

## Regional Characteristics of Tsunami Risk Perception among the Tsunami Affected Countries in the Indian Ocean

Tetsushi KURITA<sup>1</sup>, Masaru ARAKIDA<sup>2</sup> and Sisira R. N. COLOMBAGE<sup>3</sup>

<sup>1</sup>Tokyo Electric Power Services Co., Ltd.  
(formerly of the Asian Disaster Reduction Center)

<sup>2</sup>Asian Disaster Reduction Center

<sup>3</sup>Kobe University

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### ABSTRACT

The 2004 Indian Ocean Tsunami caused more than 220,000 casualties and over \$10 billion worth of damage, with the extent of the latter attributed to a lack of knowledge about tsunamis, given their rarity in this area. Questionnaire surveys on tsunami awareness were carried out among 1,000 residents in Indonesia, Sri Lanka and the Maldives, respectively, since the coastlines of these countries were some of the most severely damaged regions of the Indian Ocean. The purpose was to assess and evaluate the capacity of communities to respond to natural disasters. Additionally, a comparative analysis was carried out to identify the regional differences in tsunami risk perceptions, based on which people adjust their behavior and judgment. Careful consideration was given to differences in sociocultural backgrounds throughout the study, especially when quantitatively analyzing results and interpreting the implications and overall trends revealed several differences among the three countries on the topics studied.

### 1. INTRODUCTION

The Indian Ocean Tsunami of December 2004 was a massive disaster of a magnitude rarely seen in human history. It resulted in more than 220,000 fatalities and caused more than \$10 billion of damage (UN Office of the Special Envoy for Tsunami Recovery, 2005). The reasons for the enormity of this disaster are complex, and include not only the enormity of the tsunami that struck, but a combination of several other factors. It is argued that one of the most important of these was the infrequency of tsunami events in this part of the world, which is thought to explain the lack of knowledge concerning tsunamis in the affected regions. To prevent similar disasters from recurring in future, it is essential that efforts be made to ascertain the conditions in the affected regions and examine local perceptions of tsunami risk.

A variety of surveys have been conducted in the tsunami-affected regions, but virtually none have focused on people's attitudes and perceptions. A perception study in Sri Lanka was reported by Kurita et al. (2006), but to date, no comparative studies have been conducted across all 12 affected countries.

In this study, we conducted a questionnaire survey among more than 1,000 subjects (including residents, students, teachers, and government officials) in each of the three countries severely impacted by the tsunami, namely: Indonesia, Sri Lanka, and the Maldives. Many of the coastal areas of these countries sustained damage of catastrophic proportions. We launched this study primarily to examine and evaluate the ability of communities to

respond to natural disasters. The survey results show the diversity of tsunami risk perceptions in each country. Another purpose of this study is to quantitatively identify the regional characteristics of tsunami risk perception and to provide information that will contribute to the restoration of the affected countries. Because the areas examined in this study have diverse geographical, cultural, and social backgrounds, we extracted regional differences by conducting cross-national comparisons. This paper offers yet another perspective on some interesting insights for the interpretation of empirical findings.

### 2. SURVEY OVERVIEW

In this study, we conducted a questionnaire survey on tsunami risk among residents, students, teachers, and government officials. An overview of this survey is provided below.

#### 2.1 Survey Methods

Questionnaire for the general public (residents): This survey was conducted using an interview-style format, whereby local surveyors visited people at home, questioned them, and then recorded their answers on questionnaire forms. The survey subjects were selected by dividing the coastal region into several zones, and then conducting random sampling. The target number of respondents was 1,000.

Questionnaire for schoolchildren: This survey was conducted primarily among children in the fifth grade (aged 10). The ques-

tionnaires were completed by the schools, and the surveyors later returned to collect them. The target number of respondents was 1,000. To supplement the information provided by the students, a survey was also conducted among the teachers of the classes surveyed.

Questionnaire for government officials: This survey was conducted among organizations of both the central and local (provincial and municipal) governments. The surveyor met a manager of each organization and asked them to conduct the survey in their departments. The questionnaires were then completed by each organization, and the surveyors returned later to collect them. The target number of respondents was 50-100.

Although it is reasonable to argue that uniform interview-based surveys could have been used for the three categories of the sample, we compelled to employ alternative methods for the following reasons. (i) Reluctance of the school administration to allow foreign investigation teams to enter school buildings, since there was prior evidence of upsetting students. (ii) To avoid any disruption to the ongoing duties of dealing with disaster related issues, we requested that they fill in the questionnaire themselves. However the impact of these different methodologies on survey results is considered minimal, since the purpose and content of the survey were both well explained. Besides, the questionnaires were translated into the local language following extensive discussion and agreement with local experts concerning the jargon used inside.

## 2.2 Survey Period

The survey was conducted in Sri Lanka in March 2005, in the Maldives from June to July 2005, and in Indonesia from September to December 2005.

## 2.3 Major Survey Items

The key topics covered by the survey are as follows:

Residents:	Behavior when the tsunami struck, information gathering during evacuation, knowledge of tsunamis, future measures required
Students:	Experience studying natural disasters, knowledge of tsunamis, and dialogue with their families.
Teachers:	Natural disaster curriculum, teaching materials in disaster education.

Government officials: Disaster response, future necessary measures, dialogue with communities.

## 2.4 Structure of the Samples

**Table 1** shows the number of samples collected, by region. Because the survey could not be conducted in schools in the Maldives, no samples were obtained from that sector. For reference, **Table 2** shows the number of casualties in each of the three countries. With a total of 108 casualties, the Maldives appears to have suffered considerably less than the other affected countries. However, since the total population of the Maldives is about 1/1000 that of Indonesia, the ratio of those affected relative to the total population is significant. In addition, the Maldives comprises about 2,000 low-lying islands whose highest elevation is about 1.3 m. It is unique in that about 200 of those islands are inhabited, and was included in this study for the same reason.

