A Guidebook for Local Advocates

Working Draft
Version 2.1

Preparing Your Community for Tsunamis

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Preparing Your Community for Tsunamis:
A Guidebook for Local Advocates

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Cover photo courtesy of Last Mile Operations, www.lastmileoperations.org

Simeulue Island: Tsunami Preparedness Saves Lives

On December 26, 2004 a tsunami, caused by a large earthquake under the sea off of Indonesia, spread throughout the Indian Ocean. It killed more than 230,000 people in Indonesia, Thailand, India, Sri Lanka and elsewhere and destroyed the homes and livelihoods of many more.

That day Simeulue Island, Indonesia was one of the many places inundated with the tsunami's destructive waves. But the tsunami's impact in Simuelue Island was not like what happened in other places: only seven people were killed by the tsunami in Simeulue out of a population of nearly 80,000. Why? Because the island's residents had passed down stories about earlier tsunamis to strike the island, warning people to head to high ground if they felt strong earthquake shaking. Most island residents knew these stories from childhood. When the December 26 tsunami hit, people on the island followed the guidance of these stories and saved their lives.

The earthquake that triggered the 2004 mega-tsunami was centered only 40 kilometers away from the northern part of Simeulue. The first tsunami waves struck the northern coast of the island about ten minutes after the earthquake and caused widespread damage to buildings, which had already been evacuated. In 2004, no official tsunami warning system was in place for Simeulue, or any other part of the Indian Ocean. But even if one had existed, it would have been unlikely to warn the island's residents quickly enough to evacuate people before the first waves struck. Only local awareness of tsunamis and what to do when one might be coming could have saved people's lives.

Young people in Simeulue who survived the 2004 tsunami, standing amongst coral that was raised over a meter above the ocean level by the earthquake that caused the tsunami.

Story source: McAdoo et al.
Photo credit: Kerry Sieh, California Institute of Technology

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Introduction: Preparing Your Community for Tsunamis

This guidebook is designed to help you prepare your coastal community for tsunamis. This goes beyond preparing yourself and your loved ones. It means taking steps to educate your entire community about when and how to evacuate for tsunamis. It means helping your local government to be prepared to mobilize and coordinate evacuations, and it means working to change your community's development, so that tsunamis will cause less damage. It means becoming a tsunami safety advocate.

A tsunami is a series of waves or surges from the ocean that brings strong currents and flood waters capable of destroying everything in low-lying areas of a community. A tsunami can strike any low-lying coastal community, and some communities have a particularly high risk. While it is not possible to prevent tsunamis from occurring, there are many things that communities can do to reduce their harmful consequences and save lives.

Anyone can be an advocate for tsunami safety. Advocates can be government officials, business leaders, members of community organizations, or any concerned citizens. They can be women or men, young or old. People from every segment of society have critical roles to play in tsunami safety. Some aspects of tsunami preparedness generally need to be led by governments, such as developing official warning systems and evacuation plans. Other equally critical preparedness activities can be led by community members outside of the government. These include educating the public about when to evacuate if no official warnings are issued and preparing the studies and community collaboration needed to develop evacuation maps and warning systems that work.

Anyone can be an advocate for tsunami safety, but you need specific knowledge and skills to make a real difference. This guidebook presents a step-by-step approach to learning and using the knowledge and skills you need to be an effective advocate. You do not need any scientific expertise to use this guide. All that is required is a commitment to making your community safer and a willingness to learn.

Someday a tsunami may strike your community. Scientists cannot tell you when this will happen, whether it will be next year or in your grandchildren's lifetime, for example. When that day comes, you want your community to be ready. The most important thing your community should do is be ready to evacuate quickly and safely all areas that could be flooded by the tsunami. This saves lives.

This guidebook introduces you to the basic information you need to know about tsunamis, tsunami risk mapping, evacuation planning, community education, official tsunami warning systems, and reducing the damage tsunamis can cause in your community. It

Every Community Needs a Different Approach

This guidebook presents a step-by-step approach to preparing your community for tsunamis. However, every step may not make sense for your community. The needs of every community will vary based on size, country, economic base and many other factors. And the activities that make sense for you to organize will vary based on your background and skills. If some of the ideas described in this guidebook seem inappropriate or too complex for your community, you should modify them or focus on other activities.

also describes how to plan tsunami safety programs effectively so that people will listen. Each section of the guide points you to sources that provide more in-depth information on topics that may be important to your community.

