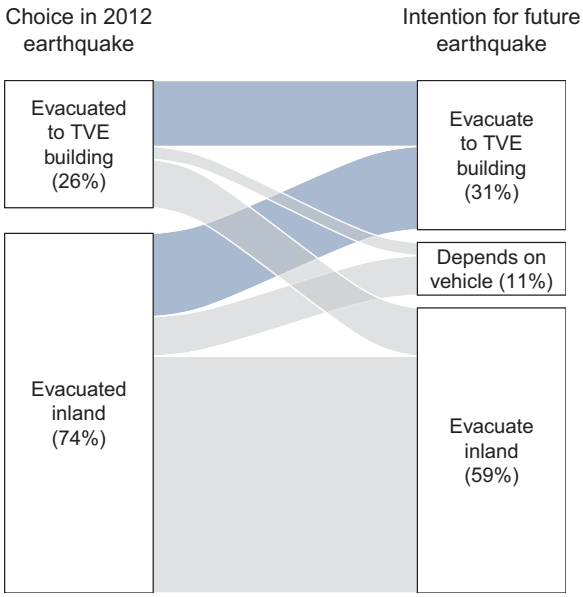

Fig. 3. Alluvial plot showing frequencies of evacuation destinations (to TVE building or horizontally to an inland destination) in the 2012 earthquake and evacuation intentions if a similar earthquake were to happen in the future. This plot includes data from study participants who were present in their village at the time of the 2012 earthquake. 'Depends on vehicle' indicates those who intend to evacuate inland if they have a vehicle or to the TVE building if they do not. Relative heights of boxes and links are proportional. Curved links show within-subject combinations: for example, just over half of those who evacuated to a TVE building in 2012 would do so again in a future earthquake. (Right column does not sum to total due to rounding, and differs slightly from proportions for the entire sample including those who were not in at home during the 2012 earthquake, as explained in the text.).

3.2. PMT constructs

Because everyone (100%) in our sample evacuated in 2012 and nearly everyone (99.5%) intends to evacuate if a similar earthquake happened in the future, our analysis contrasts evacuation destinations. For PMT constructs that we measured quantitatively, we build logistic regression models where the dependent variable is evacuation destination (0 = inland, including those who intend to evacuate inland if they have a vehicle; 1 = TVE building; Table 1).

3.2.1. Threat appraisal

Perceived likelihood and severity do not significantly predict evacuation destination in 2012, nor do they predict intended evacuation destination for a future earthquake (Table 1). This not surprising because (1) few PMT studies find a significant relationship between the threat appraisal and protective actions and intentions [10], and (2) we have no reason to expect that concern about tsunamis should have a simple relationship with evacuation destination. Self-reported level of fear at the time of the 2012 earthquake is not significantly associated with the choice of evacuation destination (Table 1); this suggests that panic is not a determinant of evacuation destination.

3.2.2. Coping appraisals

In contrast, PMT constructs are significant in each coping appraisal (Table 1). Higher self-efficacy for evacuation to the TVE building is associated with higher odds of intending to do so in the future (odds ratio (*OR*) = 1.48 (1.05, 2.13) for each level on the 4-point scale). Conversely, higher self-efficacy for horizontal evacuation is

[2] It is striking that such a large proportion of people would be willing to evacuate again if a similar earthquake happened in the future, even though the 2012 earthquake did not produce a tsunami. We provide analysis and discussion of this aspect in McCaughey et al. [43].

Table 1
Odds ratios for PMT constructs in logistic regression models of choices and intentions to evacuate horizontally to an inland destination (reference category) or to evacuate to a TVE building, for the choice in 2012 and for future intentions. Reference categories of independent variables are on the left side of 'value' column.

Parameter	Value	Choice in 2012 (evacuees only)	Intention for future (entire sample)
Threat appraisal			
Likelihood (concern tsunami could recur)	1–4	1.19	0.97
Severity (concern tsunami could reach house)	1–4	0.81	0.81
Fear in 2012 earthquake	1–4	0.66	—
Coping appraisal: vertical evacuation			
Self-efficacy (can reach TVE building?)	1–4	1.23	1.48*
Family/friends encourage vertical	No/Yes	3.44*	2.86*
Official sources encourage vertical	No/Yes	0.74	1.19
Coping appraisal: horizontal evacuation			
Self-efficacy (can reach inland?)	1.4	0.56*	0.98
Family/friends encourage horizontal	No/Yes	1.14	0.12**
Model R^2_L		.12	.14
Null / residual deviance		143.9 / 127.2	237.0 / 204.7

*** p < .001.
** p < .01.
* p < .05.
+ p < .10.

significantly associated with higher odds of having evacuated horizontally in 2012 (reciprocal *OR* = 1.79 (1.12, 3.03) for each level on the 4-point scale).