## 3. COMPARATIVE ANALYSIS OF THE NATIONAL SURVEY RESULTS

This section compares the survey findings from the three countries studied, and identifies the unique characteristics of each.

### 3.1 Survey of Residents

**Fig. 1** shows whether the respondent had any knowledge concerning tsunamis and their perceived effectiveness of such knowledge. More than 70% of people in all three countries indicated that they knew nothing about tsunamis before the 2004 tsunami disaster. The majority of respondents in Sri Lanka and the Maldives indicated that the damage could have been reduced had they known about tsunamis, while most of those in Indonesia did not feel this was the case. Two main reasons were given for this. Firstly, because many of the casualties in the tsunami-affected areas of Indonesia, primarily Banda Aceh, were caused by the inland penetration of a tsunami wave as high as 10 m in some areas, it would have been difficult to reduce the massive level of damage, even if people had had some previous knowledge about tsunamis. The second is that Indonesia, unlike the other two countries studied, was extremely close to the source of the tsunami, giving residents little time to evacuate between the earthquake and the arrival of the first tsunami wave. It is therefore believed that prior knowledge concerning tsunamis might not have done much to mitigate the damage.

**Table 1** Number of samples by region.

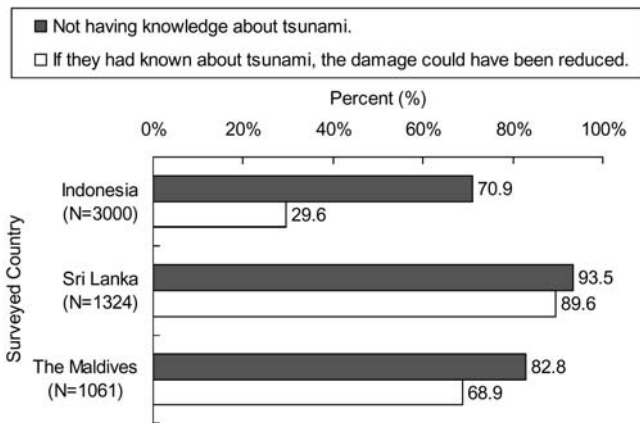
Target Survey Area	Residents	School		Government Officials	
		Students	Teachers		
Indonesia	Banda Aceh and its Surrounding Area	1,000	1,005	84	120
	Western Part of North Sumatra (Calang & Meulaboh)	1,000	1,016	100	115
	Simeulue Island	500	519	8	55
	Nias Island	500	514	7	50
	Total	3,000	3,054	199	340
Sri Lanka	Galle district	1,324	1,112	36	110
The Maldives	Laamu Atoll (Gan Is. & Fonadhoo Is.)	250	-	-	-
	Kaafu Atoll (Dhiffushi Is., Huraa Is. & Male' Is.)	555	-	-	-
	Meemu Atoll (Kolhufushi Is. & Muli Is.)	256	-	-	-
	Total	1,061	-	-	182

**Table 2** Number of casualties in each country examined.

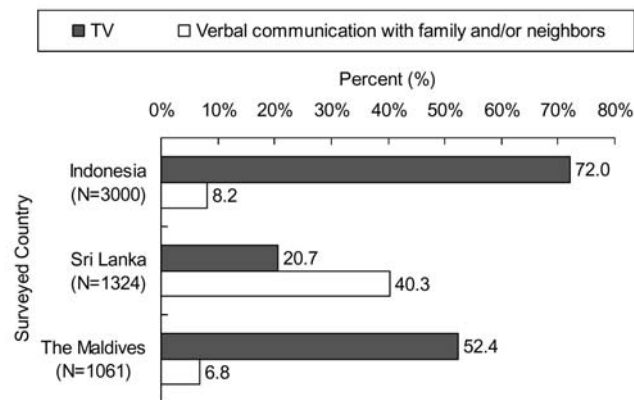
Nations	Total Population <sup>†</sup> (million)	Casualty Count <sup>‡</sup>		
		Dead	Missing	Total
Indonesia	217.5	130,736	37,000	167,736
Sri Lanka	19.3	35,322	-	35,322
The Maldives	0.3	82	26	108

<sup>†</sup> Sekainougokisha (2003).

<sup>‡</sup> UN Office of the Special Envoy for Tsunami Recovery (2005).



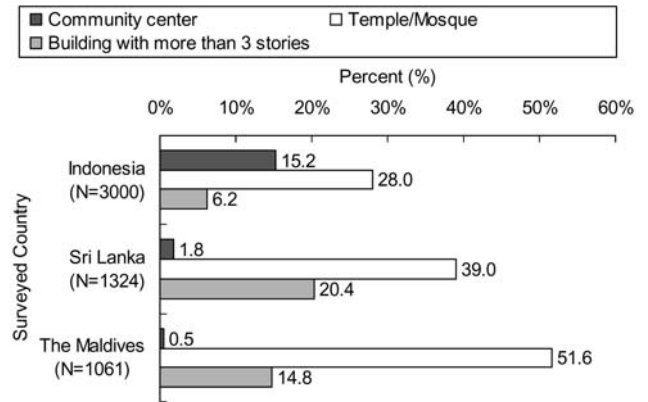
**Fig. 1** Knowledge concerning tsunamis and its effectiveness.