Communities can survive tsunamis if they prepare. Saving lives in your community depends on the preparedness of its people, government and institutions. National and international agencies can help you to get ready, but activities at these levels will not save any lives if people in your community are not ready to respond when a tsunami is approaching. Coastal residents must take responsibility for their own safety. You can make a difference by becoming a tsunami safety advocate.

Checklist: Preparing your community for tsunamis

- ☐ Learn the basics of tsunami behavior (Chapter 1)
- ☐ Organize your efforts based on what your community needs and on the partners and resources that are available to help (Chapter 2)
- ☐ Make hazard and evacuation maps to guide all of your tsunami preparedness efforts (Chapter 3)
- ☐ Involve the community in tsunami preparedness to educate everyone about evacuations and things they can do to increase community safety (Chapter 4)
- ☐ Learn about what makes official tsunami warning systems effective and advocate to improve your community's system (Chapter 5)
- ☐ Determine whether and how your community can take long-term steps to reduce damage from tsunamis (Chapter 6)
- ☐ Plan now to keep preparedness efforts going long-term (Chapter 7)

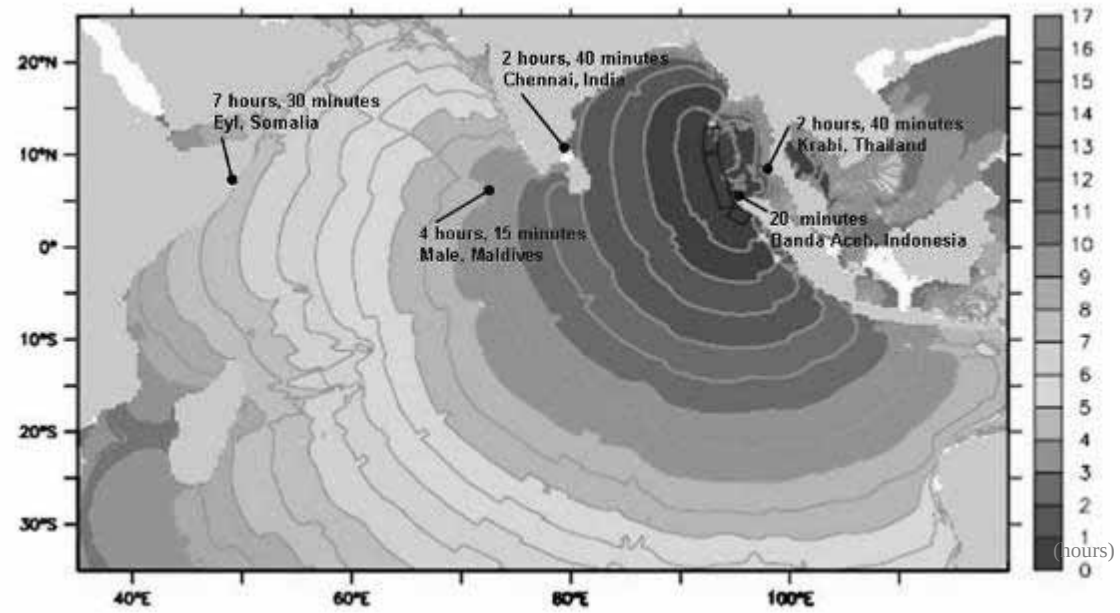
Chapter 1. Learn the Basics of Tsunami Behavior

To be a tsunami safety advocate, you need to know the basics of what tsunamis are, how they are caused, and how they can devastate communities. The physical characteristics of tsunamis have profound implications for how the public and government should plan for evacuations. Learning about the devastating consequences of tsunamis can also be a powerful motivation to prepare for them. It is not, however, necessary to be a scientist or to have a scientist's knowledge to be an effective advocate. This chapter presents the basic information you should know and explains why it is important.

