United States Agency for International Development
US Indian Ocean Tsunami Warning System Program

Last Mile Warning Communications Inventory

An on-the-ground assessment of Thailand's tsunami early warning system

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The following list is a collection of all the abbreviations used throughout the surveys and report.

- **DAO** District Administration Office
- **ADPC** Asian Disaster Preparedness Center
- **DDPM** Department of Disaster Prevention and Mitigation
- **Grohe** Grohe Company, responsible for building tsunami warning towers
- **ICT** Thai Ministry of Information and Communication Technology tsunami warning towers
- **IOTWS** Indian Ocean Tsunami Warning System
- **ITV** Tsunami warning towers funded by the ITV television
- **Kockum Sonic** Swedish Company responsible for building tsunami warning towers
- **NDWC** National Disaster Warning Center
- **PAO** Provincial Administration Office
- **POC** Phuket Provincial Operation Center
- **PKT** Tsunami warning towers built by the Phuket Provincial Office
- **PTT** Petrol company in Thailand
- **SAO** Sub-district Administration Office
- **SAO Rep** Sub district Administration Office Representative
- **Siricom** German Company responsible for building tsunami warning towers
- **UN ISDR** United Nations International Strategy for Disaster Reduction
- **UNDP** United Nations Development Program
- **US AID** United States Agency for International Development
- **US IOTWS** Indian Ocean Tsunami Warning System by US AID
- **VHF** Very High Frequency

1: EXECUTIVE SUMMARY

This study surveyed government officials, village headmen, and villagers in 210 tsunami affected villages to determine what, if any, gaps exist in the last mile of the early warning system. All Department of Disaster Prevention and Mitigation staff were surveyed as well as the village head men and sub-district officers for all villages with a tsunami warning tower. The research covered included: warning tower functions; current secondary alert systems; and suggestions to improve the current system.

It was found that there was general dissatisfaction with the current tsunami alert system among the people surveyed. This dissatisfaction was based upon negative prior experiences with the warning towers and a lack of regular drills and testing of the system to assure the villagers that in a future disaster they would receive enough advance warning to save themselves and their families.

A total of 177 warning towers have been constructed since the tsunami. Of those 100 are connected to the National Disaster Warning Center, and 77 of them are locally controlled. Depending on their design the sound from the warning towers travels 1.5 km, reaching approximately 56% of the tsunami affected coastline.

Throughout the interviews, participants showed an interest in improving the system. The major recommendations for improvement included: more information, more evacuation drills, more warning towers, testing the system regularly, building evacuation shelters, building and repairing community announcement towers, increasing the volume, and building and repairing evacuation routes.

The number of warning towers, evacuation drills, and involvement of the local government and aid agencies varies considerably by province. Krabi has invested the most in warning towers and evacuation drills; Phuket is the most satisfied with the current system; Ranong is the least worried about future tsunamis and is more interested in preparing for more common disasters such as mudslides; and Satun appears to be ill-prepared for a future disaster due to severe financial constraints.

To build trust in the warning system there is a need to demonstrate to villagers on a regular basis that the system is still functional. Suggested ways to do this included regular testing of the systems and regular evacuation drills. Other suggestions for improving the tsunami warning system include: providing additional informational material; fixing local announcement towers; attaching solar panels where needed; and building evacuation shelters for low-lying areas.

2 : I N T R O D U C T I O N

The 2004 Indian Ocean Tsunami commenced via an undersea earthquake off the western coast of Indonesia on 26 December, 2004. The earthquake generated a tsunami, which devastated the coastlines of several countries in Southeast Asia including Indonesia, Sri Lanka, India, and Thailand.

In response to the Tsunami disaster, the United States government (USG) is implementing a two-year $16.6 million program to provide technical assistance in the development of an Indian Ocean Tsunami Warning System (IOTWS) for tsunamis and related coastal hazards. The United States is supporting the combined efforts of the international community and national governments in the region to develop an integrated system. Specifically, the U.S. program contributes to the overall effort under the direction and oversight of UNESCO's Intergovernmental Oceanographic Commission (IOC) through its Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS).

This program provides technical assistance to the region using an integrated, "end-to-end" approach. This means that the system will address all stages of early warning from initial hazard detection and warning to the final communication of the message to coastal communities at risk.

Since the tsunami, the Thai government, private companies, and non-governmental organizations (NGOs) have constructed tsunami warning structures in order to protect villagers and tourists from any future natural disasters, especially tsunamis. The National Disaster Warning Center of Thailand has coordinated the installation of one of the two planned buoy systems off the coast of Thailand, which will send warning signals to the tsunami warning towers lined along the Andaman coast. The first of these was successfully launched on the 1st of December 2006. The warning system is intended to save the lives of thousands of people who live, work, and holiday along the coast of Thailand.

The development of a functional warning system is a complex institutional process, and gaps in the system are expected in the early days. The "Last Mile Communications Inventory" has been developed specifically to identify any gaps that may exist in the "Last Mile." The last mile refers to the vulnerable areas along the coast. People within these coastal communities include fisherman, employees of the hotel industry, tourists, and villagers who live, work, and vacation near the water. The findings from the Last Mile Warning Communications Inventory will be presented to key stakeholders in an effort to assist in the strengthening of the overall disaster communications system.

3: SURVEY DESIGN AND METHODOLOGY

3.1 Survey coverage

The study was conducted from October 2006 to April 2007 in Thailand's six tsunami-affected provinces of Ranong, Phang Nga, Phuket, Krabi, Trang, and Satun. A total of 210 tsunami-affected villages were visited with 297 surveys conducted.

Villages were chosen from the list of 407 tsunami-affected villages identified by the Thai Department of Disaster Preparedness and Mitigation (DDPM). Each of the 100 villages that had a warning tower at the time of the research was visited. The other 110 villages were chosen as a representative sample with special attention given to ensuring that a proportional number of islands were included. On average, 35 villages per province were visited and the village headman was interviewed.

Each of the senior sub-district officers or assistant senior sub-district officers from the provincial DDPM office in all six provinces was surveyed using the government office survey. Additionally, the sub-district officer or their assistant from all sub-districts with a tsunami warning tower were surveyed. Researchers visited a total of 74 sub-districts and a total of 73 sub-district officers were surveyed. The survey covered tsunami preparedness on a governmental level. Questions in this survey included the procedures that must occur in the event of an emergency and the way that information is dispersed from the top levels of the government to the general public. Additional sections covered questions relating to elements of tsunami and disaster preparedness.

The village headman survey was used in interviews with village headmen or other village leaders such as Sub-District Administration Office representatives (SAOR). When possible, the village headmen or the SAO representative of all villages with warning towers were surveyed. In a few cases, neither was available and general villagers were surveyed in their stead. There were a total of 178 village headmen interviews conducted.

The general village survey was used in interviews with 35 villagers. Villager interviews were conducted when convenient for both the villager and the researchers. The aim of this survey was to gather information concerning the general population's tsunami preparedness knowledge. These surveys were considerably shorter then the previously mentioned surveys and included at least one question from each of the six categories outlined above.

It was discovered in the first province that the best way to ensure that the village headmen are available for the interview was to schedule the interviews at the sub-district administrative office (SAO). When possible, all of the village headmen were scheduled at different times throughout the same day. Following the interviews, the researchers visited each of the villages with a tsunami warning tower, took a GPS reading, and verified information provided in the interviews. It is during these trips that villagers and hotels were interviewed.

3.2 Survey Design

There were four different surveys used based on the information required from key informants. The surveys, ranging from most inclusive to the most basic are as follows: *Government Office Survey, Village Headman Survey*, *General Village Survey, and Hotel Survey.* The survey is broken into six parts (A-G); Organization and Preparedness, Tsunami Alert Systems, Tsunami Warning Towers, Beach Guard Towers, Announcement Towers, Evacuation Procedures and VHF Towers. Each survey was created to determine levels of understanding for both local and regional tsunami early warning systems and community contingency plans. The surveys were field-tested in Phang Nga Province and then modified accordingly.

3.3 Research Limitations

Due to the fact that all initial interviews were conducted at the sub-district office, there were opportunities for village headmen to meet with each-other before and after the interviews and discuss the topics brought out in the interview. The effect of this information sharing showed up most noticeably in the recommendations for improving the early warning system. In some sub-districts, suggestions were the same from each person interviewed.

There were numerous occasions when the village headmen brought additional people with them to the interview, turning a single person survey into a small group discussion. It is through these discussions that more of the descriptive data was gathered. However, the answers reflect that of the group rather than a single individual.

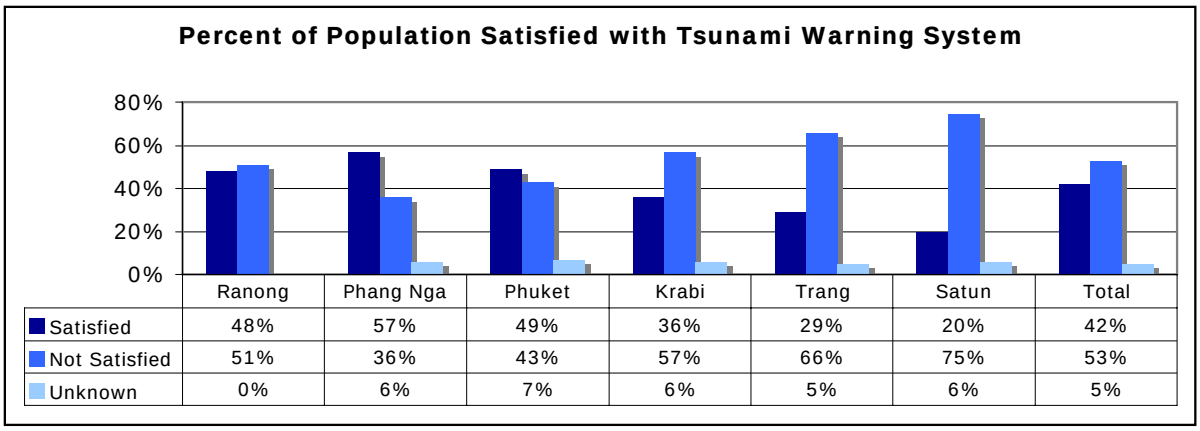
4: RESULTS

In general, the participants were interested in improving and expanding the current alert system to ensure that all people are prepared for and notified of future disasters. There was also interest expressed in learning more about the tsunami warning system as well as the causes of disasters and how to best prepare for them.