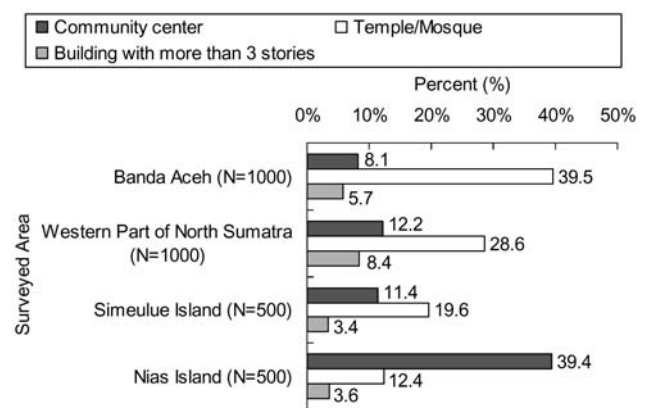
**Fig. 2** Optimal channel of communication for obtaining the information I wanted.

**Fig. 2** shows an international comparison of the most effective channels of communication via which people obtained the disaster information they wanted. Most people in Indonesia and the Maldives indicated that TV was the most effective channel of communication. In Sri Lanka, on the other hand, most people indicated that they obtained information directly from friends and neighbors, while few relied on the TV.

**Fig. 3** shows the responses regarding the optimum tsunami evacuation sites in each country. “A temple or mosque” was the most popular response in all three countries, reflecting the residents’ high level of trust in religious facilities. However, this ratio was slightly lower in Indonesia than in the other countries, where “community centers” were also indicated among the optimal evacuation sites. Respondents in Sri Lanka and the Maldives followed similar trends, with the most popular response being “a temple or mosque” followed by “a building of three or more sto-



**Fig. 3** Optimal location to use as a tsunami evacuation site.



**Fig. 4** Optimal location to use as a tsunami evacuation site, by region.

ries.” Because the trends in Indonesia differed from the other countries, we carefully examined the regional characteristics within that country, with **Fig. 4** showing a regional comparison within Indonesia. This reveals that an extremely large percentage of respondents in Banda Aceh and the western part of north Sumatra chose “a temple or mosque,” while this was a less common response on Simeulue and Nias Islands. Most respondents on Nias Island chose “a community center,” followed by a considerable percentage indicating “a temple or mosque.” Clearly the characteristics of both Simeulue and Nias Islands have an impact on the results shown in **Fig. 3**.

### 3.2 Survey of Schoolchildren

Since this survey was only conducted at schools in Sri Lanka and Indonesia, only these two countries are compared in this section. **Fig. 5** shows the results on questions regarding students’ “interest in studying natural disasters” and their “discussions of what they learned at school with their families.” It is worth noting that the results obtained from two independent questions are combined in this figure, meaning the former questions did not influence the results of the latter. Moreover, questions in the latter concern not only natural disasters but also general learning issues. The figure shows that students in both countries are highly interested in studying natural disasters, and that they also tend to discuss what they learn at school with their families. These results suggest that introducing disaster education at this stage, when students are eager to learn about natural disasters, would be an effective mea-

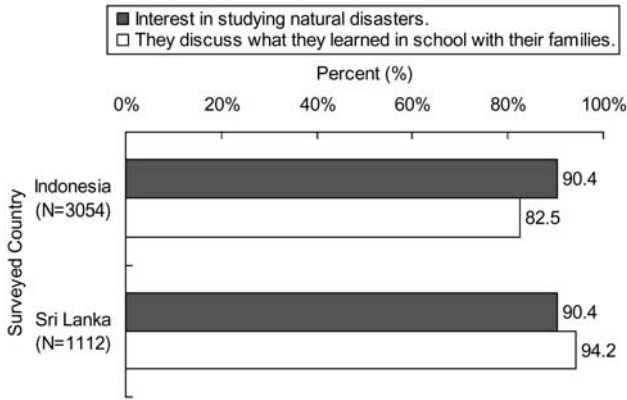


Fig. 5 Interest in studying natural disasters and discussions with family.

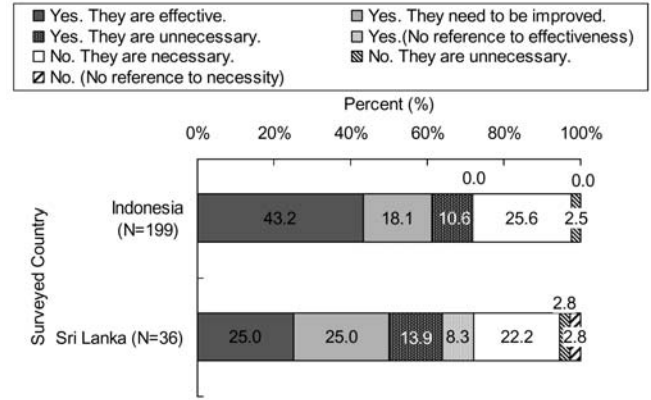


Fig. 7 Are lessons on natural disasters conducted? Are they effective? Are they necessary?

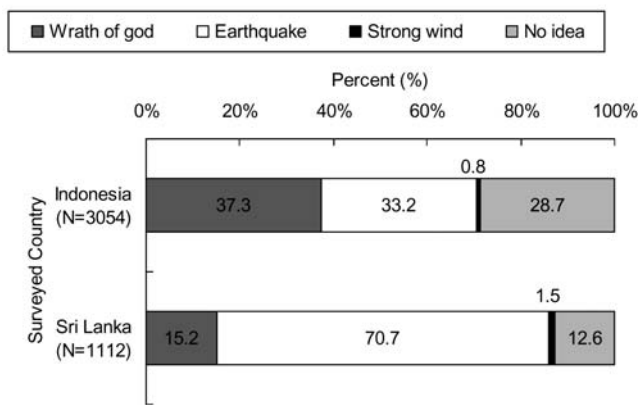


Fig. 6 Causes of the tsunami.