Tsunami Behavior

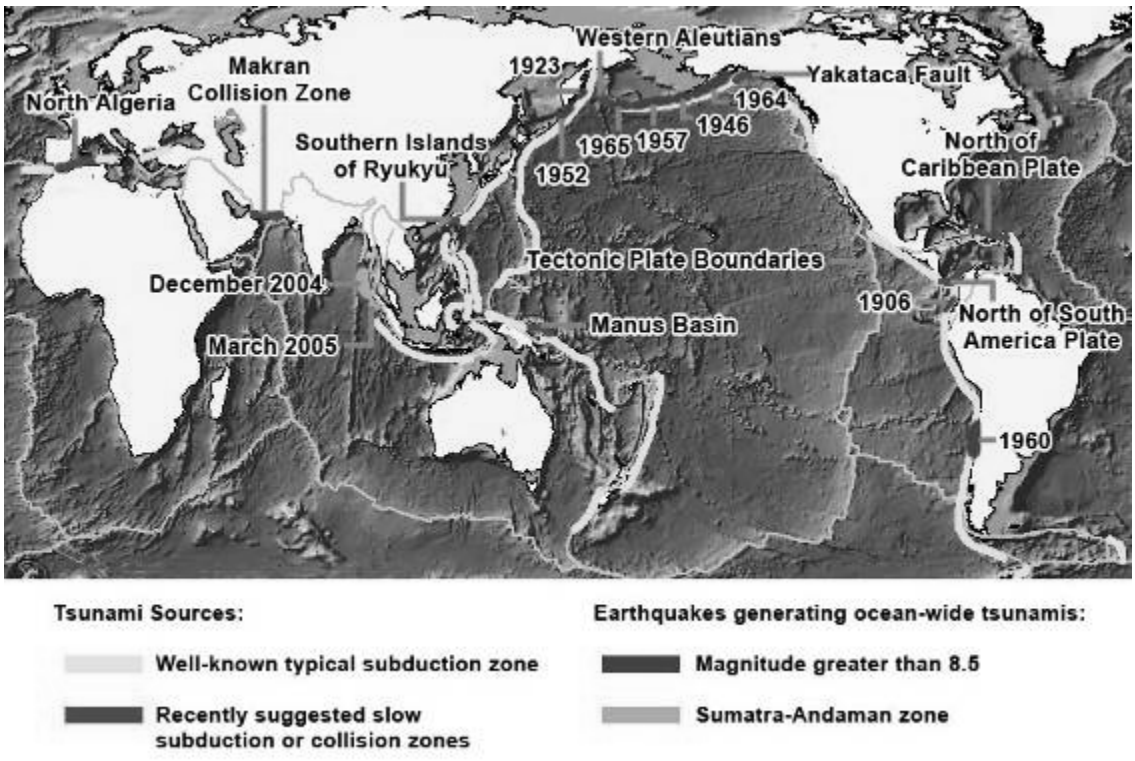
A tsunami is a series of waves or surges caused by a major disturbance in the ocean floor, such as a large underwater earthquake, landslide or volcanic eruption. Tsunami waves are different from large waves brought by storms. They usually look like a surge of the sea inland, rather than breaking waves. Tsunamis bring many surges that can last for hours, arriving every ten to sixty minutes.

Tsunamis usually affect communities close to where the earthquake or other triggering event occurred, but in rare cases they can travel across the open ocean and strike communities thousands of miles away. Tsunamis travel across the ocean at speeds comparable to that of jet airliners, up to 800 kilometers per hour. Tsunamis may hit distant communities hours after they are generated. In these cases there is time to warn the residents of those communities, if scientists detect the tsunami before it strikes. Locally generated tsunamis, however, can strike the shore minutes after they are generated, before official warnings can transmit from warning centers to local warning systems.



This map shows how many hours after the December 26, 2004 earthquake occurred offshore of Sumatra, Indonesia that tsunami waves struck shorelines around the Indian Ocean.
Map source: NOAA/PMEL/NOAA Center for Tsunami Research

Tsunamis can strike any coastal community, but some communities are at particularly high risk because large earthquake faults lie close to their coasts. The map below identifies earthquake zones that are particularly likely to cause tsunamis and shows where some earthquakes that generated significant tsunamis occurred.