The primary themes from the study included: a general dissatisfaction in the current system; a need to increase the warning tower coverage area; the need for improved evacuation routes and shelters; a strong desire for regular practice drills and system tests; a need for more information; and finally increased coordination and information sharing amongst the various levels of government. Although there appeared to be an interest in disaster preparedness on the part of both government offices and villagers, the amount of interest varied by location and was dependent upon other pressing issues the village, district, or province was facing.

4.1 Dissatisfaction with the Current Alert System

Of the people surveyed, an average of 42% said that they were satisfied with the current system. Phang Nga rated the highest in satisfaction with 57% feeling comfortable with the current system. Satun rated the lowest with only 20% of the population comfortable with the current system (see Figure 1).



	Ranong	Phang Nga	Phuket	Krabi	Trang	Satun	Total
Satisfied	48%	57%	49%	36%	29%	20%	42%
Not Satisfied	51%	36%	43%	57%	66%	75%	53%
Unknown	0%	6%	7%	6%	5%	6%	5%

Figure 1. Participant satisfaction with tsunami warning system by province

Participants gave several reasons for their dissatisfaction with the current warning system. In general these reasons were related to the concern that, in the event of a future disaster, the alert will either not be heard or understood. This concern was based on two distinct incidents mentioned in most interviews in conjunction with a perceived inadequate testing of the systems to ensure they work. Factors discussed include: the false alarm of December 2005, the nighttime earthquake in March of 2005, inadequate testing of the system, lack of knowledge about daily pinging of the towers, problems caused by lack of electricity, and vandalism of the towers.

The first incident was the March 2005 earthquake that struck off the Nicobar Islands and was felt throughout many of the tsunami-affected provinces. This occurred just 3 months after the 2004 tsunami and highlighted failures in the warning systems being developed. The second incident was the false alarm that was sounded on 14 December 2005. The tsunami warning was set off accidentally by an employee of the NWDC the day before a test alert was planned. The unexpected warning caused panic in many communities.

Often the villagers' responses to questions pertaining to warning sounds came from the latter incident. Because it was accidental, the message was not played in its entirety, so the average villager did not hear the entire alert. Villagers reported to the survey teams that they did not know what to expect from the warning tower system. Many expressed fear that if another emergency were to occur, he or she would not recognize the evacuation warning sound.

Additionally, participants were uncertain if the towers function properly. Most villages surveyed have a community announcement system that is used to convey local information. In many communities, these announcement systems were broken at the time of the interview-- 10 villages suggested fixing the current announcement systems. Due to the fact that broken announcement systems are a common problem and because the warning towers are rarely tested publicly, villagers did not trust that the systems were functional. 29% of the people surveyed suggested regular testing of the system.

Although it was not generally known among participants, the towers are tested daily via satellite. In interviews all but one of the DDPM officers was familiar with the daily tests. Of the sub-district officers and village headmen surveyed, 58% of those with a warning tower in their village knew about the daily tests, 14% were uncertain about testing, and 28% stated that the tower was not tested daily.

To test the systems, a signal is sent out to the towers via satellite If all connections are working properly, the signal bounces back to the satellite. If no return signal is received, repairmen are dispatched within 24 hours to fix the towers. Since the daily pinging is silent, most villagers are unaware that the towers are tested on a regular basis. On occasions when the system was explained during the survey, several informants still suggested testing the system regularly. The reason given for this suggestion was that even if the tower receives the satellite signal this does not guarantee that the speakers are still functional. One informant suggested an audible pinging, such as playing the Thai National Anthem daily.

Vandalism of the towers also led to increased concern about their ability to function in a disaster. In both Phang Nga and Phuket, the tower wiring from several towers had been cut and sold. In Krabi Province, vandals removed the metal catwalk from the towers. Both Phang Nga and Phuket Provinces requested that the wiring be changed so that this does not happen again. Several people surveyed suggested hiring and training a local person to maintain the towers. Two of the six DDPM staff interviewed were concerned about long-term maintenance of the towers once their warranty expires

Electrical issues were brought up in many conversations regarding disaster response. A large number of island villages do not have regular electrical service and rely on generators or solar power. Several mainland villages do the same. In Thung Nang Dam on Prathong Island in Phang Nga Province, there was a report of an ICT tower not functioning on the night of the March 2005 earthquake. The reason provided for the malfunction dealt with the solar panels not storing up enough electricity to power the towers at night. In addition, Grohe towers (described below) do not have solar panels and therefore only work when there is adequate electricity. In Phang Nga Province the village Tah Pae Yoi, also on Prathong Island, has a Grohe tower, The sole source of electricity in the village is a generator turned on daily from 6 to 10 pm. Therefore, the tower will only function during those four hours. On Koh Ban Yi Island in Phang Nga Province, the village announcement system is solar powered; on the night of the March 2005 earthquake they were unable to use their announcement system to inform villagers. There was a concern expressed during many interviews that if another disaster were to strike during the night there would be no way to get a warning to their island.

One final factor leading to distrust in the current system was the fact that most tsunami practice drills have been done using announcement vehicles or community announcement systems instead of the actual towers. The reason provided for the use of other announcement systems was the difficulty in receiving official permission to use the warning towers. Several DDPM staff and sub-district officers requested that the towers be placed more under local control so that they can run tests and drills as needed. Because most people have never heard the alert or have heard only interrupted alert announcements, they are concerned that if there is another disaster that they will not recognize the real alert and react appropriately.

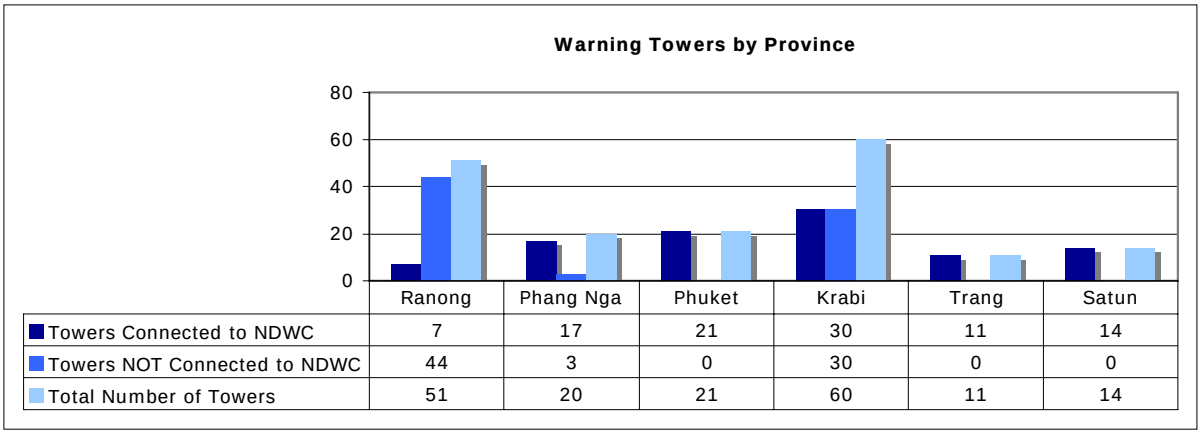
4.2 Tsunami Warning Tower Coverage

There are six types of tsunami warning towers in Thailand that are linked to the National Disaster Warning Center's signal.

- Thai Ministry of Information and Communication (ICT) Towers- These towers were built by the Thai government. They are sixteen meters in height and the sound emitted from the alert can reach up to 1.5 km away. The tower also includes a control box, solar panel, one antenna, and four speakers.
- Phuket Towers- These towers were built by the Phuket Provincial Office. Their appearance is different from the ICT towers in that they have a white, ladder-like, concrete pole that supports the alert system at the top. This tower also is 16 meters in height and the sound emitted from the alert can reach up to 1.5 km away. The tower includes a control box, solar panel, one antenna and four speakers.
- Siricom and Kockum Sonic- These towers were built privately by a Swedish Company. Although they are linked to the NDWC, they are different in appearance to the other towers. Two of the three towers, all of which are located in Phuket, are situated on the roof of hotels. They are a few meters in height and are made up of twelve speakers. The third tower is located on Patong Beach and is a free standing warning tower, similar to the ICT towers. This Siricom and Kockum tower has twenty-four speakers.
- American Signal Towers- There are two of these towers in Phang Nga Province. They were built by Petchaburi Red-Cross, and Channel 3. They are approximately fifteen meters in height. They have eight speakers and therefore are heard up to 2 km away. The control box for both of these towers is located a few meters away in separate structure, which also powers the tower via an electric cord.
- Krabi Towers- These towers were built by the Krabi Provincial Office. They have the same make-up and function as the ICT towers.
- ITV warning towers were funded by the television network ITV and were built by the Phuket Provincial Office; they are identical to the ICT towers.

There are four types of announcement systems that are not connected to the NDWC system but can be used to alert people to a variety of hazards.

- Grohe towers were funded by the German Company Grohe. These towers are connected to a radio signal in Takua Pa District, Phang Nga Province, and will broadcast in the event of an emergency. No one interviewed had ever heard a Grohe tower sound an alert.
- Very High Frequency (VHF) towers. These were installed by the provincial government in both Ranong and Krabi provinces in an effort to increase the warning coverage area. The towers are controlled by the district offices and can be used to warn people of a variety of disasters.
- Village announcement systems. These are locally controlled announcement systems with either a single speaker or a series of speakers throughout a village. The speakers have a range of approximately 0.5 kilometers. In general the announcement system is controlled by the village headmen and is used on a regular basis to convey news and events
- Mosque speaker systems used to call people to prayer. There were many instances reported when the speaker systems were used to announce disasters or announce that a threat has passed.



	Ranong	Phang Nga	Phuket	Krabi	Trang	Satun
Towers Connected to NDWC	7	17	21	30	11	14
Towers NOT Connected to NDWC	44	3	0	30	0	0
Total Number of Towers	51	20	21	60	11	14

Figure 2. NDWC connection in warning towers by province.

Although it varies according to the type of warning tower and the number of speakers on the tower, on average the tsunami warning towers' sound travels 1.5 km. There are 100 warning towers connected to the NDWC system, averaging a range of 300 km in total. With the Andaman coastline at 954 kilometers, this means that potentially 32% of the coastline may be covered by NDWC warning towers. With the additional 77 warning towers not connected to the NDWC system, an additional 231 km of coastline may be covered, or 56% of the coastline. Many villages are not within the range of any tower.

There are several factors that were reported to dampen or overpower the sound emitted from the towers and decrease the range in which they can be heard. These factors included:

- Mangrove forests and other heavy vegetation
- Mountains which prevent the sound from traveling further
- Strong wind blowing the sound in a different direction
- Rain overpowering the announcements
- Boat engines overpowering the announcements
- Air conditioning units and closed windows.