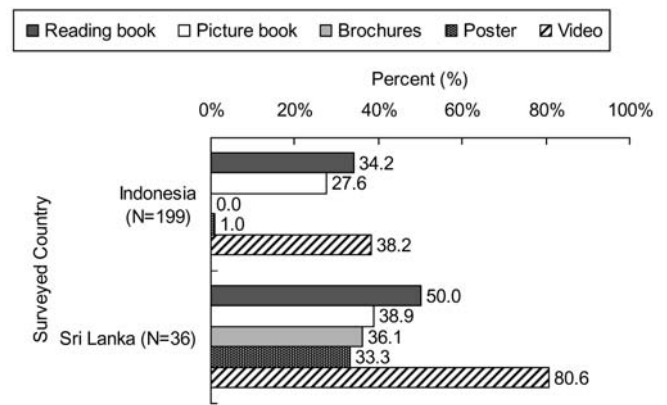


Fig. 8 Disaster education materials deemed effective (multiple responses allowed).

sure. If disaster education were provided to children, we could also expect the effects to extend to their families, with whom they share what they learn. During interviews with residents in the affected area, it emerged that some hold similar opinions, which is confirmed by the results of the analysis.

Fig. 6 shows the responses to a question concerning what caused the tsunami. Most children in Sri Lanka indicated that it was caused by “an earthquake,” while in Indonesia the responses were fairly evenly split between, “the wrath of God,” “an earthquake,” and “I don’t know.”

3.3 Survey of Schoolteachers

Fig. 7 shows the responses to questions concerning whether natural disaster lessons are taught in schools, and whether they are effective and necessary. In both countries, more than 70% of teachers indicated that natural disaster lessons are being taught. However, there is a large gap between them concerning the perceived effectiveness of these lessons. While a relatively large number of teachers (more than 40%) in Indonesia feel they are effective, this feeling is shared by only 25% of teachers in Sri Lanka. In both countries, many teachers in schools where such lessons are not currently being taught feel that they need to be adopted.

The responses to a question regarding the most effective teaching medium in disaster education are shown in Fig. 8. In both countries, videos were cited by teachers as the most effective medi-

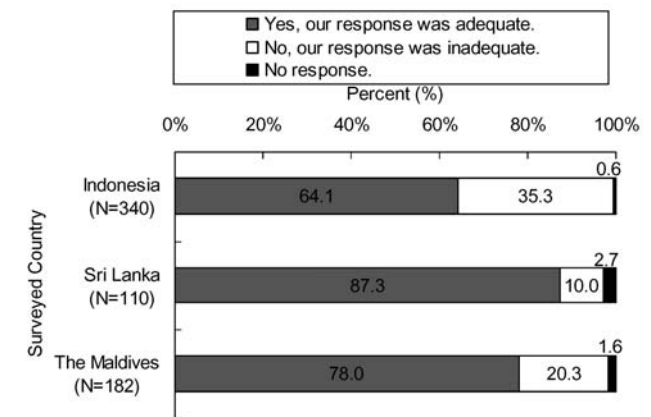


Fig. 9 Did you respond adequately to the tsunami?

um, followed by reading books and picture books. In Indonesia conversely, virtually no teachers saw brochures or posters as effective.

3.4 Survey of Government Officials

Fig. 9 shows the responses to a question concerning how government officials responded when the 2004 tsunami struck. In all three countries, the most frequently cited response was that they “responded adequately enough,” but this figure was lowest in Indonesia at only 64%, indicating that more than 30% of govern-

ment officials there feel they did not respond adequately. This clearly shows that the disaster situation in Indonesia, the country most severely affected by this disaster, far exceeded that nation's response capabilities.

Fig. 10 shows the results of a question regarding ties between the government and the community and efforts to improve community disaster reduction capabilities, and a question regarding the availability of opportunities for government officials and community members to mutually share ideas. In responding to questions concerning the opportunity for the government to exchange ideas with the community, it is evident that officers in central government and their local government counterparts view the patterns of communication very differently. However, it is difficult to distinguish them determinately, since institutional settings and the administration system of each country differ considerably from each other in each case. It shows that less than half of government officials in the Maldives feel that such opportunities exist. In Indonesia, by contrast, more than 90% of government officials feel that they have access to such opportunities, while Sri Lanka lies between these two. Clearly each country is characterized by a differing level of relationship between government officials and local communities. In response to a question regarding the need for the government and communities to hold integrated evacuation drills, most government officials in all countries indicated that such drills are, indeed, necessary, meaning they are all are aware of the need for community involvement in disaster reduction efforts if damage

is to be reduced in future.

Fig. 11 shows the locations that government officials consider to be the optimal tsunami evacuation sites. In all countries, most government officials selected "buildings designated as evacuation centers," but in the Maldives, "a temple or mosque" was also a very common response. The reason for this is explained in the "SURVEY RESULTS FROM THE MALDIVES," as discussed below. If these responses are compared with those from residents shown in Fig. 3, we see that most government officials favor designated buildings as evacuation sites over religious facilities.

4. REGIONAL COMPARISON OF SURVEY RESULTS FROM INDONESIA

Surveys were conducted in four regions in Indonesia, each with its own distinct characteristics. Here we compare the regional characteristics within Indonesia.