Map Source: UNESCO-IOC ITIC

Tsunamis waves are small in deep water and are not visible in the open ocean, but when they reach shallow water near shore they grow in height and can, in rare cases, reach many meters high. The size of a tsunami at the shore depends on the event that triggered the tsunami, on the depth and shape of the local coastline, and on the characteristics of the particular wave. Different communities can experience very different levels of damage from the same tsunami.

Most tsunamis are preceded by one or more of these natural warning signals:

- strong earthquake shaking, particularly shaking lasting longer than 30 seconds,
- withdrawal of the sea to unusually low levels, or
- loud sound or roar from the ocean, similar to a jet airplane, an explosion or a sudden downpour of rain.

Local Tsunamis Are Most Common Killers

Over 90 percent of the casualties and damage recorded from recent tsunamis were caused by locally-generated tsunamis. Locally-generated tsunamis strike communities quickly, usually before official warning systems can call for evacuations.

Source: National Geophysical Data Center

People in low-lying coastal areas should immediately evacuate to higher ground if they observe any of these natural phenomena. They should evacuate without waiting for any official warnings.

Natural Tsunami Warning Signals: Attractions to Those Who Don't Know

On July 17, 1998, residents living near Sissano Lagoon in north-western Papua New Guinea felt a large earthquake. As in many tsunami disasters, people did not understand natural tsunami warning signals and behaved in the exact opposite way they should have: they ran towards the ocean rather than heading for the hills. About 20 minutes after the earthquake, the sea retreated around 70 meters. People walked out on the ocean floor to collect the exposed sea life. Right before the first surge struck, sounds described as jet planes, helicopters or bombs came from the ocean. More people ran to the beach to see what was happening. When the tsunami came, over 2,000 people were killed, more than 15 percent of the area's total population. A few older residents with memories connecting earthquakes and tsunamis survived by heading to high ground after the earthquake.

Source: Dengler and Preuss 2003

Strong earthquakes can cause tsunamis whether they occur underwater or on land. Tsunamis are most likely to be caused by earthquakes with strong shaking that lasts for more than 30 seconds. However, during an earthquake it is difficult for people to keep track of time. A few seconds of shaking may feel like several minutes. The strength and duration of shaking experienced in any community will depend on how close it is to the source of the earthquake and the characteristics of its local soils. Generally, it is best that people be advised to evacuate to high ground whenever they feel prolonged, strong shaking. This may result in some unnecessary evacuations, but will lead to the most lives saved and will help to prepare people for future tsunamis.

Some natural warning signals—particularly loud ocean noises—occur only seconds before a tsunami reaches the shore. Nonetheless, people still may be able to evacuate to safety, if they leave low-lying areas immediately. Often, the first tsunami wave is not the largest one and may cause only minimal damage. Climbing up trees or onto roofs during the first wave may allow people to survive, but they must continue to evacuate after the first wave recedes. People should evacuate to the highest practical local area and remain there, even if early tsunami waves are small.

A tsunami brings many successive waves or surges that strike the coast for hours. The most damaging waves may arrive hours after the first wave strikes. Damaging waves can continue for as long as ten hours. Surges can travel as much as several kilometers up rivers, affecting areas along river shorelines far from the coast. It may take many hours before the sea level and currents return to normal.

Effects of Tsunamis

Tsunami waves travel onshore faster than a person can run. Even surges that look small can be damaging: knee-high waves can have strong enough currents to sweep people off their feet and move cars and small structures. Waves half a meter high can tear buildings off of their foundations. Tsunami waves push inland and then recede back to the ocean with great force. Damage can occur as waves flow in and as they flow out. When the waves recede, the water is filled with debris—parts of buildings, cars, boats, trees, etc.—and people can be swept off their feet, rammed into structures, pulled under the water, or

carried out to sea. Even tsunamis that are not large enough to cause flooding can cause strong currents that destroy docks and rip boats from their moorings.