Social influence variables are also significant in each coping appraisal (Table 1). Encouragement from friends and family to evacuate to the TVE building is significantly associated with higher odds of having done so in 2012 (*OR* = 3.44 (1.20, 10.13)) and with intending to do so in a future evacuation (*OR* = 2.86 (1.17, 7.32)). Similarly, encouragement from family and friends to evacuate horizontally is significantly associated with higher odds of intending to do so in the future (reciprocal *OR* = 8.33 (2.27, 50.00)).

While encouragement from family or friends significantly correlates with evacuation destination, encouragement or instructions from official sources does not. This is consistent with other findings that social influence is strongest when it comes from people in close social proximity, such as family and friends, and weaker when it comes from socially distant others, such as government officials [39]. For analytical reasons, we exclude official information from the coping appraisal for horizontal evacuation, as only four participants reported official information encouraging horizontal evacuation.

For reasons discussed in methods, we assess response efficacy qualitatively. We coded answers to open-ended questioning about participants' reasons for their chosen and intended evacuation destinations (Figs. 4 and 5). This qualitative evidence indicates that participants perceive higher response efficacy for their chosen or intended evacuation destination, relative to the alternative destination.

Many of those who evacuated horizontally in 2012 or intend to do so in the future expressed distrust in the safety of the TVE building in an earthquake and tsunami; this was the most commonly mentioned reason in response to open-ended questioning (Fig. 4). In the words of one resident, *'There is just a small chance I would go [to the TVE building in an evacuation] … because it is close to the sea … I remember [from the 2004 tsunami] that no matter how big the buildings were, all the buildings near the sea were swept away. That is the only thing I have in mind.'* In the words of another resident, *'We do not believe in the building. I already saw many cracks there.'* For some people, the proximity of the TVE building to the coast is problematic in another way, as expressed by another resident: *'I'm afraid of seeing the tsunami wave … we really try to avoid seeing the tsunami wave, especially those who are traumatized.'* In contrast, they feel that evacuating inland is safer; many said that they went to (or intend to go to) places that were safe in the 2004 tsunami.

Many of those who evacuated to the TVE building or intend to do so in the future feel that they cannot reach a safe inland destination before a tsunami arrives; this is shown in our quantitative measure of self-efficacy for horizontal evacuation (Table 1) and is the most frequently mentioned reason in response to open-ended questioning (Table 2). Concern about traffic accidents during horizontal evacuation is a major reason for future intentions to evacuate to a TVE building. This concern likely intensified following traffic accidents during the 2012 earthquake. Relatively few participants say explicitly that they trust the TVE building to be safe in an earthquake and tsunami. We infer that those who evacuated to a TVE building or intend to do so in the future do not necessarily trust the TVE building to be safe, but tend to consider it safer than horizontal evacuation.

3.3. Other independent variables

Aside from the PMT constructs, we examine a wide range of individual, household, and situational factors that may influence choices of evacuation destination. We examine this through open-ended questioning (Figs. 4 and 5) and closed-ended questions (Table 2). Because of the large number of categorical predictors and the modest sample size, including these variables along with PMT constructs led to unstable logistic regression models. We therefore present separate logistic regression models here excluding the PMT constructs (Table 2).

We find little support for the idea that panic may explain why people evacuate horizontally, rather than to the TVE buildings. Our data show that self-reported level of fear is not significantly related to evacuation destination (Table 1).[3] Although people were afraid during the 2012 earthquake and evacuation, the intensity of this fear does not appear to determine evacuation destination. Furthermore, 'following others' is a reason given by both those who evacuated inland and those who evacuated to a TVE building (Figs. 3 and 4).

Strikingly, factors related to disaster-preparedness programs are not significantly associated with choices of evacuation destination. These include official information (in the coping appraisals, Table 1), evacuation drills, having a family evacuation plan, familiarity with the TVE building, trust in warning systems, and disaster knowledge (Table 2).

[3] We note that fear is a reason people mentioned (open-response) for horizontal but not for vertical evacuation (Figs. 4 and 5). However, this is not directly comparable, as people were justifying different evacuation destinations. For interpretation we favor the quantitative measure of fear because we asked this question the same way for all survey participants. This quantitative measure of fear is not a significant predictor of evacuation destination (Table 1).