4.1 Regional Characteristics in the Survey of Residents

Fig. 12 shows the results of a question regarding prior knowledge of tsunamis, totaled up by region. In regions other than Simeulue Island, most people had no knowledge about tsunamis, but on Simeulue Island, more than 70% of the residents had such knowledge. Table 3 shows the number of casualties by region. The numbers of dead and missing shown here include those who perished as a result of the earthquake and shows that the number of casualties on Simeulue Island, where people had prior knowledge about tsunamis, was very small compared with elsewhere. After the earthquake struck, the residents of this island immediately evacuated to high ground, thereby saving many lives. Why did the

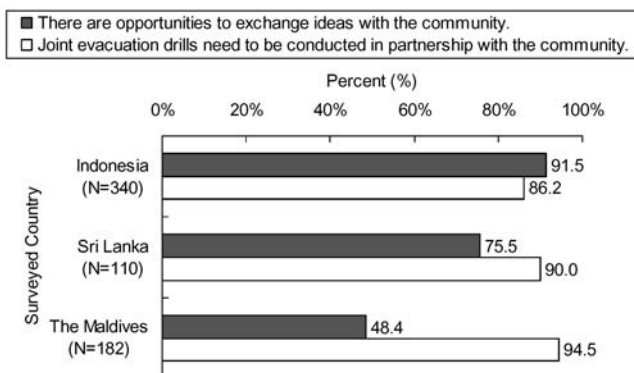


Fig. 10 Opportunities for the government to exchange ideas with the community and the need for joint evacuation drills.

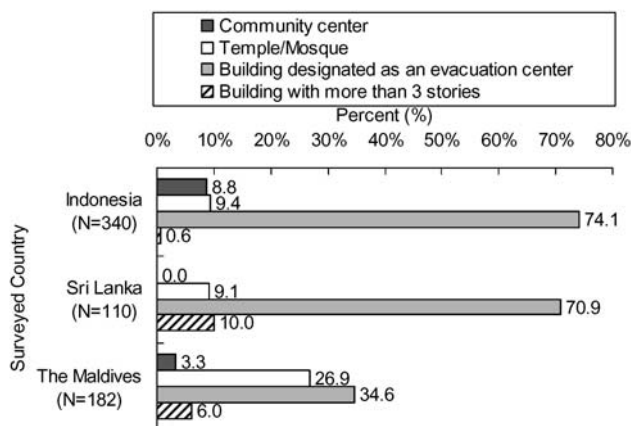


Fig. 11 Optimal locations to be used as tsunami evacuation sites indicated by government officials (multiple responses allowed).

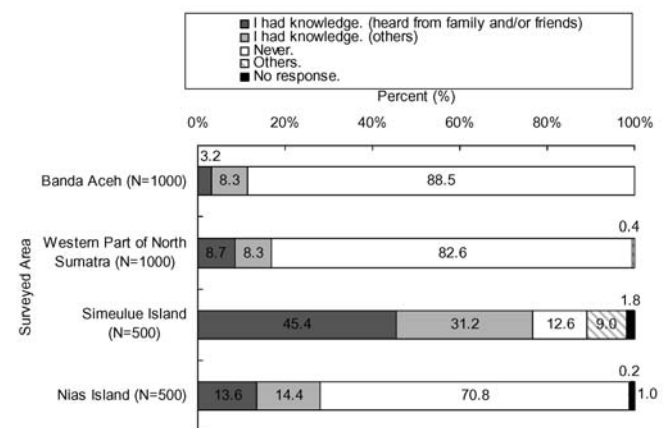


Fig. 12 Existence of prior knowledge about tsunamis, by region in Indonesia.

Table 3 Number of casualties in the examined regions of Indonesia.

Target Survey Area	Number of Dead & Missing †	Population ‡ (approximate figures)
Banda Aceh	30,000	240,000
Western Part of North Sumatra	19,800	300,000
Simeulue Island	9	72,000
Nias Island	257	433,000

† BAKORNAS PBP(2005)

‡ BPS of NAD Province (2005), BPS Provinsi Sumatera Utara (2005) and Interview Survey at Syiah Kuala University by the Asian Disaster Reduction Center (2006).

residents of Simeulue Island know about tsunamis? This is the legacy of a tsunami that struck the island about a century ago in 1907, of which residents had been made aware (Drs. Darmili, 2005) and a breakdown of the responses regarding prior knowledge concerning tsunamis shows that nearly half had heard about tsunamis “from family and/or friends.” This shows that information is being communicated between those close to one another. The people of this island refer to tsunamis as “smong,” and the older generation has passed down lessons from the previous tsunami through stories and songs. One song that has been passed down explains the characteristics of a tsunami, and teaches people what they should and should not do if one occurs. The descendants of Simeulue Island were able to minimize the damage they sustained by carefully following the lessons that had been passed down from their ancestors. The effectiveness of that prior knowledge was tested and proven in a tsunami a century on.

The results of this survey have quantitatively shown that having prior knowledge concerning tsunamis can reduce disaster damage, thereby confirming the importance of disaster education.

Fig. 13 shows the results of a question concerning effective ways of raising public disaster awareness. It shows that in all regions, incorporating disaster education into the school curriculum was the option deemed most effective. This ratio was lowest on Simeulue Island, where tsunami-related knowledge has thus far been passed down through the community. On Nias Island, by contrast, which had a significant number of casualties, many residents recognized the importance of disaster education.