Air conditioning units and closed in hotels and offices both prevent the sound from entering the building and create a white noise that masks the announcements. Of the five hotels interviewed, none of them had heard any warning announcements. In Krabi province there are warning towers located beside or on top of hotels, yet 87% of all people surveyed said they could not hear a warning alert sound over an air conditioning unit.

4.3 Suggestions for Improving Coverage

Typically the tsunami warning towers were built on public land. In certain instances, this restriction has caused the warning towers to be placed in less than ideal locations, such as areas with low population density while neighboring villages with more populated areas have no warning tower. For example, in Mai Kao sub district in Phuket province, the SAO officer said the warning tower was placed in Mai Kao village instead of Tah Chad Chai village even though the latter village has a higher concentration of villagers residing close to the sea. Perhaps because of this, 34% of the people surveyed suggested building more towers (see figure 3). Participants suggested that each village located near the water have its own tower since the sound did not travel far enough to reach from village to village. Other participants

suggested increasing the coverage area of the warning towers by connecting them to pre-existing announcement systems such as village announcement towers and mosque speakers.

In every province there were recommendations to increase the volume of the current warning towers. In Satun province, 45% of respondents suggested that additional speakers could increase the volume of the warning towers and other alert towers while 8% of respondents in Phang-Nga province suggested additional speakers should be added. SAO officers and village headmen alike stressed the need to use more speakers to increase the volume of the towers.

Building more village announcement systems or repairing the current systems was mentioned by 21% of those surveyed as a way to improve the tsunami warning system. Many village announcement systems were broken or did not cover a large enough area. The speaker systems in mosques tended to be in good repair because they were used several times a day to call people to prayer. It varied by village as to whether or not the mosque speakers could be used to make general village announcements, but there was a general agreement that they could be used in the event of a disaster.

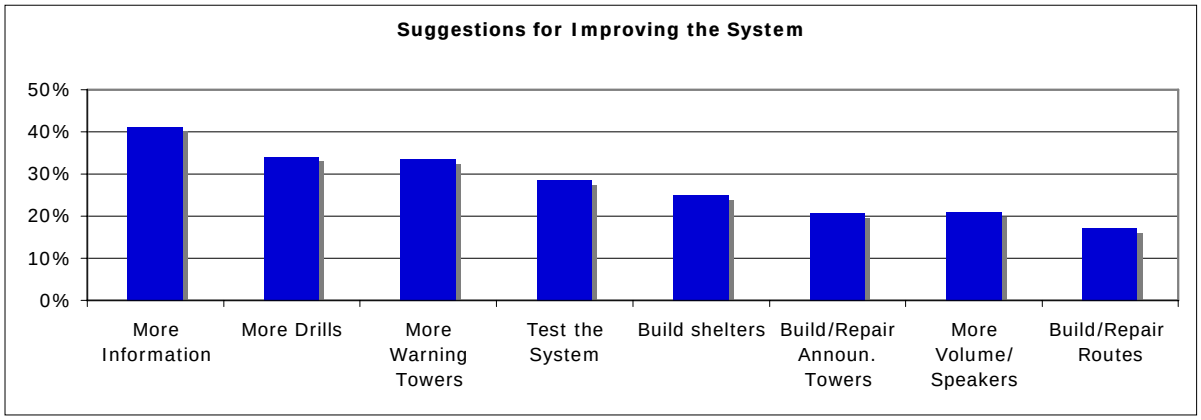


Figure 3. Summary of participant suggestions for improvement of the tsunami warning system

4.4 Drills and Testing of the System

Participants' requests for regular testing of the system were accompanied by requests for regular evacuation drills. Figure 4 shows the number of evacuation drills up to the date the researchers were in each province. Following the end of the field research, there have been additional drills conducted by NDWC and DDPM including a drill in June of 2007 and a planned drill in July 2007.

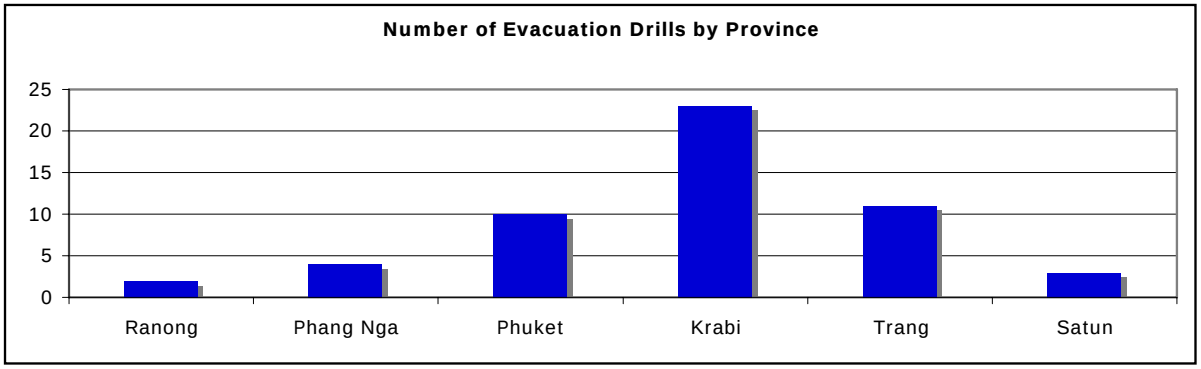


Figure 4. Number of evacuation drills conducted in each province over the period from January 2005 - April 2007

Thirty-four percent of the people surveyed requested regular evacuation drills. Although the frequency of desired evacuation drills varied, on average participants requested drills twice yearly. As of the end of the field research in April 2007, there had been 53 drills. Approximately 13% of the tsunami affected villages having had a practice drill. The number of drills varied dramatically by province with Krabi having the most at 23 and Ranong having the least at 2. In almost all of these drills, the tsunami warning towers were not used.

29% of the people surveyed suggested the need for regular testing of the system so that villagers know it still works. It was suggested that system tests could coincide with evacuation drills or be more frequent. It was strongly recommended that all testing of the system and drills be announced well in advance. Previous unannounced evacuation drills have lead to panic and confusion. In Chalong, Phuket, an unannounced evacuation drill caused people to run leading to injuries and a death. According to participants, when drills are announced in advance they do not cause panic and are well organized.

There was a repeated suggestion that the actual towers be used in the practice drills. As of the date of the research most of the evacuation drills had used either announcement vehicles or the community announcement system to conduct the drills. The reason given for this procedure was the difficulty in obtaining permission to use the actual announcement towers. People would like the towers used so that they become familiar with the sound and will recognize it in the event of a disaster.

Participants expressed concern that some previous drills were poorly attended. Reasons given for this included not announcing the drill well in advance, not announcing the drills to a wide enough audience, and villagers not taking them seriously. Incentives have been provided for participation in some drills.

In eight interviews, village headmen and DDPM officers requested additional funding to allow them to conduct more drills. They felt that their current funds are not sufficient for them to lead drills on a regular basis. According to the DDPM, an average of 75% of districts were developing community evacuation plans. In this study, averages of 73% of SAOs interviewed had disaster preparedness and response plans in place, with large variations by province. For example, 100% of SAOs in Phuket Province report having disaster preparedness and response plans, while only 47% of SAOs in Satun Province have disaster preparedness and response plans (see figure 5).

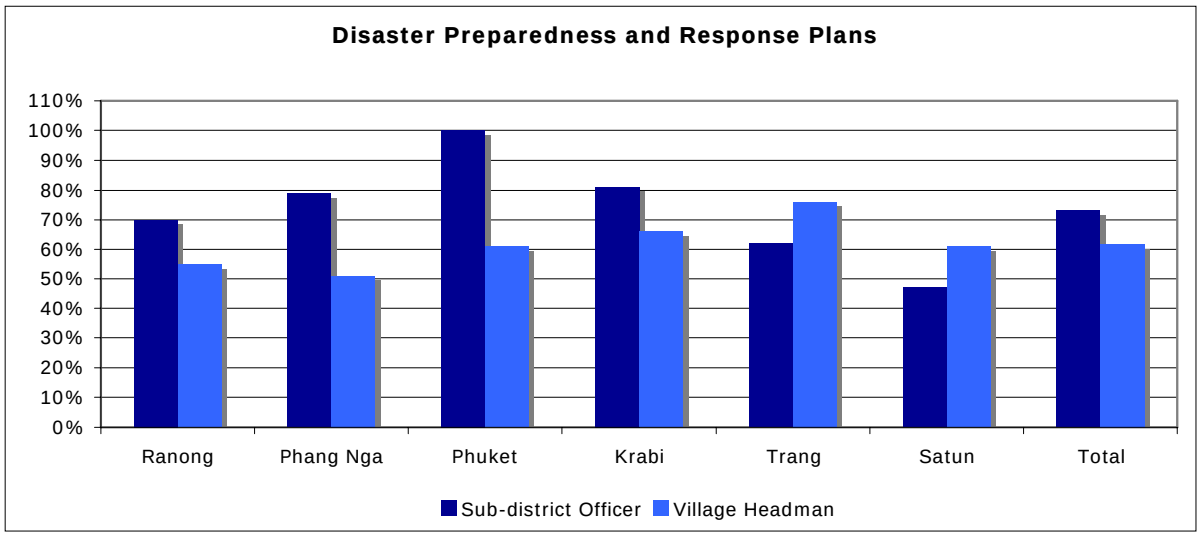


Figure 5. Percentage of village headmen/ SAOs reporting disaster preparedness plans by province

4.5 Evacuation Routes and Shelters

Of the people surveyed, 17% suggested constructing new evacuation routes or repairing the current routes. In general evacuation routes are existing roads in the village. Evacuation shelters are, primarily, pre-existing structures; few shelters have been purposely built for disasters. Twenty-five percent of the people surveyed suggested constructing evacuation shelters.

There are many problems that were identified with the current evacuation routes including size, location, and condition of the route. In many of the villages surveyed there was only one road going from the beach to high ground. There was concern that this road would become quickly congested and could potentially lead to accidents as cars, motorcycles, and pedestrians all attempt to use the same narrow road. Many of the designated evacuation roads were scenic roads which parallel the ocean for several kilometers before turning inland. The distance to a safe location from the beach was a concern for the villagers interviewed.

Several of these roads are dirt roads and are currently in poor condition, leading to concerns about safety in an emergency. Suggestions were also provided that evacuation routes have lit signs to make them easier to follow at night.