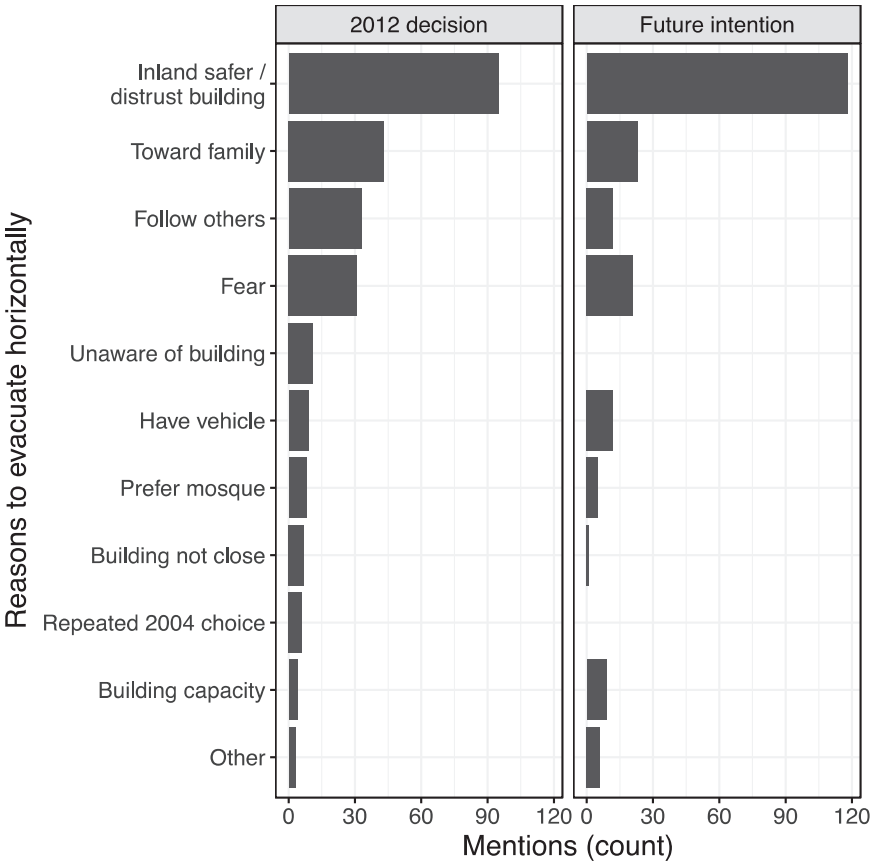

Fig. 4. Reasons people mentioned (open-response) to evacuate horizontally to an inland destination, for their decision in 2012 (left) and for their intentions for a future earthquake (right).

Importantly, the choice to evacuate horizontally is not explained by an unrealistic expectation of the time available between and earthquake and tsunami: this factor is not significant either for the choice in 2012 or for future intentions (Table 2).

Personal experience with the 2004 tsunami is not significantly associated with evacuation destination (Table 2). This is consistent with our finding that risk perceptions (threat appraisal; Table 1) are not significantly associated with evacuation destination.

Some aspects of personal mobility and the location of TVE buildings are significant. Odds of intending to evacuate to a TVE building in a future earthquake are higher for those who have someone with limited mobility in their household (OR = 2.47 (1.16, 5.37)) and for those for whom their most direct route toward an inland destination passes by a TVE building (OR = 3.64 (1.07, 13.00)). Although the number of vehicles in the household was not significant (Table 1), some of those who evacuated horizontally said they did so because they had a vehicle (Fig. 4), while 9% of the sample say that in a future earthquake, they would evacuate horizontally if they had a vehicle at the moment or to a TVE building if they did not.

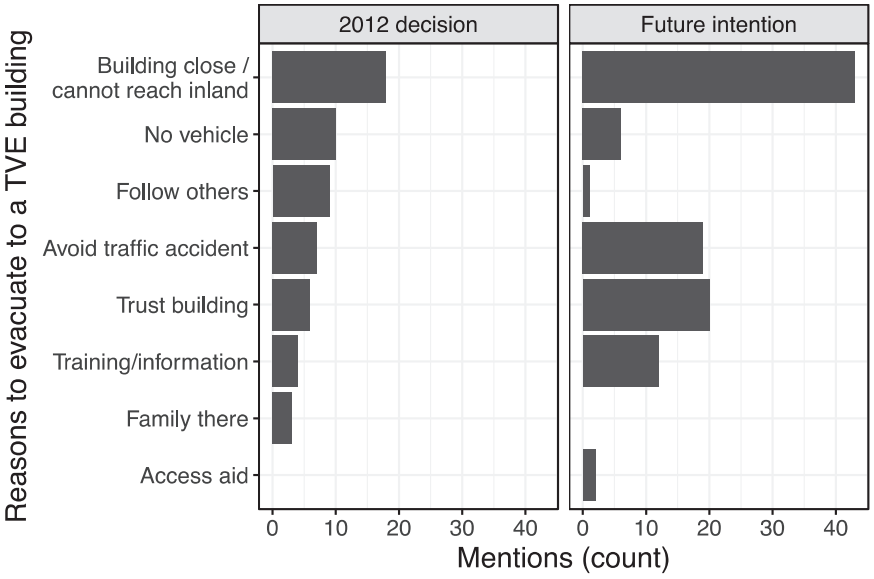

Fig. 5. Reasons people mentioned (open-response) to evacuate to a TVE building, for their decision in 2012 (left) and for their intentions for a future earthquake (right).

Table 2
Odds ratios for variables other than PMT constructs in logistic regression models of choices and intentions to evacuate horizontally to an inland destination (reference category) or to a TVE building, for the choice in 2012 and for future intentions. Reference categories of independent variables on left side of 'value' column.