Tsunamis affect communities in many ways. Currents can carry people or heavy objects, such as parts of buildings and large vehicles, and cause damage by shoving them into other objects. Rising water can drown people and animals. Sea water, often contaminated with human waste and hazardous materials, such as chemicals and diesel fuel, that were spilled by the strong currents, may flood areas of the community for a long time. Fires can start, fed by fuel leaks. When the water recedes, large amounts of sand and other debris cover the entire area that was flooded. The shape of coastlines can change dramatically. If the tsunami was generated by a large earthquake, nearby communities can experience damage from the earthquake shaking and significant and lasting uplift or sinking of the ground. This means that lands that used to be dry may now be flooded by the ocean, or vice versa. Often, nearly all buildings and infrastructure, including roads, power lines, drinking wells, pipelines and everything else, are destroyed in areas inundated by a tsunami. All local industry may also be destroyed: farm lands may be unusable, fishing boats may be destroyed, factories and offices may be damaged, tourism may be stopped. It can take communities decades to recover from major tsunami damage. This is especially true in communities that lose a large percentage of their population—the most vital asset for rebuilding—either through deaths caused by the tsunami or through migration caused by the lack of work in its aftermath.

Tsunami damage in Banda Aceh, Indonesia, 2004

Photo credit: Jose Borrero, University of Southern California Tsunami Research Center

A Survivor's Story: December 26, 2004, Khaolak, Thailand

Karin and I are staring at the TV. The power flickers and we complain. Then we hear some yelling outside. I look outside the front door of our brand new house just 100 meters from the beach. People are running up our street screaming. Then a small line of brown water comes rolling up our street towards us. That's weird. We go upstairs so we don't get wet. We go to the window and try to take some pictures. The water's getting higher and higher, and then it destroys our neighbor's cement bungalow. Then our front door caves in. Then the water's coming up our stairs. This is the last point my brain worked for a long time.

We try to throw a mattress out the window to float on, but the water's rising too fast. By the time we're on our second story roof, the water is coming out the windows. We jump. We're separated. I scream Karin's name until I am hit by something and pulled under. I pull myself up through trash and wood to the surface and off I go. Ahead, a man is struggling in the water. As I float by at 50 kilometers per hour, I realize he is impaled on a piece of wood.

With Karin gone, all I can do now is survive. I swim. I can see the water hit buildings, and then watch the buildings collapse. Massive diesel trucks roll end over end. A car launches through the second story wall of a former luggage shop. I pass a guy, cut on his cheek, holding onto a big piece of foam. We make eye contact and shrug at each other. When I look back, he's gone.

I'm pulled under and my pants catch on something. I decide that this is not the time to die and I rip my pants off. I surface into a hunk of wood and cut my forehead. I'm hit by a refrigerator and pushed towards a building that is collapsing. I swim and swim and I'm still pushed right towards a huge clump of jagged sticks and metal. I'm pushed under, cut my feet, and start to kick. I pop up on the other side, spin around, and am pulled under again. This goes on for a long time. I grab the edge of a mattress and float, tumbling over the edge. I'm sucked under again, and I swirl into a coconut grove.

The water seems to have stopped. I'm not swimming or climbing, but something in between. I make my way to the land. I climb up onto a dike and look around. I scream out for Karin. A small boy in a tree whimpers and I pull him down. We go inland. I had finished my medic training exactly one month before, so I go to work, pulling people out of mud, from under houses. I pull people out of the water, only to have them choke and die. It is beyond any nightmare I ever had.

An older woman comes up to me with a pair of shorts and averted eyes. She is ashamed that I am totally naked. I slip them on. I stumble back down to the town. I find only bodies. One looks like Karin, under some rubble. I pull her out and it's a woman I don't know, still gripping her scooter, mouth agape.

When I find out Karin is alive, I fall apart. She had gotten hold of a coconut tree, wrapped herself around it, and never let go. She has a few bruises and a black eye. I'm ecstatic to see her like that.

The next day I go back to where my house was to survey the damage. The bottom floor of our house is gone. The upper floor is missing a couple of walls. None of our possessions are left.