Evacuation routes on islands vary depending on the availability of high ground on the island. There were several villages such as Tah Pae Yoi in Phang Nga where the evacuation route is a 25 minute boat ride to the mainland. In two other village interviews, it was suggested that a bridge be built to connect the island to the mainland. There were also requests to build elevated shelters on low-lying islands.

In general buildings chosen as evacuation shelters are schools, mosques, and sub-district offices. Most, but not all, of these are located outside the inundation lines of the 2004 tsunami. Concerns with shelters dealt primarily with their location. Many shelters were located too far away for people to run to and may be located in a neighboring village or, for islanders, on the main land. There were also several designated shelters that were located within the inundation lines of the previous tsunami. In some cases there was no shelter; instead, an area of high ground was designated as the evacuation point. In cases where the shelters were a significant distance away, requests were made to build shelters within the village.

4.6 Secondary Warning Systems

In addition to the tsunami warning tower system, there were a number of secondary warning systems in place that were used to increase the range of the warning towers and to notify villagers of other disasters such as floods and landslides. Some of these systems were in place before the disaster and many were started as a result of the tsunami. The most common alternate warning mechanisms are mobile phones, followed by television, word of mouth, radio, announcement cars, amateur radios, and faxes (see figure 6).

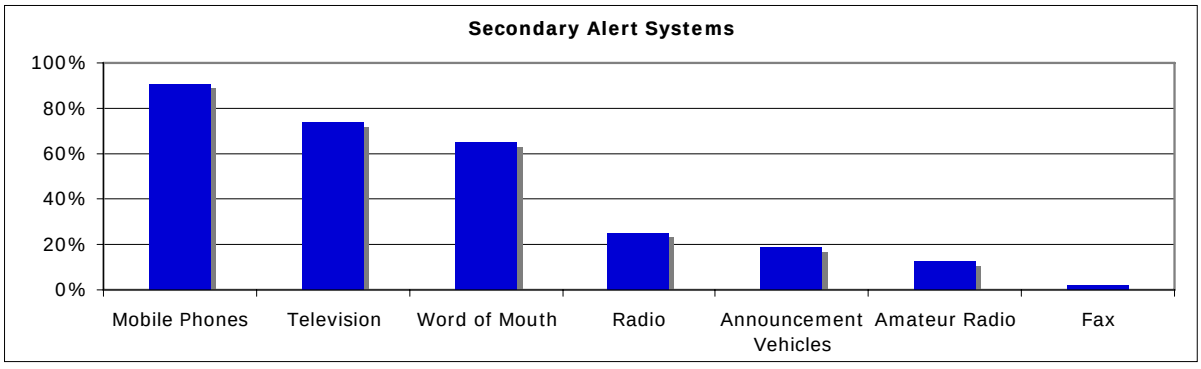


Figure 6. Percentage of participants reporting alternate alert systems in use

The most commonly mentioned methods used to receive and send information on potential disasters were cell phones and text messaging. However, people admitted that this cannot be relied upon in a disaster since the system quickly gets overburdened. Additionally many areas fall outside of cell phone range.

Amateur radios are often suggested as a solution since they can provide two-way communication in a disaster without the system overload that occurs with cell phones. Amateur radios were purchased and used in several of the sub-districts. Choeng Talay Sub-district in Phuket had them in use when the tsunami struck and were able to remain in two-way communication with village headmen. The sub-district officer felt this helped greatly in reducing the fear level and providing accurate information.

Television and radio were mentioned as a way to both hear about potential disasters and as a means of verifying rumors and false alarms. A concern expressed by many villagers on islands or without regular electricity was the inability to receive or verify alerts in the hours when there is no electricity. A number of villagers stated that announcements should be made over television since people trust the television more than the towers.

Announcement vehicles have been purchased and used in several sub-districts. These are generally trucks or three wheeled motorcycles with a public announcement system attached. These systems were often employed in tsunami warning drills or to announce what to do in the event of an emergency. They also play an additional role as a means of transporting the elderly, young, or impaired to the evacuation shelters.

Beach guard towers are warning structures that were installed by the Royal Thai Navy following the tsunami. Beach guard towers are approximately eight meters high and were constructed along the western coast of Thailand as a means of providing a look out point to see ocean hazards approaching the shore. The data suggested that there is no entity in charge of the beach towers; they do not send an alert signal and they are not connected to the NDWC. Most beach guard towers were not manned, and those that were manned were used as lifeguard stations.

4.7 A Need for Information and Training

Information dissemination was the single most recommended method of improving the current system. 41% of those surveyed including villagers, village headmen, and DDPM staff expressed the need for more information and training. With the exception of Phang Nga, which ranked the lowest in availability of information on natural hazards (see Figure 8), information dissemination ranked as the number one suggestion in all provinces. As the interviews were conducted, there appeared to be a marked increase in knowledge and understanding of the warning system and disaster response by people that had received information and training.

The two primary requests for information from village headmen were information on the warning towers and the NDWC system for themselves as well as information on responding to natural disasters for the villagers. There were many instances where village headmen knew little about the warning towers. A common story told was that the headmen were consulted about the location of the tower, but once the system was installed they did not receive any information on how the towers worked or on the NDWC system. There were several village headmen that unaware that their village contained a tsunami warning tower or VHF tower.

Part of the need for information may be related to distribution. Although DDPM officers appear well versed in the NDWC system and local hazards, on average 70% of the SAO offices have received information on hazard risks and 49% of villagers have received information (see Figure 7).

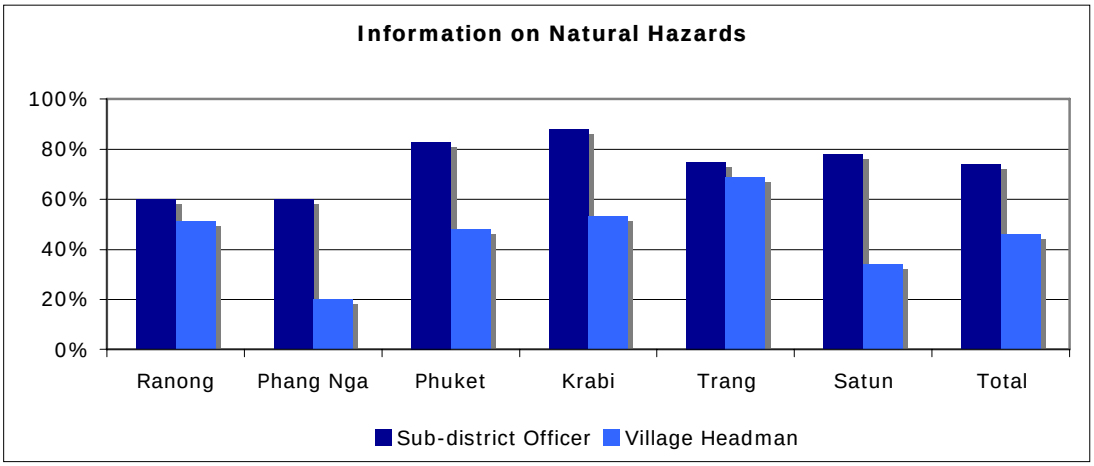


Figure 7. Percentage of village officials reporting receiving information on natural hazards. Comparison of Sub-district officers and village headmen by province.

4.8 Warning Systems for Migrants and Tourists

Surveys revealed participant concern regarding information dissemination to tourists. Although hotels are required to have evacuation procedures, these were general evacuations and not specifically related to tsunamis. There were concerns that some evacuation routes were not well marked and that there was a lack of information for tourists on tsunamis and other natural disasters.

Although there is a large population of Burmese workers as well as Moken populations in the tsunami affected provinces, information on tsunamis and other natural disasters is not available in written Burmese or Moken languages. Additionally, the tsunami warning towers broadcast in Thai, English, Japanese, Chinese, German, and Swedish, but do not broadcast in Burmese or the Moken Language.

During the course of the interviews, when the topic of migrant workers was mentioned the general answer was that the employers of Burmese workers are responsible for their safety. Additionally it was thought that the majority of Burmese spoke enough Thai or English to understand the warnings.

5.1 Phang Nga Province Overview

According to DDPM, of the eight districts within Phang Nga Province, six districts were directly affected by the December 2004 tsunami: Takua Pa, Kuraburi, Takua Thung, Thai Muang, Koh Khor Khao, and Koh Yao. A total of 4,225 persons died in the tsunami; 1,389 Thai, 2,114 foreign, and 72 unidentified people were lost. Thus, approximately half of all tsunami deaths in Thailand occurred in Phang Nga Province.

Date of Survey: October, 2006

37 Villages surveyed
61 Total surveys conducted

WARNING TOWER SUMMARY

17 Warning Towers connected to NDWC
51 km of coastline potentially covered

3 Warning Towers not connected to NDWC
9 km of coastline potentially covered

20 Total Warning Towers
60 Total km of coastline potentially covered

240 km of coastline
25% of coastline potentially covered by tsunami warning system

15 ICT Tsunami Warning Towers
Bak Weep, Village 1
Ban Kayah, Village 2
Khuk Khak, Village 3
La Own, Village 7
Nam Khem, Village 2
Tap Tawan/ Bang Sak Dai, Village 7
Bang Sak Nua, Village 8
Muang Mai, Village 1
Nok Nah, Village 2
Thung Dok, Village 4
Ban Baw Dan/ Nai Rai, Village 7
Khao Lak, Village 2
Tab Lamu, Village 5
Thung Nang Dam, Village 5
Ban Thung Dap School, Thung Dap, Village 1

2 American Signal Corporation Warning Towers
Bang Muang Sub-district
Thung Wah Village 6

3 Grohe Tsunami Warning Towers
Nam Khem, Village 2
Koh Ko Khao Subdistrict
Tah Pah Yoi, Village 2

EVACUATION DRILLS

4 Villages have held evacuation drills
Bang Niang (Takua Pa),
Tap Tawan (Takua Pa),
Tab Lamu (Thai Muang),
Koh Yao Yai (Koh Yao)

COOPERATING ORGANIZATIONS

Organizations mentioned in surveys as assisting with disaster preparedness activities:

DDPM	Rotary
Petchaburi Red Cross (Puen Pah)	Thai Red Cross
GTZ	World Vision

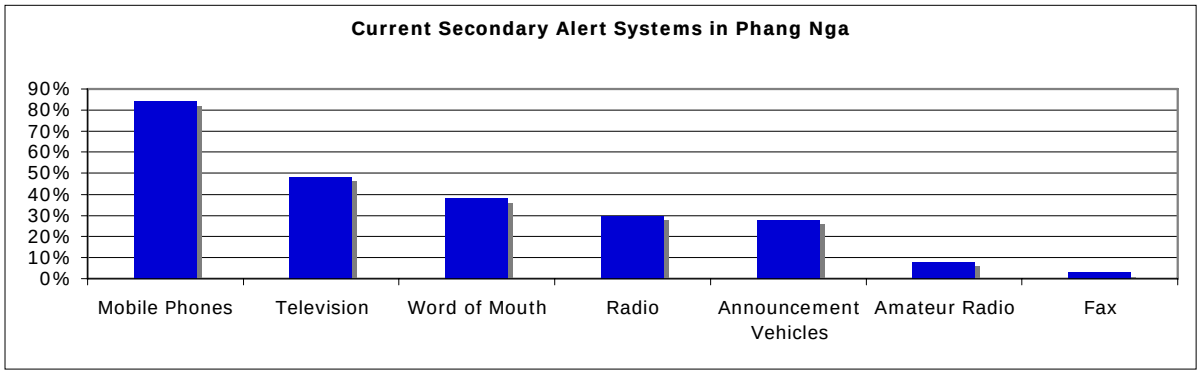


Figure 8. Secondary alert systems currently employed in Phang Nga Province

Mobile phone far outrank any other type of secondary information system. 84% of the people surveyed rely on mobile phones and 48% on televisions (see figure 8).