Parameter	Value	Choice in 2012 (evacuees only)	Intention for future (entire sample)
Disaster experience			
Caught in 2004 tsunami	No/Yes	1.03	0.56
Injured in 2004 tsunami	No/Yes	1.90	0.78
Lost family in 2004 tsunami	No/Yes	1.37	1.59
Mental trauma from 2004 tsunami	No/Yes	0.64	1.21
Disaster training, knowledge, trust			
Participated in evacuation drill	No/Yes	0.79	0.46^{+}
Ever visited TVE building	No/Yes	2.23	1.85
Have family evacuation plan	No/Yes	1.06	1.11
Trust in warning system	Low/High	0.97	1.32
Knowledge (small earthquakes)	No/Yes	1.42	0.47
Knowledge (sea may not retreat)	No/Yes	1.08	0.57
Knowledge (< 30 min for evac.)	No/Yes	0.47	0.75
Mobility and immediacy of evacuation			
Persons with limited mobility	No/Yes	1.41	2.47*
Children	No/Yes	0.56	1.08
Vehicles	0–1 / 2^{+}	0.37^{+}	0.55
Evacuation immediacy	Delayed/Immediate	1.25	0.98
Location of house			
Distance to TVE building	km	0.14	8.57
Distance to safe inland area	km	1.40	0.61
Inland route passes TVE building	No/Yes	1.80	3.64*
TVE building in own village	No/Yes	1.57	2.64^{+}
Demographics			
Gender	Male/Female	0.60	0.45^{+}
Age	Years	0.98	1.02
High-school education	No/Yes	0.78	1.29
Model R^2_L		.12	.16
Null / residual deviance		135.0 / 118.2	234.7 / 197.5

*** p < .001.
** p < .01.
* p < .05.
+ p .10.

3.4. Influence of alternate TVE building designs on intentions for evacuation

Given the high proportion of people who did not use the TVE building in their evacuation in 2012 and do not intend to do so in the future, it is essential to understand what alternative designs might encourage higher rates of use. To find this out, we asked participants to rate their likelihood of using a TVE building under a series of alternate design scenarios.

Fig. 6 shows the proportion of participants who chose the highest evacuation intention on the 4-point scale ('*I would definitely go there*') for each scenario. The proportion who would 'definitely' evacuate to the existing TVE building (27%) is consistent with other measures of choices in 2012 and intentions for the future. Many scenarios did not significantly increase intentions for use in evacuation (taller: 26%, school: 29%, farther from sea 32%, closer to your house: 37%; none significant at $p < 0.05$ using the Marascuilo procedure). Some participants said that while they wonder if the TVE building is tall enough, they are also concerned that a taller building may be less likely to remain standing. The 'stronger' scenario increased intended evacuation use somewhat (41%, but not significant at $p < 0.05$ using the Marascuilo procedure); the relatively modest effect of this may reflect the idea stated by some participants that nothing built by humans could withstand a large tsunami.

However, we found that two scenarios result in substantively and statistically significant increases in intended evacuation use, relative to the existing TVE buildings. First, if the TVE building had available food, water, and medicine, the proportion who would 'definitely' evacuate there nearly doubles (50%; significant at $p < 0.05$ using the Marascuilo procedure; Fig. 6). Although food, water, medicine, and other facilities

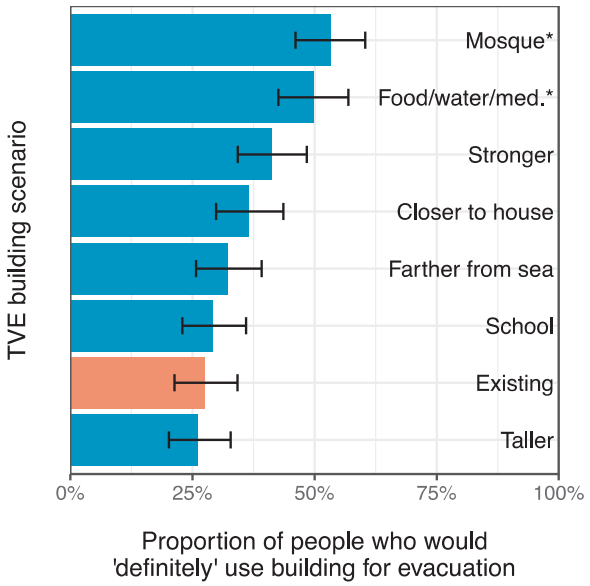

Fig. 6. Proportion of people who would 'definitely' evacuate (highest value on a 4-point likelihood scale) to the existing TVE building (red bar), compared with hypothetical alternative TVE building scenarios (blue bars). Scenarios with an asterisk (*) have proportions significantly different than the proportion for the existing TVE building (at $p < 0.05$ using the Marascuilo procedure for multiple proportions). 95% confidence interval error bars from exact (Clopper-Pearson) method for binomial proportions.