Source: Paul Landgraver

For web links to more information about tsunami causes, behavior, videos, photographs, computer simulations, descriptions of past tsunamis and survivor stories, visit the GeoHazards International website at:
http://www.geohaz.org/contents/projects/tsunamiguide.html

Chapter 2. Build a Team

Perhaps the most important and challenging part of preparing your community for tsunamis is organizing activities that people will listen to and learn from, despite the many other priorities and concerns of their daily lives. To do this, you need a good team. The most effective thing you can do to make people listen to your tsunami preparedness messages is to involve energetic and influential people in your programs. This chapter discusses whom to involve and suggests ways to get them to participate.

Whom to Involve

People often think of emergency planning and preparedness as the government's job, but the best prepared communities involve every sector of society in disaster planning. Tsunami safety programs need to affect everyone in a community, which requires involving a wide range of people from every element of society in developing those programs. This includes people who represent the most vulnerable sectors of society. Women, children, the poor, and disabled people, all of whom are often neglected in disaster planning efforts, often face some of the highest risks and should participate in designing programs that address their needs.

People whom you should consider involving in your discussions include:

- Local emergency responders: police, fire fighters, medical personnel, and other safety officials
- Emergency responders from higher levels of government: military, departments or ministries with emergency management or response roles, agencies with geology or science expertise
- Local and province-level political leadership: mayors, council members, representatives, etc.
- Local media
- Local community groups with emergency response mandates or expertise, such as the Red Cross/Crescent
- Other government or non-government groups concerned with disasters or disaster mitigation
- Community leaders from low-lying coastal neighborhoods
- Women's groups and representatives of disadvantaged groups likely to be strongly affected by tsunamis (poor, foreign language speakers, disabled, elderly, schools)
- Respected local figures: religious leaders, professors, representatives of professional associations (engineering, architecture, medicine), etc.

Preparedness for Tsunamis Goes Together with Preparedness for Other Types of Disasters

Your community probably faces risk from many types of natural hazards in addition to tsunamis, such as coastal storms, earthquakes, floods, fires and landslides. Many of the steps required to prepare for these hazards also help to prepare people for tsunamis. It makes sense to focus on preparing your community for all types of disasters it could face, especially the most frequent ones. This can help you get the attention of the public and government officials and may improve your ability to get resources. It's important that your community be able to recover from any hazard event that occurs.

- Businesses leaders and representatives from tourism and hotel industries
- Non Governmental Organizations that are active in the community

Involving Respected People Makes a Difference

The right partners can give your tsunami preparedness efforts many advantages:

- *credibility* – involving respected individuals and institutions, or obtaining their endorsement, adds credibility to tsunami preparedness efforts;
- *influence* – involving these individuals can make it easier to change or influence community thinking or policies;
- *access* – involving these individuals creates ties to centers of power;
- *ideas* – involving individuals with expertise on specific topics or particular groups in the community broadens and strengthens your planning;
- *help* – increasing the number of people who can work on preparedness activities; and
- *sustainability* – involving more people means building a support network that survives even when individuals retire or need to turn their attention elsewhere.

Enlisting good partners will help you to find the resources—people, skills, and money—that you will need to prepare your community for tsunamis. Tsunami preparedness campaigns do not need to be expensive, but they do require different kinds of people to spend time thinking about and working on the issue. Many communities have made progress on tsunami safety with efforts led by part-time volunteers. You may be able to identify someone with a paid position—such as a government official or a professor—who can take on advocacy for tsunami preparedness as part of their regular duties.

Ways to Involve Influential People

Respected community members with influence over public opinion or policies are usually busy people, and it may be challenging to get them interested in becoming involved in tsunami preparedness. Some strategies to encourage involvement of good people include:

- Invite them to be members of an advisory committee: Including them in an advisory committee is an efficient way to use their time. It allows programs to benefit from their experience and connections, educates them about tsunami preparedness, and enables them to interact with people on the committee from different fields.
- Invite them to be keynote speakers or give them an award: These honors encourage people to participate in events, while also educating them about tsunamis and efforts to prepare the community.
- Provide them with regular briefings or updates on progress: This builds relationships and keeps people informed. The presence of international visitors from respected institutions, such as scientists or emergency planning specialists, can enable local advocates to schedule meetings with difficult-to-access government officials or community leaders.