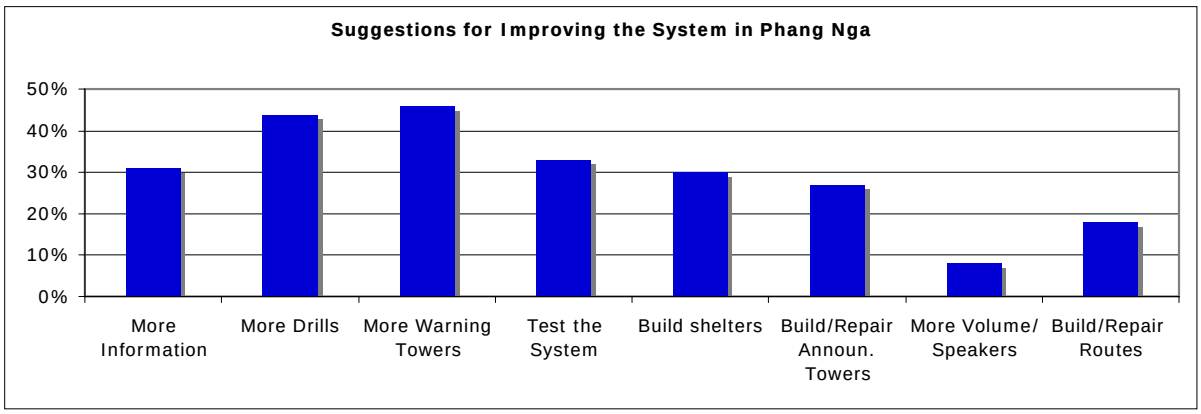


Figure 9. Suggestions from participants on ways to improve the warning system in Phang Nga Province

With only 25% of its 240 km coastline potentially covered by the warning towers and only 4 evacuation drills held, it follows that participants in Phang Nga suggested more warning towers and more drills for improving the early warning system (see figure 8).

An unusual finding was that seven percent of those surveyed requested amateur radios. In Laem Kaen Sub district in Takua Pa, the Sub district Office funded an amateur radio system so that all village

headmen and some villagers owned his or her own personal amateur radio, which are all synchronized to the same station. In an emergency, all of these people will be made aware of a potential threat in real time and can then warn others.

This province has experienced issues with vandalism to the warning towers, in Khuk Khak Sub-district in three different warning towers wires were cut and sold for a reported 13,000 baht. The village headman is requesting that the wiring system be altered so that it cannot be vandalized in the future.

A repeated concern expressed in Phang Nga Province was the lack of electricity, especially on islands. Although it was not a survey question, 6 of the 37 villages surveyed mentioned concerns and problems in early warning systems directly related to a lack of electricity, and four people requested that announcement towers be fitted with solar cells and batteries. These villages either have no electricity or use generators that provide electricity during limited times of the day.

5.2 Ranong Provincial Overview

Ranong has the distinction of being Thailand's smallest province. The region relies heavily upon its coastal geography to fuel its fishing industry; hence, the 26 December, 2004, Indian Ocean Tsunami directly affected Ranong's three coastal districts: Suk Samran, Kapoe and Muang Ranong.

According to the same figures, the tsunami claimed the lives of 159 people in Ranong Province, six of whom were foreigners. Approximately 407 people were injured, six lost and a total of 670 homes were either damaged or destroyed. Excluding damage to outlying islands in Muang District, villages in Suk Samran District, the southern-most district in Ranong, had the highest death toll and sustained the greatest amount of damage in the entire province.

Date of Survey: November and December 2006

37 Villages surveyed
49 Total surveys conducted

WARNING TOWER SUMMARY

7 Warning Towers connected to NDWC
21 km of coastline potentially covered

44 Warning Towers not connected to NDWC
132 km of coastline potentially covered

51 Total Warning Towers
153 Total km of coastline potentially covered

7 ICT Tsunami Warning Towers
Ao Kuey, Village 4
Talay Nok, Villge 1
3 at Nua, Village 2
2 towers not officially on the NDWC list
Had Sai Koa, Village 7
Laem Now, Village 6

There are two additional tsunami warning towers in Kam Puan Sub district. They are located in Village 2 at the Andaman Coastal Research Center for Development. The two towers were installed by the Fishery Department of Kasetsart University in Bangkok. According to the villager from Village 2, the towers are linked to the NDWC, yet the NDWC does not list these two towers as connected to their system.

44 VHF Towers – not all locations identified
2 in Poh Sin Hai, Village 4
3 in Koh Lao, Village 6
1 in La Ong, Village 1
1 in Kah Jud Pai, Village 8
5 in Ao Kuey, Village 4
1 in the national park
1 in Talay Nok, Village 1
1 in Poo Khao Thong, Village 4
1 in Had Sai Kao, Village 7
28 towers, locations unidentified

EVACUATION DRILLS

2 Villages have held evacuation drills
Kam Puan/ Pra Part Beach (Suk Sam Ran)
Muang Glang Sub-district (Kapoe)

COOPERATING ORGANIZATIONS

Organizations mentioned as assisting with disaster preparedness activities

DDPM	USAID
World Vision	La Thai
NDWC	Fishery Department of Kasetsart University

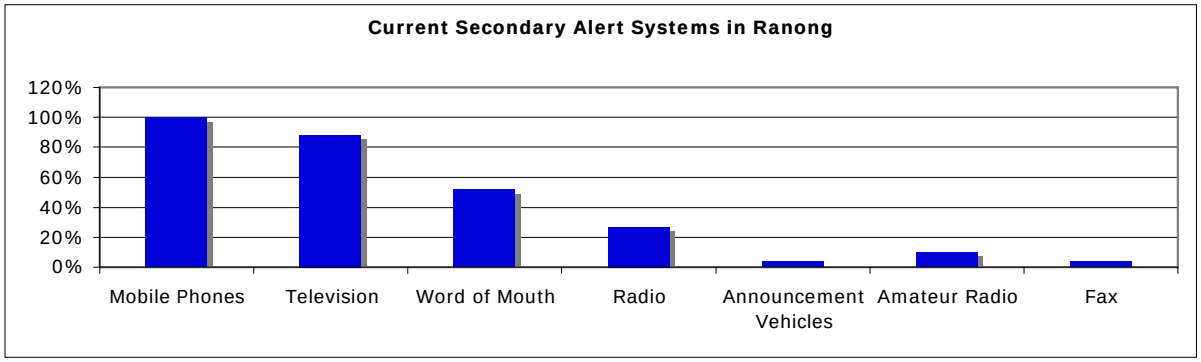


Figure 10. Secondary alert systems currently employed in Ranong Province

Ranong is the only province where 100% of the people surveyed stated that they us their phones as a means of secondary alert.

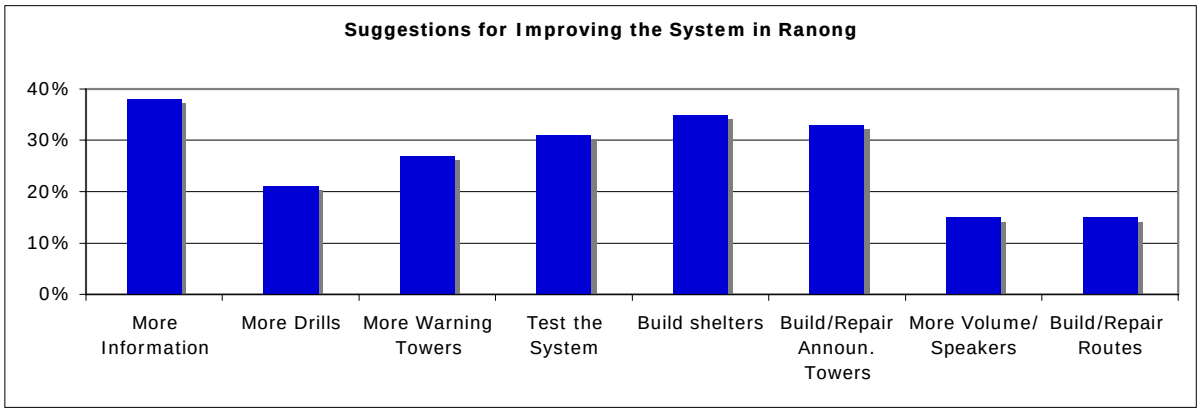


Figure 11. Suggestions from participants on ways to improve the warning system in Ranong Province

VHF towers were erected by the Provincial Office and are now controlled by each respective District Office. According to the Provincial Office, there are 44 of these structures. These towers are connected to a regional radio, which will be broadcasted in the event of an emergency; they are not hooked up to the NDWC. In the majority of villages surveyed, the VHF towers have been heard only one time by villagers, and during that occasion the sound quality was poor and no message could be understood over the static of the speaker. Eight percent of the people surveyed specifically mentioned fixing the VHF towers.

Ranong DDPM is aware of this issue but stated that it currently does not have the budget to fix the towers.

Including the VHF towers, Ranong has 51 warning towers-- only Krabi has more at 60. However, if the VHF towers are malfunctioning, Ranong potentially has the smallest number of functional towers at 7 ICT towers. Village announcement systems had been used in the past to notify villagers of the threat or lack of threat of flooding and landslides associated with heavy rains. This may be a factor that led to Ranong having the highest request for building or repairing announcement towers at 33%.