were planned for the TVE buildings [40], these were not available at the time of the 11-April-2012 earthquake, nor were they available at the time of our study. Second, if the TVE building were the village mosque, the proportion who would 'definitely' evacuate there also nearly doubles (53%; significant at $p < 0.05$ using the Marascuilo procedure). Mosques have great significance in the post-tsunami Acehnese context. In the words of one resident, *'Take a look at Ulee Lheue Mosque … as we can see it still stood up [in the tsunami] while the surrounding buildings were smashed to pieces.'* Many residents expressed both practical and spiritual reasons that mosques are attractive for evacuation; in the words of one resident, *'I am not sure that the building is strong enough. It might collapse, if it is God's will. So, I will go to the mosque first, go together with others. We can read the Quran there.'* In the words of another resident, *'God knows everything, the people inside of [the mosque], maybe they will be saved as well, because there were many mosques that survived the disaster.'*

4. Discussion

Our survey of residents living near tsunami vertical evacuation (TVE) buildings shows that they clearly prefer horizontal evacuation. In the 2012 earthquake, only 26% evacuated to a TVE building, while 74% evacuated horizontally. If a similar earthquake happened in the future, only 32% intend to evacuate to a TVE building, while 68% intend to evacuate horizontally. Accounts from evacuees suggest that the TVE buildings were not filled to capacity. This stands in stark contrast to the idea that TVE buildings should be maximally used in evacuations. Using our extended model of protection motivation theory, we find that response efficacy, self-efficacy, and social influence are significantly related to people's choices between horizontal and vertical evacuation. These three factors thus may provide points of leverage to influence people's choices to use TVE buildings during an evacuation.

Those who evacuated horizontally to an inland destination in the 2012 earthquake or intend to do so in the future think that the TVE building is unsafe and that they are able to reach an inland destination in time. In contrast, those who evacuated to a TVE building in the 2012 earthquake or intend to do so in a future earthquake tend to think that horizontal evacuation puts them at risk of traffic accidents, that they cannot reach a safe inland destination in time, but that they can reach the TVE building in time. These findings suggest that interventions that seek to increase the use of TVE buildings in an evacuation should focus not only on increasing trust in the TVE buildings, but also on increasing appreciation of the dangers of horizontal evacuation. However, such interventions should accurately account for the objective safety and total capacity of the TVE buildings.

Social influence was also significantly related to evacuation destination. Those who had been encouraged by family and friends to evacuate to a particular destination were more likely to have done so in the 2012 earthquake and are more likely to intend to do so in the future. In contrast, encouragement from official sources to evacuate to a TVE building was not significantly associated with evacuation destination. This is consistent with findings that people follow the social norms of those who are similar or socially connected to them [22]. These findings suggest that interventions that seek to increase the use of TVE buildings in an evacuation may be most effective if oriented around families.

Beyond the PMT constructs, other variables provide further evidence that is relevant for disaster management. First, we find no evidence that panic determines choices and intentions for evacuation destinations. Second, people with mobility challenges are more likely to evacuate to a TVE building. Finally, many factors that are commonly the focus of disaster preparedness programs were not associated with evacuation destinations. These factors include official instructions to evacuate to the TVE building, evacuation drills, trust in warning systems, risk perceptions, and disaster knowledge. More research is needed to better understand what kinds of disaster preparedness programs would effectively influence people's choices to evacuate to a TVE building. This research would ideally use experimental designs and be carried out in varied contexts.

Our findings also indicate some alternate designs that may increase TVE building use. Having the TVE building on the most direct route to inland destinations correlates with intentions to evacuate to the TVE building. Therefore, locating new TVE buildings on main horizontal evacuation routes may increase their use in evacuations. Of the alternative TVE building scenarios that we tested, two substantially increased intentions to evacuate to the TVE building: (1) if it had available food, water, and medicine; and (2) if it were the village mosque. The first is an ongoing management challenge. The second is a planning and design challenge to incorporate or retrofit tsunami vertical evacuation functionality into mosques. However there is reason to think that such an approach may be effective well beyond the Aceh context. Across many contexts, people turn toward religious places, groups, and practices in times of crisis [41,42]. More broadly, in any given context it is important to identify which community locations or types of buildings people would most naturally gravitate toward in a time of crisis and, as much as possible, to maximize the safety of those buildings in the face of natural hazards.

Given that this is the first study on trust in an use of TVE buildings, more research on these questions in other contexts is clearly needed. There is suggestive evidence that the patterns found in this study are not unique to urban areas in Aceh. On 7-Dec-2016, a destructive M6.5 earthquake struck Pidie Jaya, Pidie, and Biruen Regencies, an area of Aceh Province that lies ~100 km further east along the coast from Banda Aceh. During the post-2004 reconstruction, a TVE building had been built in rural Sukon village, Pidie Regency. This TVE building is less than 1 km from the coast and is not as tall as the TVE buildings in our study in Banda Aceh. One of us (I.M.) visited Sukon village one day after the 7-Dec-2016 earthquake and interviewed residents. Their accounts indicate that no-one evacuated to the TVE building in Sukon village; instead people evacuated horizontally toward inland destinations, especially to mosques. This pattern in a rural village is consistent with our more detailed findings in urban areas of Banda Aceh.