#### 4.2 Comparison of Responses by Residents and Government Officials

This section comparatively analyzes the perceptions of the residents and government officials in each region. Table 4 shows the top five policies deemed necessary by residents to reduce tsunami damage in future and Table 5 shows the top five policies indicated by government officials. Although there were 15 response options on the residents’ survey and 17 on that for government officials, the top options selected were largely similar. Most respondents considered “the establishment of an early warning system” to be the most necessary policy. However, the most necessary policy indicated by the residents of Simeulue Island, where tsunami dam-

age was avoided by passing on an old story by word of mouth, was “planting trees along the coast.” In the western part of north Sumatra, the respondents ranked “planting trees along the coast” in 6th place, while residents in Nias Island ranked the same in 12th place. Among both residents and government officials, there was a tendency to favor not only policies related to infrastructure development, but also efforts to enhance the government disaster response and promote education. These results show that both residents and government officials alike understand the importance of conducting evacuation activities, based on early warnings and accurate information as an effective tsunami preparedness policy. We also found that there was no significant regional difference in people’s perceptions in this regard.

### 5. SURVEY RESULTS FROM THE MALDIVES

In the Maldives, this survey was conducted in a total of three atolls: two atolls that sustained significant damage and the Kaafu Atoll, where the capital of Male Island is located. The following discusses the survey results by region and by respondent class.

#### 5.1 Survey Results of Residents

Fig. 14 shows the results of survey questions regarding the degree of residential damage by island. On Male Island, where damage was reduced by seawalls that were constructed using Japanese ODA, very few homes either totally or half-collapsed. The most significant damage was sustained on Kolhufushi Island, followed by Muli Island, indicative of the significant level of damage sustained by Meemu Atoll.

Fig. 15 shows the level of personal exposure faced by the respondents. It reveals that most of the residents of Fonadhoo Island were caught in the tsunami in their homes. On Meemu Atoll, many people were caught in the tsunami while trying to evacuate. Excluding Male Island, the number of people caught in the tsunami was smallest on Gan Island, but this is attributed to the fact that this island is larger by comparison than the others, and consequently not completely inundated.

Table 6 shows the results of the damage survey conducted by the government of the Maldives. It shows that while the Kaafu Atoll sustained few human casualties, it sustained extensive building damage. Because the Kaafu Atoll includes the capital island of Male, and includes numerous buildings, although the absolute number of damaged buildings is higher than the other atolls, the ratio of damaged buildings is lower. Human casualties on Laamu and Meemu, by contrast, were extensive. On Laamu Atoll, there were few casualties on Gan Island, which has a large land area, but many casualties on Fonadhoo Island. These results are consistent with those shown in Figs. 14 and 15, which indicate that many homes either totally or half-collapsed on Laamu and Meemu Atolls, and that many people were caught in the tsunami in their homes on Fonadhoo Island.

#### 5.2 Comparison of the Residents and Government Officials

The Maldives is a nation comprising many islands, each of which has its own island office. Of the 182 survey responses collected from government officials in the Maldives, 98 were from island office officials. Here we analyze the differences in perception between residents and island office officials, and residents and

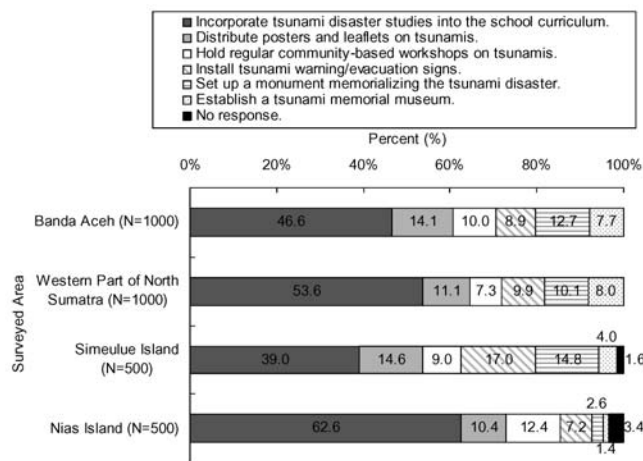


Fig. 13 Effective methods of raising public awareness by region in Indonesia.

**Table 4** Policies necessary for reducing tsunami damage, as reported by residents (multiple answers allowed).

Target Area	Selected Items (Top 5)		
Banda Aceh (N=1000)	1	Establishment of a tsunami early warning system	60.9%
	2	Planting trees along the coast	51.0%
	3	Building infrastructure for disaster prevention, such as seawalls	49.4%
	4	Strengthening of the government response capability for disaster	38.5%
	5	Enhancement of the emergency information dissemination system	35.7%
Western Part of North Sumatra (N=1000)	1	Establishment of a tsunami early warning system	68.9%
	2	Strengthening of the government response capability for disaster	56.9%
	3	Enhancement of the emergency information dissemination system	53.3%
	4	Strengthening the capability of search and rescue operations and the emergency medical service	43.8%
	5	Raising public disaster awareness at the community level	38.9%
Simeulue Island (N=500)	1	Planting trees along the coast	55.2%
	2	Establishment of a tsunami early warning system	41.2%
	3	Improvement of public information on disaster risk management (including the distribution of hazard maps)	38.4%
	4	Building infrastructure for disaster prevention, such as seawalls	34.6%
	5	Designating potential risk areas (e.g. making and publishing tsunami inundation area maps)	26.8%
Nias Island (N=500)	1	Establishment of a tsunami early warning system	66.2%
	2	Raising public awareness on disaster at the community level	50.0%
	3	Improvement of public information on disaster risk management (including the distribution of hazard maps)	49.6%
	4	Building infrastructure for disaster prevention, such as seawalls	44.6%
	5	Strengthening of the government response capability for disaster	41.8%

## - Response Options -

No.	Items of Choice
1	Establishment of a tsunami early warning system
2	Enhancement of the emergency information dissemination system
3	Strengthening the capability of search and rescue operations and the emergency medical service
4	Improvement of public information on disaster risk management (including the distribution of hazard maps)
5	Strengthening of government response capability for disaster
6	Raising public awareness on disaster at the community level
7	Fostering community leaders for disaster management
8	Promotion of school education on disaster reduction
9	Development of evacuation sites and routes
10	Designating potential risk areas (e.g. making and publishing tsunami inundation area maps)
11	Conducting evacuation training/drills
12	Building infrastructures for disaster prevention, such as sea walls
13	Planting trees along the coast
14	Others
15	No idea.