With much of the coastal area in Ranong being part of a bay with Burma, and because many mangrove forests are intact, people feel relatively safe from future tsunamis. They are concerned about other, more frequent natural disasters such as landslides and floods. This may account for Ranong having the greatest request for evacuation shelters at 35% of respondents.

5.3 Phuket Provincial Overview

The Province of Phuket is Thailand's largest Island comprising 570 square kilometers. The island is located off the western coast of Thailand in the Andaman Sea, connected to the mainland by the Sarasin Bridge. It is comprised of three provinces: Muang Phuket, Kathu, and Thalang; and three municipalities: Nakon Phuket, Patong and Kathu.

Phuket was directly affected by the 2004 tsunami, which claimed the lives of 279 people and caused damage to coastal villages. There were also a total of 1,111 injured and 608 missing. In terms of property damage 742 houses were completely destroyed while 291 homes were damaged. In total 13,065 people and 2,613 families were affected by the 2004 tsunami.

Date of Survey: December, 2006

45 Villages surveyed
61 Total surveys conducted

WARNING TOWER SUMMARY

21 Warning Towers connected to NDWC
63 Total km of coastline potentially covered

0 Warning Towers not connected to NDWC

4 ICT Tsunami Warning Towers
Laem Tuk Kae, Village 4
Rawai Beach, Rawai, Village 2
Koh Loan, Village 3
Chalong Bay

11 PKT Tsunami Warning Tower
Phuket City
Karon Beach, Karon Community, Village 1
Kata Beach, Kata Community, Village 4
Rawai Beach, Rawai, Village 2
Koh Loan, Village 3
Ba Rae, Village 6
Kamala Beach, Nok Lay, Village 3
Bah Sak / Don , Village 4
Mai Khao, Village 4
Nai Yang Beach, Nai Yang, Village 1
Ao Paw, Village 6
Ban Sapan Hin

3 ITV Tsunami Warning Tower
Kata Noi Beach, Khok Tah Nod, Village 5
Nai Harn Beach, Nai Harn, Village 1
Raja Yai island

3 Sircom and Kockum Sonic Tsunami Warning Towers
Patong Beach
Sunset Hotel
Seaview Patong Hotel

The German and Swedish companies privately built the Siricom and Kockum Sonic towers. These towers are hooked up to the NDWC, but can also be locally controlled by the Patong Municipality Office and the Phuket Provincial Operation Center. In order for this to happen, permission must be requested from NDWC. Two of these towers were installed above hotels on Patong Beach while the third is located on the beach in Patong. The structures on the hotel are shorter as they use the building structure for height while the warning tower on the beach is supported by a larger base. The speakers on these towers are smaller; therefore more speakers are used on these towers. Approximately 12 speakers are used on the towers on top of the hotel, while about 24 speakers are hooked up to the Siricom towers on the beach.

Eight towers were tested on February 22, 2006 – 4 ICT towers and 4 PKT towers. The alert was heard but no evacuations occurred. This was a controlled test of the signal; the villagers where informed of this before it happened.

EVACUATION DRILLS AND SEARCH AND RESCUE TEAMS

10 Villages with evacuation drills
- Kamala
- Kathu
- Muang
- Bah Klok
- Wi Chit
- Chalong
- 2 in Mai Kaoh Sub-district
- 2 in Bah Klok Sub-district

In addition, Patong Municipality, the Deputy Mayor stated that evacuation drills were held at schools in 2006.

5 Search and Rescue Teams are active in the Province.

COOPERATING ORGANIZATIONS

Organizations mentioned as assisting with disaster preparedness activities
- DDPM
- Rotary

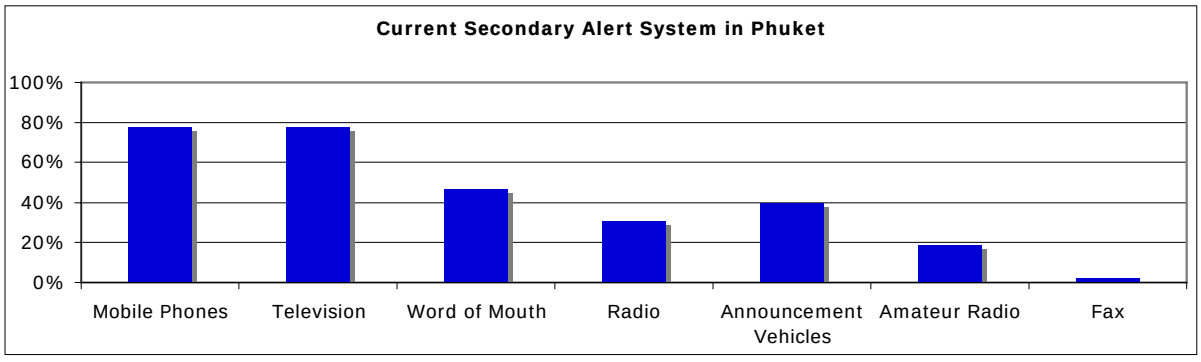


Figure 12. Secondary alert systems currently employed in Phuket Province

Phuket ranked lowest in the use of mobile phones at 78% and highest in the use of announcement vehicles and amateur radio at 40% and 19% respectively (see figure 12)

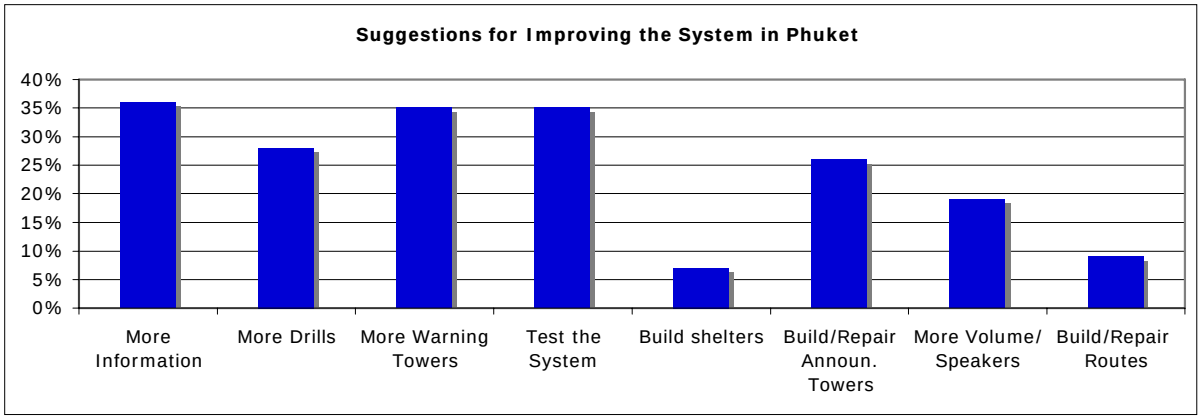


Figure 13. Suggestions from participants on ways to improve the warning system in Phuket Province

With the number of high-end hotels in Phuket, there is a concern that the tower volume is not loud enough. Notably, at the Laguna resort, a warning tower is actually situated directly next to the hotel and yet they cannot hear it inside the building. Hotels have requested making the sirens louder and clearer so they can penetrate the building. There was much discussion by people other than hotel owners about the need to make information available to tourists so that they can evacuate in time if another disaster happens.

When an unannounced drill was held in Chalong sub-district, people panicked. There were numerous injuries and one person died. There was a strong request to pre-warn villagers of a test at least one week in advance of testing.

Three towers have been vandalized in Phuket, as in Phang Nga their wires were cut and sold. The locations of the vandalism were Phuket City, Nai Harn, and Koh Loan.

Phuket Island's western coast is exposed to the open sea while its eastern coast is in a protected bay. In discussing disaster preparedness with SAOs on the east coast, many representatives stated that due to the area's natural protection, disaster preparedness is not the primary concern of the public and that people generally feel safe.

5.4 Satun Provincial Overview

Out of Satun's seven districts and 36 sub-district; four districts, 17 sub-district, and 70 villages were directly impacted by the tsunami. According to figures from Satun's Department of Disaster Prevention and Mitigation, there were six deaths in the province and 3,028 families were affected; four deaths were in La Ngu District and two were in Thung Wah District. There were a total of 21 injuries in Satun.

The 2004 tsunami primarily affected the livelihoods of the inhabitants of Satun Province; 1,653 pieces of fishing equipment and 1,182 floating fish pens were either damaged or destroyed. Also a total of 680 boats were destroyed and 582 Rai of land were affected by the tsunami.

Date of Survey: January and February, 2007

35 Villages surveyed
52 Total surveys conducted

WARNING TOWER SUMMARY

14 Warning Towers connected to NDWC
42 Total km of coastline potentially covered

0 Warning Towers not connected to NDWC

145 km of coastline
29% of coastline covered by tsunami warning system

14 ICT Tsunami Warning Towers
Dan Yong Gling, Village 3
Ra Ya Dod Nui, Village 4
Koh Sah Rai, Village 5
2 on Koh Li Beh, Village 7
Ban Koh Yao, Village 1
Don Yong Gah Boi, Village 2
Ban Thung Rin, Village 1
Bow Jed Luuk, Village 1
Bak Bah Rah, Village 2
Koh Bu Loan School, Koh Bu Loan, Village 3
Bu Boi, Village 3
Rah Wai Nua, Village 4
Ban Ma Ngang, Village 1

Of the 14 warning towers, eight are on islands. There is a desire to build an additional 12 warning towers because it is felt that six towers on the mainland is too few.

EVACUATION DRILLS AND SEARCH AND RESCUE TEAMS

3 Villages have held evacuation drills
Bui Boi Beach, Laem Son Sub district, La Ngu District;
Rawai Beach, Khon Klan Sub district, Thung Wah District
Bak Bah Rah, Bak Nam Sub district, La Ngu District.

The ICT tsunami warning towers were not used in any of the drills. There were a total of three times that people heard the warning tower, depending on when the tower was completed. The first was the accidental warning in December of 2005, a test of the system in December of 2006 and an accidental warning in January of 2007.

5,500 people have been trained in search and rescue techniques.