Nonetheless, it is critical to know whether the low level of trust in and evacuation use of TVE buildings is normal, or particular to the Aceh context. Research in contexts where the population has not experienced a devastating tsunami, where the population has witnessed TVE buildings survive a tsunami, or where cultural and religious perspectives differ would shed light on whether these contextual factors are influential on TVE building use during evacuations.

More generally, these findings highlight a gap in disaster management that has been known for a long time. In what Ken Hewitt [43] called the 'dominant paradigm', disasters are conceived as unusual geophysical extremes, thus their mitigation is a matter for the physical science of natural hazards and engineering. Yet as our study vividly illustrates, engineering solutions can be rendered less effective if they are out of step with the social context. Simply providing people instructions and holding evacuation drills is insufficient: these factors were not associated with people's evacuation destinations in our study. Rather, in order to make disaster-mitigation projects as effective as possible, it is necessary to include expertise in social science from the start in order to examine and base design decisions as much on the social aspects as we do on the natural-hazard and engineering aspects.

The theoretical contribution of this study is of general interest for the study of self-protective behavior across diverse contexts. In this paper we extended protection motivation theory (PMT) to include choices among multiple protective actions under social influence. These aspects had previously been underdeveloped both theoretically and empirically in PMT studies, as we have shown in Appendix B. We demonstrated that our extended PMT model provided useful insights in a natural-hazard case. We believe that this model could also be useful for researchers and practitioners seeking to understand self-protective behavior in other contexts. One open question is how single-action bias

[18] or other effects may influence people's choices among multiple protective actions. Much more theoretical and empirical work is needed to incorporate the substantial body of knowledge on social influence [19,22,23] into the PMT framework. Important questions include whether the type of social influence (such as injunctive vs. descriptive social norms) and its valence (do vs. do not) have different effects on self-protective behavior. It is also important to investigate whether social influence is mediated by PMT constructs. Finally, this study has considered social influence only within coping appraisals, while future work could examine social influence within the threat appraisal and other aspects of PMT.

Acknowledgements

The International Centre for Aceh and Indian Ocean Studies facilitated this research in collaboration with Syiah Kuala University and the Ar-Raniry State Islamic University. Rizanna Rosemary and Lely Safrina helped design measures of risk perception. Nizamuddin, Ardian Syah, and Muzailin Affan carried out geospatial analyses. Hayatullah, Nyak Anwar, Zulkifli Ak, Asiah Uzia, Cut Murnita, Fanny Nailufar, Fitriani, Ida Fitria, Israyani, Jihan, Safrina, and Syafriani Tahir helped refine research instruments and carried out field research. Nanda Elviera, Ida Fitria, Jonah Yong, Rita Zahara, Sari Novita, and Divya Hundlani carried out data management and verification. Maida Irawani, Cut Dian Fitri, and Ivan Arisandy provided operational support. This research is supported by the National Research Foundation Singapore and the Singapore Ministry of Education under the Research Centres of Excellence initiative. This work was funded by the Earth Observatory of Singapore (EOS) and is EOS Contribution Number 134. We thank three anonymous reviewers whose comments have led us to improve this manuscript. We express our deep gratitude to the people of Aceh for their participation in this research.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ijdrr.2017.06.016.

Appendix B. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ijdrr.2017.06.016. These data include Google maps of the most important areas described in this article.

References

[1] M. Di Mauro, K. Megawati, V. Cedillos, B. Tucker, Tsunami risk reduction for densely populated Southeast Asian cities: analysis of vehicular and pedestrian evacuation for the city of Padang, Indonesia, and assessment of interventions, Nat. Hazards 68 (2013) 373–404, http://dx.doi.org/10.1007/s11069-013-0632-z.

[2] N. Wood, J. Jones, J. Schelling, M. Schmidtlein, Tsunami vertical-evacuation planning in the U.S. Pacific Northwest as a geospatial, multi-criteria decision problem, Int. J. Disaster Risk Reduct. 9 (2014) 68–83, http://dx.doi.org/10.1016/j.ijdrr.2014.04.009.

[3] S. Fraser, G.S. Leonard, H. Murakami, I. Matsuo, Tsunami vertical evacuation buildings - Lessons for international preparedness following the 2011 Great East Japan Tsunami, J. Disaster Res. 7 (2012) 1–12.

[4] H. Murakami, K. Takimoto, A. Pomonis, Tsunami Evacuation Process and Human Loss Distribution in the 2011 Great East Japan Earthquake – A Case Study of Natori City, Miyagi Prefecture -, 15th World Conf. Earthq. Eng. (2012) 1–10. 〈http://www.iitk.ac.in/nicee/wcee/article/WCEE2012_1587.pdf〉.