**Table 5** Policies necessary for reducing tsunami damage, as reported by government officials (multiple answers allowed).

Target Area	Selected Items (Top 5)		
Banda Aceh (N=120)	1	Establishment of a tsunami early warning system	82.5%
	2	Strengthening of the government response capability for disaster	64.2%
	3	Enhancement of the emergency information dissemination system	56.7%
	4	Building infrastructure for disaster prevention, such as seawalls	45.0%
	5	Planting trees along the coast	40.0%
Western Part of North Sumatra (N=115)	1	Establishment of a tsunami early warning system	82.6%
	2	Enhancement of the emergency information dissemination system	60.9%
	3	Strengthening the capability of search and rescue operations and the emergency medical service	60.9%
	4	Strengthening of the government response capability for disaster	39.1%
	4	Promotion of school education on disaster reduction	39.1%
Simeulue Island (N=55)	1	Establishment of a tsunami early warning system	58.2%
	1	Improvement of public information on disaster risk management (including the distribution of hazard maps)	58.2%
	3	Strengthening the capability of search and rescue operations and the emergency medical service	52.7%
	3	Raising public awareness on disaster at a community level	52.7%
	5	Enhancement of the emergency information dissemination system	47.3%
Nias Island (N=50)	1	Establishment of a tsunami early warning system	90.0%
	2	Improvement of public information on disaster risk management (including the distribution of hazard maps)	52.0%
	2	Promotion of school education on disaster reduction	52.0%
	4	Strengthening of the government response capability for disaster	50.0%
	5	Raising public awareness on disaster at the community level	40.0%
5	Designating potential risk areas (e.g. making and publishing tsunami inundation area maps)	40.0%	

## - Response Options -

No.	Items of Choice
1	Establishment of an early warning system for natural disaster
2	Enhancement of the emergency information dissemination system
3	Strengthening the capability of search and rescue operations and the emergency medical service
4	Improvement of public information on disaster risk management (including the distribution of hazard maps)
5	Strengthening of the government response capability for disaster
6	Raising public awareness on disaster at the community level
7	Fostering community leaders for disaster management
8	Promotion of school education in school on disaster reduction
9	Development of evacuation sites and routes
10	Designating sites for emergency evacuation such as high buildings and hills
11	Displaying tsunami warning/evacuation signs
12	Designating potential risk areas (e.g. making and publishing tsunami inundation area maps)
13	Building infrastructure for disaster prevention, such as sea walls.
14	Planting trees along the coast
15	Conducting emergency drills
16	Others
17	No idea

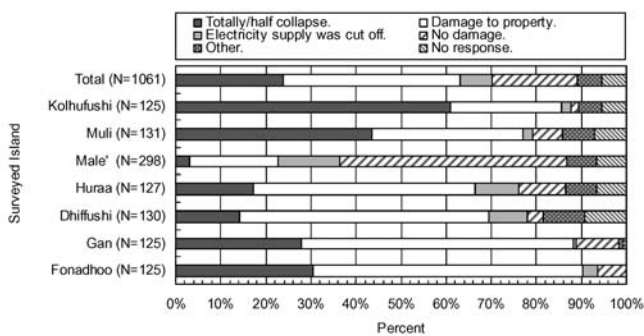


**Table 6** Damage assessment by atoll (National Disaster Management Centre, 2005).

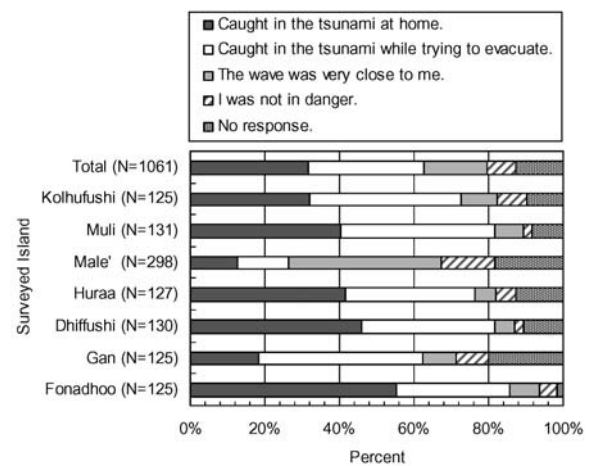
Atoll	Population <sup>†</sup>	Death Toll	No. of Missing	Flooding Status <sup>‡</sup> (Number of Islands)			No. of Damaged Buildings	
				Completely	Half	Partially		
Laamu	Gan Is. Fonadhoo Is.	11,318	22	3	7	2	3	285
Kaafu	Dhiffushi Is. Huraa Is. Male' Is.	8,458	3	2	6	1	1	482
Meemu	Kolhufushi Is. Muli Is.	4,845	21	13	8	0	0	346

<sup>†</sup> As of mid-2004.

<sup>‡</sup> As of January 5, 2005.



**Fig. 14** Damage to homes, by island.



**Fig. 15** Personal exposure of respondents, by island.

officials in other ministries.