COOPERATING ORGANIZATIONS

Organizations mentioned as assisting with disaster preparedness activities

- DDPM
- NDWC
- Thai Red Cross

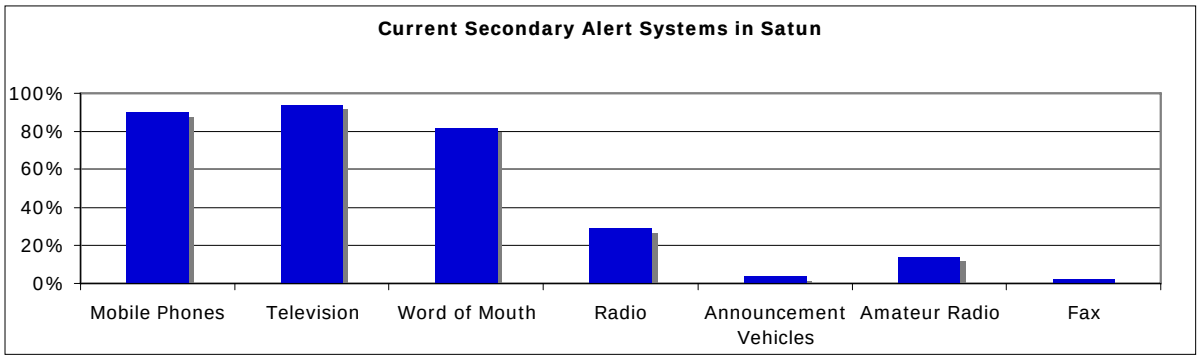


Figure 14. Secondary alert systems currently employed in Satun Province

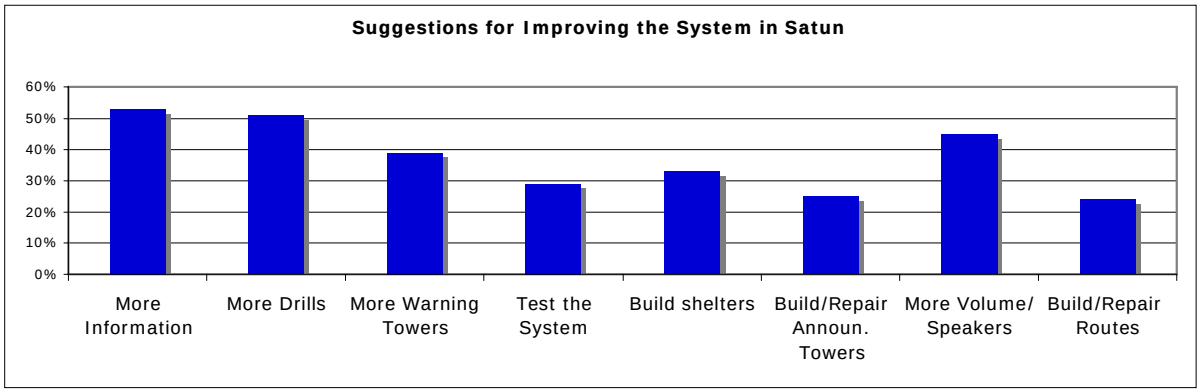


Figure 15. Suggestions from participants on ways to improve the warning system in Satun Province

The Muang Satun District Office has distributed SMS land-line telephones meant to establish a two way communication system between the District Office, Sub district Offices and Village Headmen in the event of an emergency. These devices are currently not being utilized because the people they have been issued to do not know how to use them.

The evacuation routes in most villages appeared in worse condition than in other provinces. Participants from the sub-district offices stated that they did not have adequate budget to fix the roads at the moment, as a large proportion of their budget is spent on buying water during the dry season. Overall, disaster preparedness was not the primary concern for sub-districts in Satun as issues such as water and sanitation were considered to be more pressing.

In addition to evacuation routes in poor condition, Satun also had needs for more adequate shelters. A plan heard in both Thung Bu Lang and Khon Klan sub-districts was that the sub-district would use their office as a meeting point and then the SAO would provide a car to take villagers to safety in a neighboring sub-district. This is because they do not feel they have adequate safety equipment and only a very small evacuation shelter, making it difficult to accommodate all people.

Some locations do not have any evacuation shelter, such as Bu Loan Don Island. Their evacuation shelter is Bu Loan Lay Island. Other evacuation shelters were located very close to the beach and within the inundation line of the previous tsunami. They were chosen not for their location, but because they were a public structure such as a Mosque that could hold a large number of villagers.

In addition there were a large number of villages with broken public announcement systems. Again, inadequate budgets were the primary reason given for the disrepair of the systems. This meant that if another disaster were to strike, there would be no announcement system in place to help notify the villagers in time.

One of the tsunami warning towers, located in Village 1 Pu You sub-district has another problem: its foundation is becoming severely eroded by high tides. Villagers fear the tower will fall over due to the undermining of its foundation.

Disaster preparedness was a concern for the people of Satun. Interviews scheduled with specific community leaders often included twice as many people as requested. Interviews, in Laem Son for example, turned into a sub district conference as over ten people showed up to the SAO in order to discuss and ask questions concerning disaster preparedness. In interviews, people in Satun expressed a large degree of concern over their ability to prepare for future disasters, and one sub-district officer and a village headman request ed psychological support for people as they were still scared from the previous disaster. This was the only province in which psycho-social support was mentioned.

5.5 Krabi Provincial Overview

Krabi Province is located in southwestern Thailand and stretches 160 kilometers along the Andaman Sea, set between the provinces of Trang, Surat Thani, Phang Nga, and Nakhon Si Thammarat. The province is characterized by its array of solitary limestone hills, both on the land and in the sea. There are total of 130 islands that line the Krabi coast; however, only 13 islands are inhabited by villagers.

According to the Krabi Provincial Office, 23,036 people in five districts were affected by the December, 2004 tsunami. A total of 722 people in Krabi Province died, 4,571 were injured and 587 people remain missing. Also, 262 houses were damaged and 662 houses were completely destroyed. Out of Krabi's eight districts, 53 sub district, and 374 villages; 5 districts, 22 sub district, and 112 villages were affected by the tsunami.

In terms of occupational losses, Krabi's fishing industry suffered major setbacks. Again, according to the Provincial Office statistics, seven large fishing boats from Muang Krabi District were either damaged or destroyed and 1,173 small fishing boats were damaged or lost, bringing the total number of tsunami-affected fishing boats in the province to 1,180. A total of 612 tourist boats (long-tail and speed boats) were either damaged or destroyed, bringing the total financial loss of tourist boats to 29,731,280 Baht.

Date of Survey – February and March 2006

32 Villages surveyed
48 Total surveys conducted

WARNING TOWER SUMMARY

30 Warning Towers connected to NDWC
90 km of coastline potentially covered

30 Warning Towers not connected to NDWC
90 km of coastline potentially covered

60 Total Warning Towers
180 km of coastline potentially covered

160 Kilometer of coastline
100% of coastline potentially covered by tsunami warning system

11 ICT Tsunami Warning Towers
- 3 in Ao Nang, Village 2
- Koh Phi Phi, Village 7
- Klong Hang, Village 3
- Koh Kwang, Village 3
- Klong Muang
- Si Raya, Village 2
- Sah Lah Dan, Village 1
- Klong Doh, Village 1
- Ding Rai, Village 5

19 Krabi Tsunami Warning Towers
- Laem Dong, Village 8
- Koh Paw Da, Klong Hang, Village 3
- Tah Len, Village 3
- Klong Prasong, Village 2

Bah Gan, Village 2
Laem Sak, Village 3
Long Sod, Village 1
Klong Nin, Village 5
Klong Dob, Village 8
Sang Gah Ouh, Village 7
Bak Klong, Village 3
Lang Sod, Village 5
Loh Bah Rah , Village 3
Tah Maprow, Village 9
Ma Muang, Village 4
Had Yao, Village 4
Laem Gluad, Village 8
Koh Poo, Village 2
Koh Jum, Village 3

These warning towers installed by the Krabi Provincial Office will officially be turned over to the NDWC in 2007. This means that the Krabi towers can only be set off by the local provincial office, after receiving the approval of the NDWC.

30 VHF Towers

Ao Nang, Village 2
Koh Phi Phi, Village 7
Laem Dong, Village 8
Tah Len, Village 3
Koh Klang, Village 1
Klong Gom, Village 3
Bang Kanun
Klong Muang, Village 2
Ban Gan, Village 2
Hun Kao, Village 1
Ao Nam, Village 2
Laem Sak, Village 3
Thung, Village 3
Tah Klong, location could not be confirmed
Sah Lah Dan, Village 1
Loh Bah Rah , Village 3
Thung Kork, Village 11
Tah Maprow, Village 9
Ma Muang, Village 4
Klong Rua, Village 1
Had Yao, Village 4
Bak Rah, Village 5
Laem Gluad, Village 8
Klong Doh, Village 1
Koh Poo, Village 2
Koh Jum, Village 3
Koh Hung, Village 4
Ding Rai, Village 5
Koh Si Bo Ya, Village 6
Lang Koh, Village 7

Based on the interviews from Krabi, almost all individuals did not know they have a VHF system within their village and have never heard it.

All warning towers installed by the Krabi Provincial Office were tested in November 2006. Government officials were notified of the tower testing, and villagers did not panic.

EVACUATION DRILLS

22 Villages having had evacuation drills
- Koh Phi Phi, (used ICT tower)
- Klong Prasong (used ICT tower)
- Nong Talay (used ICT tower)
- Koh Lanta Yai (used ICT tower)
- Ao Nang (used ICT tower)
- Laem Sak,
- Laem Dong
- Tah Len
- Khao Thong
- Tah Thong Lang
- Klong Muang
- Koh Kwang
- Hua Laem, Village 1
- Si Raya, Village 2
- Jae Lee, Village 3
- Koh Baw, Village 4
- Klong Hin, Village 5
- Klong Nin, Village 6
- Sang Gah Ouh, Village 7
- Klong Dob, Village 8
- Klong Dao
- Laem Gluad,

All warning towers installed by the Krabi Provincial Office were tested in November 2006. Government officials were notified of the testing days before the towers were set off. Village Headmen informed villagers throughout the province about the testing that was to occur.