[5] E. Mas, A. Suppasri, F. Imamura, S. Koshimura, Agent-based simulation of the 2011 Great East Japan Earthquake/Tsunami evacuation : an integrated Model of Tsunami Inundation and evacuation, J. Nat. Disaster Sci. 34 (2012) 41–57.

[6] FEMA, Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, (2008). doi:http://dx.doi.org/10.1061/40978(313)7.

[7] R.W. Rogers, A Protection Motivation Theory of Fear Appeals and Attitude Change, J. Psychol. 91 (1975) 93–114, http://dx.doi.org/10.1080/00223980.1975.9915803.

[8] J.E. Maddux, R.W. Rogers, Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change, J. Exp. Soc. Psychol. 19 (1983) 469–479, http://dx.doi.org/10.1016/0022-1031(83)90023-9.

[9] D.L. Floyd, S. Prentice-Dunn, R.W. Rogers, A meta-analysis of research on protection motivation theory, J. Appl. Soc. Psychol. 30 (2000) 407–429.

[10] S. Milne, P. Sheeran, S. Orbell, Prediction and intervention in health-related behavior: a meta-analytic review of protection motivation theory, J. Appl. Soc. Psychol. 30 (2000) 106–143, http://dx.doi.org/10.1111/j.1559-1816.2000.tb02308.x.

[11] T. Grothmann, F. Reusswig, People at risk of flooding: why some residents take precautionary action while others do not, Nat. Hazards. 38 (2006) 101–120, http://dx.doi.org/10.1007/s11069-005-8604-6.

[12] P. Bubeck, W.J.W. Botzen, J.C.J.H. Aerts, A review of risk perceptions and other factors that influence flood mitigation behavior, Risk Anal. 32 (2012) 1481–1495, http://dx.doi.org/10.1111/j.1539-6924.2011.01783.x.

[13] P. Bubeck, W.J.W. Botzen, H. Kreibich, J.C.J.H. Aerts, Detailed insights into the influence of flood-coping appraisals on mitigation behaviour, Glob. Environ. Chang. 23 (2013) 1327–1338, http://dx.doi.org/10.1016/j.gloenvcha.2013.05.009.

[14] T. Grothmann, A. Patt, Adaptive capacity and human cognition: the process of individual adaptation to climate change, Glob. Environ. Chang. 15 (2005) 199–213, http://dx.doi.org/10.1016/j.gloenvcha.2005.01.002.

[15] M. Fishbein, I. Ajzen, Predicting and Changing Behavior : The Reasoned Action Approach, Psychology Press, New York, 2010.

[16] M.K. Lindell, R.W. Perry, The protective action decision model: theoretical modifications and additional evidence, Risk Anal. 32 (2012) 616–632, http://dx.doi.org/10.1111/j.1539-6924.2011.01647.x.

[17] G. Gigerenzer, Out of the frying pan into the fire: behavioral reactions to terrorist attacks, Risk Anal. 26 (2006) 347–351, http://dx.doi.org/10.1111/j.1539-6924.2006.00753.x.

[18] E.U. Weber, Experience-based and description-based perceptions of long-term risk: why global warming does not scare us (Yet), Clim. Change. 77 (2006) 103–120, http://dx.doi.org/10.1007/s10584-006-9060-3.

[19] R.I. McDonald, C.S. Crandall, Social norms and social influence, Curr. Opin. Behav. Sci. 3 (2015) 147–151, http://dx.doi.org/10.1016/j.cobeha.2015.04.006.

[20] I. Ajzen, From intentions to actions: a theory of planned behavior, in: J. Kuhl, J. Beckmann (Eds.), Action Control From Cogn. to Behav. Springer Berlin Heidelberg, Berlin, Heidelberg, 1985, pp. 11–39, , http://dx.doi.org/10.1007/978-3-642-69746-3_2.

[21] D. Albarracín, B.T. Johnson, M. Fishbein, P.A. Muellerleille, Theories of reasoned action and planned behavior as models of condom use: a meta-analysis, Psychol. Bull. 127 (2001) 142–161, http://dx.doi.org/10.1038/nbt.3121.ChIP-nexus.

[22] C.R.B. Cialdini, The focus theory of normative conduct, in: P.A.M. van Lange, A.W. Kruglanski, E.T. Higgins (Eds.), Handb. Theor. Soc. Psychol. SAGE Publications, Inc, London, 2012, pp. 295–313, , http://dx.doi.org/10.4135/9781446249222.n41.

[23] N.E. Friedkin, Social cohesion, Annu. Rev. Sociol. 30 (2004) 409–425, http://dx.doi.org/10.1146/annurev.soc.30.012703.110625.

[24] JICA, BAPPENAS, Provincial Government of Nanggroe Aceh Darussalam, The Study on the Urgent Rehabilitation and Reconstruction Support Program for Aceh Province and Affected Areas in North Sumatra, 2005. 〈http://open_jicareport.jica.go.jp/pdf/11802766_01.pdf〉.