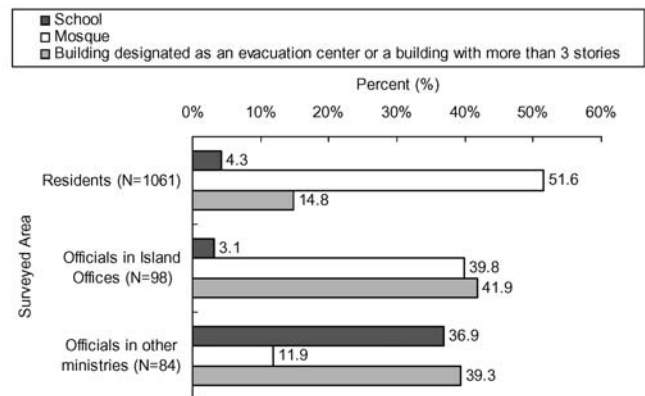
**Fig. 16** shows the optimal places to use as evacuation sites, as reported by the three categories of population described above, with two aspects of buildings combined in this figure to facilitate comparison. Clearly, most residents reported the “mosque” as the optimal evacuation site, while many officials in other ministries selected a “school” or “building designated as an evacuation center or a building of more than three stories.” Likewise, most officials in the island offices selected a “building designated as an evacuation center or a building with more than three stories.” However, nearly the same number indicated a “mosque”, suggesting that because the island office officials are very closely integrated into their communities, their perceptions are very similar to those of ordinary local residents.

**6. CONCLUSIONS**

This study examined the tsunami risk perceptions of people of three countries affected by the 2004 Indian Ocean Tsunami: Indonesia, Sri Lanka, and the Maldives. In this paper, we report the tabulated results of the primary analysis of questionnaire-based surveys. Because each country has its own geographical, social, and cultural traits, we were able to identify those distinctive traits by comparing regions. The results of this study may prove useful for the reconstruction efforts in each country and can help contribute to the creation of communities that are better prepared for disasters. The results of this study can be summarized as follows.

**6.1 Cross-National Comparison of Survey Results**

A lack of prior knowledge concerning tsunamis among resi-



**Fig. 16** Optimal location to use as a tsunami evacuation site, as indicated by residents and government officials in the Maldives.

dents was a common trait in all three countries, but many residents in Indonesia indicated that the damage would not have been reduced, even had they been equipped with such knowledge in advance. Most residents in Sri Lanka and the Maldives, however, felt that the damage would have been reduced had they known about tsunamis. This result suggests that prior knowledge alone might not have been enough to mitigate the enormous disaster that struck Indonesia. In addition, residents of Indonesia and the Maldives indicated that the optimal channel via which they obtained the desired information in the immediate disaster after-

math was TV, while in Sri Lanka, more respondents indicated obtaining information directly from family and neighbors than from the TV. When asked about the optimal locations for evacuation sites, residents in all countries selected "a temple or mosque," reflecting their high level of trust in religious facilities.

The survey conducted among schoolchildren showed that in both countries where this survey was conducted, namely Indonesia and Sri Lanka, students had a strong "interest in studying natural disasters." Also, since most students discuss what they learn in school with their families, the effects of disaster education in the schools are expected to extend to the adults in those families as well.

Among school teachers, 70% indicated that they were already conducting lessons on natural disasters. While many teachers in Sri Lanka did not consider the content of these lessons to be adequate, more than half of Indonesian teachers indicated that the lessons being taught were effective. In both countries, respondents reported the most effective disaster teaching medium to be videos, followed by reading books.

According to the survey conducted among government officials, many government officials in these three countries feel that they "responded adequately enough" at the time of the earthquake. In Indonesia, however, more than 30% indicated that they "didn't respond adequately enough." This suggests that government officials in that country struggled with how best to respond when faced with such an enormous disaster. The most frequently cited response among officials in all three countries regarding the optimal location to use as an evacuation site was a building designated as an evacuation center. In the Maldives, however, a considerable number of government officials also selected a mosque as a potential evacuation site. This reflects the opinions of the many island office officials who tend to be more closely integrated into their communities.

### 6.2 Discussion of Survey Results from Indonesia

The survey results from Indonesia revealed a significant difference in the level of prior knowledge concerning tsunamis in the four regions studied. Many residents of Simeulue Island (more than 70%), where stories about the 1907 tsunami had been passed down over time, already had knowledge about tsunamis. They thus minimized the damage sustained by carefully following the lessons that had been passed down from their ancestors. These results quantitatively show the effectiveness of prior knowledge about tsunamis. Accordingly, following the success of the community-based transmission of tsunami stories on Simeulue Island, the ratio of respondents who agreed with the notion of introducing disaster education in the schools to enhance disaster awareness was the lowest among all the regions. On Nias Island, in contrast, where the number of casualties exceeded that of Simeulue Island, many respondents indicated the need for disaster education in the schools.

A comparison of the residents' and government officials' suggested policies for reducing damage shows that they are fairly consistent across both populations. In most regions, residents and government officials alike pointed to the need to construct an early warning system. They also highlighted efforts to enhance the gov-

ernment disaster response and promote education. These results show that both residents and government officials alike understand the importance of conducting evacuation activities based on early warnings and accurate information.

### 6.3 Discussion of Survey Results from the Maldives

In the Maldives, sorting the results by atoll reveals that Laamu and Meemu Atolls suffered the most severe damage. This finding is consistent with the damage assessments conducted by the government of the Maldives. Gan Island meanwhile, which has a large land area and which was not fully inundated, and Male Island, which was protected by coastal seawalls, had smaller ratios of tsunami victims, meaning we were able to confirm trends concerning the magnitude of damage based on the specific characteristics of each island.

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