COOPERATING ORGANIZATIONS

Organizations mentioned as assisting with disaster preparedness activities

UNDP	ADPC
DDPM	Raks Thai

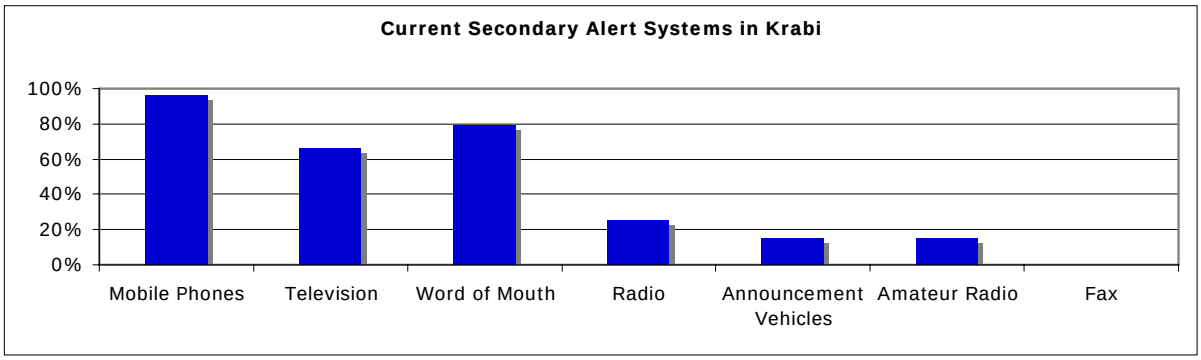


Figure 16. Secondary alert systems currently employed in Krabi Province

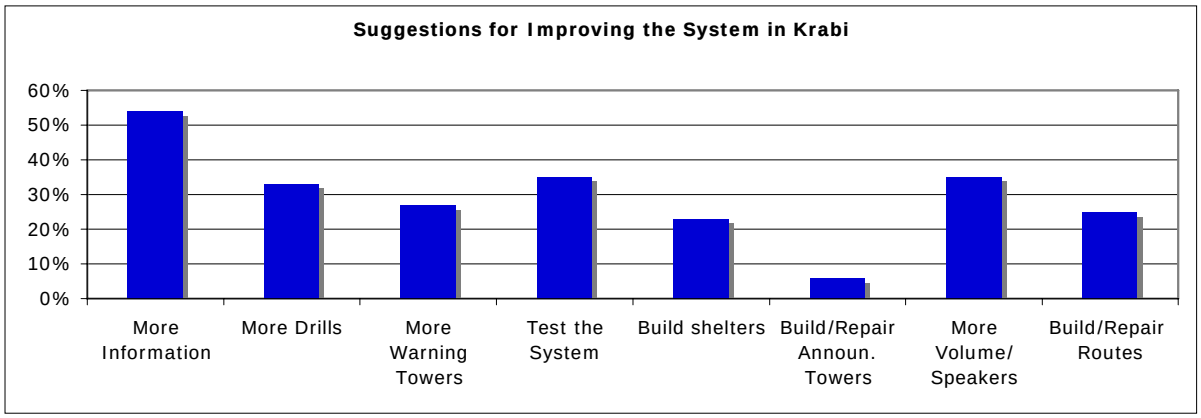


Figure 17. Suggestions from participants on ways to improve the warning system in Krabi Province

Krabi ranks as the most prepared province with the greatest number of warning towers, 60, and twice as many evacuation drills than any other province.

In general, evacuation sites are areas of higher ground rather than actual structures. Koh Prasong Island, which is located approximately two km off the coast of Ao Nang Sub-district, has an official evacuation plan that states that villagers are to go by boat to the mainland. The SAO requested that an evacuation shelter be built on the island.

Landslides are the most frequent natural disaster in the province. Krabi and Ranong are the only two provinces that have installed VHF towers, they are also the two provinces that mentioned frequent flooding and landslides. VHF towers are multi-hazard announcement systems.

The grating from one of the ICT towers was stolen for resale. There is concern about future maintenance as the current responsibility ends in September of 2008.

5.6 Trang Provincial Overview

Of the ten districts within Trang Province, four districts were directly affected by the December 2004 tsunami: Pa Lian, Si Gao, Kan Tang and Had Sam Ran. According to statistical figures from Trang's Department of Disaster Prevention and Mitigation (DDPM), there were five tsunami related deaths in the province, 168 people were injured and one person is still missing, presumed dead. The majority of damage caused by the 2004 tsunami occurred within the livelihood sector, primarily to individual inhabitants of Trang province. The DDPM reported 40 destroyed houses, 162 damaged homes, many destroyed or lost fishing/tourist boats and damage to fishing equipment.

Date of Survey – March and April, 2007

14 Villages surveyed
26 Total surveys conducted

WARNING TOWER SUMMARY

11 Warning Towers connected to NDWC
33 Total km of coastline potentially covered

0 Warning Towers not connected to NDWC

119 km of coastline total
28% Percent of coastline covered by tsunami warning system

11 ICT Tsunami Warning Towers
Laem, Village 2
Lao Liang Nua, Island
Lao Ling Dai, Island
Koh Pe Dra. Island
Laem Ma Kham, Village 5
Bak Meng, Village 4
Had Yao – Joa Mai, Village 6
Pang Ka Bay, Koh Muk, Village 2
Koh Kra Dan, Island
Koh Muk, Village 2
Baan Lang Khao School, Lang Khao, Village 5

EVACUATION DRILLS

11 Villages have held evacuation drills
Ban Nah Sub-district
Dah Sah,
Khao Mai Kaew,
Laem Sia
Laem Ma Kham
Chang Lang,
Nae Lae,
Had Sam Ran Sub-district
Bak Meng
Mai Fad
Bang Sak

COOPERATING ORGANIZATIONS

Organizations mentioned as assisting with disaster preparedness activities

- Mineral Resource Department
- NDWC
- CHARM

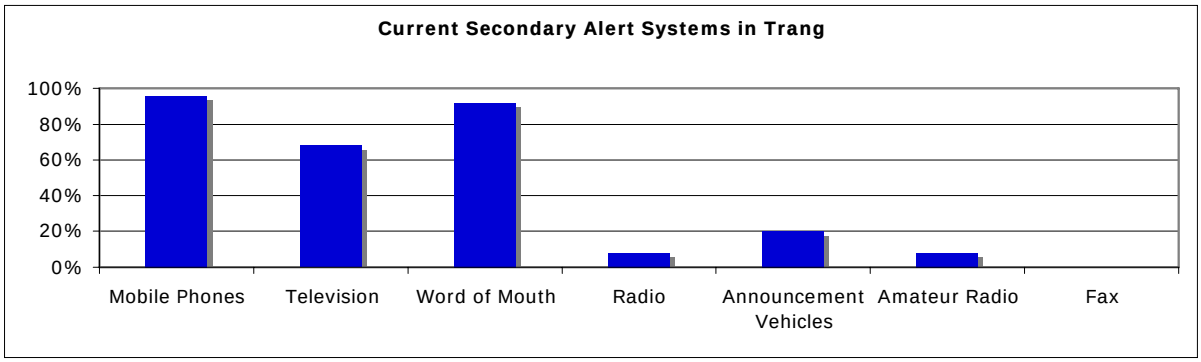


Figure 18. Secondary alert systems currently employed in Trang Province

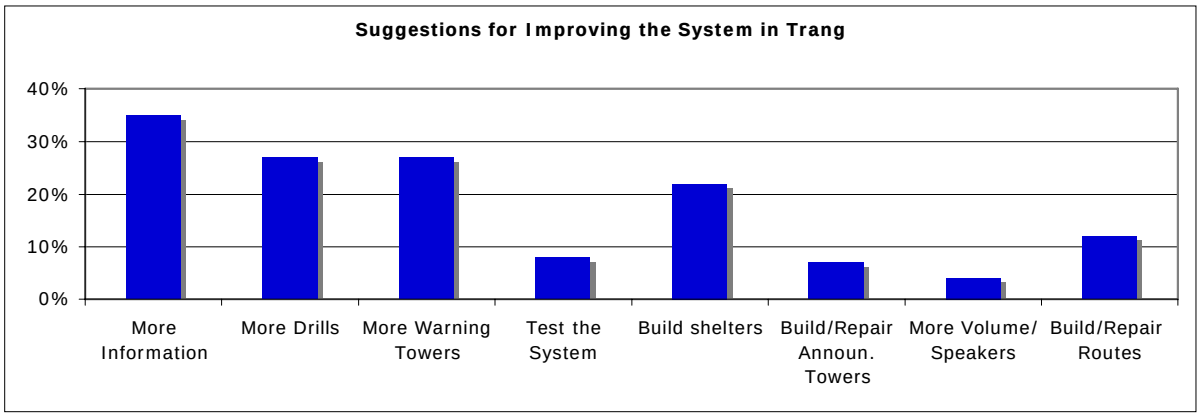


Figure 19. Suggestions from participants on ways to improve the warning system in Trang Province

The warning towers in Trang have never been intentionally set off.

There were originally plans to build nine additional towers in Trang; however, those plans were organized by the previous government in Thailand. As a result of the political coup, the plans to construct these 9 additional towers have been terminated.

Interviews in Trang stressed a need for increased communication between the various governmental departments. This need was mentioned in four different interviews.

6.0 Recommendations and Conclusions

6.1 Recommendations

Based on research findings, we provide the following suggestions to help improve the overall tsunami warning system and increase villager trust in the system.

- Develop procedures by which regular drills and tests can more easily be held to demonstrate to the villagers that the towers will function properly in a disaster.
- Increase the coverage of the warning system either by improving/increasing speakers, repairing community announcement systems, or investing in the development of secondary warning systems
- Test the solar panels on the warning towers and add solar panels to towers that do not currently have them so that warnings can be issued in the nighttime.
- Build evacuation structures for those locations where evacuating to high ground is not feasible, such as low-lying islands.
- Produce and actively distribute educational materials on both the warning system and on preventing and responding to natural hazards
- Improve information sharing between government offices and villagers
- Adapt the system to be used with multiple hazards including landslides and flooding

6.2 Conclusion

General dissatisfaction in the system was based upon negative prior experiences with the warning towers and a lack of regular drills and testing of the system to assure the villagers that in a future disaster they would receive enough advance warning to save themselves and their families. While current satisfaction with the system is low, improvements to the system and information on the how the system works have the potential of significantly increasing villager trust.

The current system needs to be tested regularly to demonstrate that it is still functional. One possibility is to adapt the daily pinging so that is not silent, but instead produces a recognizable sound. Additionally, evacuation drills need to be held in all tsunami affected villages so that villagers feel confident that they know what to do in the event of a future disaster.

Due to the fact that the warning system reaches an average of only 56% of the coastline, future improvements need to address ways in which the coverage area can be expanded. This may include increasing the volume of the current system, increasing the number of towers, or developing secondary alert systems.

Solutions to may of the other concerns outlined in this paper may be as simple as providing additional informational material, fixing local announcement towers, attaching solar panels where needed, and building evacuation shelter for low-lying areas. Addressing villager concerns and needs can potentially greatly improve general satisfaction and trust that the warning system will reach people in time for them to save themselves and their families.