[25] F. Lavigne, R. Paris, D. Grancher, P. Wassmer, D. Brunstein, F. Vautier, F. Leone, F. Flohic, B. Coster, T. Gunawan, C. Gomez, A. Setiawan, R. Cahyadi, Reconstruction of Tsunami Inland Propagation on December 26, 2004 in Banda Aceh, Indonesia, through field investigations, Pure Appl. Geophys. 166 (2009) 259–281, http://dx.doi.org/10.1007/s00024-008-0431-8.

[26] E. Frankenberg, T. Gillespie, S. Preston, B. Sikoki, D. Thomas, Mortality, the family and the Indian Ocean Tsunami, Econ. J. 121 (2011) 162–182, http://dx.doi.org/10.1111/j.1468-0297.2011.02446.x.

[27] J.W. McCaughey, P. Daly, I. Mundir, S. Mahdi, A. Patt, (In prep.) Socio-economic segregation resulting from policies to return displaced residents following a coastal disaster, (2017).

[28] S. Agustina, C. Aryani, Escape Building: The New Kid on the Block in Post Disaster Urban Landscape of Banda Aceh, in: 4th Biannu. Int. Conf. Aceh Indian Ocean Stud. Kampus UNIMAL, Lhokseumawe, 8–10 June 2013, (2013).

[29] JICS, Nippon Koei Co Ltd, Japan International Cooperation System Procurement of the Services Under Japan's Grant Aid 2004: Bid Document for Model Area Development for Reconstruction of Banda Aceh City: Community Building Deah Tengoh. (2006).

[30] Y. Goto, M. Affan, N. Fadli, Quick Report No. 2. Response of the People in Banda Aceh Just After the 2012 April 11 Off-Sumatra Earthquake (Mw8.6), Unpubl. Rep. (2012) 33.

[31] A. Suppasri, N. Shuto, F. Imamura, S. Koshimura, E. Mas, A.C. Yalciner, Lessons learned from the 2011 Great East Japan Tsunami: Performance of Tsunami Countermeasures, Coastal Buildings, and Tsunami Evacuation in Japan, Pure Appl. Geophys. 170 (2013) 993–1018, http://dx.doi.org/10.1007/s00024-012-0511-7.

[32] N.D. Weinstein, A. Kwitel, K.D. McCaul, R.E. Magnan, M. Gerrard, F.X. Gibbons, Risk perceptions: assessment and relationship to influenza vaccination, Health Psychol. 26 (2007) 146–151, http://dx.doi.org/10.1037/0278-6133.26.2.146.

[33] G.F. Loewenstein, E.U. Weber, C.K. Hsee, N. Welch, Risk as feelings, Psychol. Bull. 127 (2001) 267–286, http://dx.doi.org/10.1037//0033-2909.127.2.267.

[34] P. Slovic, The Feeling of Risk, Earthscan, 2010.

[35] F. Thomalla, H. Schmuck, "We all knew that a cyclone was coming": disaster preparedness and the cyclone of 1999 in Orissa, India, Disasters. 28 (2004) 373–387, http://dx.doi.org/10.1111/j.0361-3666.2004.00264.x.

[36] U. Sharma, A. Patt, Disaster warning response: the effects of different types of personal experience, Nat. Hazards 60 (2012) 409–423, http://dx.doi.org/10.1007/

s11069-011-0023-2.
[37] B.K. Paul, Factors affecting evacuation behavior: the case of 2007 Cyclone Sidr, Bangladesh, Prof. Geogr. 64 (2012) 401–414, http://dx.doi.org/10.1080/00330124.2011.609780.
[38] J.R. Smith, W.R. Louis, Group norms and the attitude–behaviour relationship, Soc. Personal. Psychol. Compass 3 (2009) 19–35, http://dx.doi.org/10.1111/j.1751-9004.2008.00161.x.
[39] BPBD, Standard Operational Procedure (SOP) Penggunaan dan Pemanfaatan Gedung Evakuasi (Escape Building), (2011).
[40] D.K. Chester, A.M. Duncan, C.J.L. Dibben, The importance of religion in shaping volcanic risk perception in Italy, with special reference to Vesuvius and Etna, 172 (2008) 216–228.
[41] D. Chester, A. Duncan, C. Kilburn, H. Sangster, C. Solana, Human responses to the 1906 eruption of Vesuvius, southern Italy, J. Volcanol. Geotherm. Res. 296 (2015) 1–18, http://dx.doi.org/10.1016/j.jvolgeores.2015.03.004.
[42] K. Hewitt, The idea of calamity in a technocratic age, in: K. Hewitt (Ed.), Interpret. Calam. Allen and Unwin, Boston, 1983, pp. 3–32.
[43] J.W. McCaughey, I. Mundir, R. Rosemary, L. Safrina, S. Mahdi, P. Daly, A.G. Patt, (In prep.) Feelings drive precautionary evacuation, (2017).