- Invite them on trips: These can include traveling to conferences, disaster sites elsewhere in the country or world, and training courses. Travel educates people about the importance of tsunami preparedness, raises their interest in the topic, and takes busy people away from their normal schedules, allowing them to focus on this issue.

Some community leaders may not immediately acknowledge tsunami preparedness as a good thing. Common arguments against preparing for disasters include:

- It will harm the economy because businesses and tourists will be scared away,
- People will panic if this topic is discussed publicly,
- The community is too poor to prepare for tsunamis, and
- There are too many other high priority problems in the community to focus on tsunami preparedness.

Worldwide experience shows that none of these arguments are valid. Some of the world's strongest economies and favorite tourist destinations, such as Hawaii and Chile, have been publicly discussing and planning tsunami preparedness for decades with no harm done to tourism. Hundreds of communities can point to experiences in which openly focusing on how to reduce disaster risk built confidence in their population and business community, rather than causing problems. Poor communities around the world have focused on disaster preparedness: many risk-reducing activities require people-power, not financial resources. And while every community has numerous short-term priorities, it is important to keep in mind that disasters like tsunamis destroy all progress a community has been making in every area. With time and persistence of advocates, community leaders will learn that tsunami preparedness is not just good for the community, it is essential to its long-term health and survival.

KOGAMI: A small group of volunteers makes a difference in Padang, Indonesia

Padang lies on the south-western coast of Sumatra. It is a growing city of 750,000 people. It was not seriously impacted by the earthquake or tsunami that devastated Banda Aceh, many kilometers to the north, but the same fault that generated the tsunami of December 2004 lies off its shore and could send a deadly tsunami heading towards Padang.

A small group of volunteers from Padang, mostly recent graduates from the local university, were working to deliver aid to devastated parts of Sumatra after the 2004 tsunami when they realized the risk facing their own city. They decided to form a group, KOGAMI (an acronym for Tsunami Alert Community, in Indonesian), to help prepare the residents of Padang.

Their efforts started small and grassroots, knocking on doors in at-risk neighborhoods. They were able to get the support of some community leaders, such as professors and business people, and international specialists in tsunami science and disaster planning. Their efforts drew support from local businesses (free office space), UN agencies (funding for signs), and other international organizations. Word of their activities spread. As KOGAMI built successes, local and national government groups became interested in their efforts. They gathered more funding from international organizations. Their work to prepare residents of Padang continues and has expanded to cover communities throughout the province of West Sumatra.

Source: Patra Rina Dewi

Beginning Your Work

Start by gathering a good team and develop a structure that makes sense for your community and the resources available to you. The level of formality and structure of tsunami preparedness teams can vary greatly, from loose networks of volunteers with advisory committees to legally incorporated community organizations. Different organizational forms may make sense at different times during your work.

For web links to more information about organizing disaster preparedness campaigns and groups that work on local tsunami issues around the world, visit the GeoHazards International website at:
http://www.geohaz.org/contents/projects/tsunamiguide.html

Chapter 3. Make Hazard and Evacuation Maps

Most communities find that making tsunami hazard and evacuation maps is the best way to begin preparedness efforts. Tsunami hazard maps show areas that tsunami waters could flood. Evacuation maps show hazard areas and provide information on how to evacuate those areas, such as safe places to congregate. Clear maps defining the tsunami hazard of your community build interest in tsunami preparedness and provide essential support for education and evacuation planning efforts.

This chapter presents the steps necessary to create hazard and evacuation maps. It compares analysis approaches of hazard zones, discusses how to make decisions necessary for evacuation planning, and describes how to get community members involved in this process to develop the maps and plans that will work best.

Purpose of Hazard and Evacuation Maps

Hazard and evacuation maps serve three primary purposes. They:

- Educate and prepare the public,
- Assist emergency responders to plan evacuations, and
- Involve and motivate the public to prepare for tsunamis.

Tsunami hazard maps show areas that could be flooded or inundated by a tsunami. Most tsunami hazard maps show a "worst case" scenario, meaning that they identify areas that will flood if a large tsunami occurs. Evacuation maps show additional information needed for evacuations. This includes:

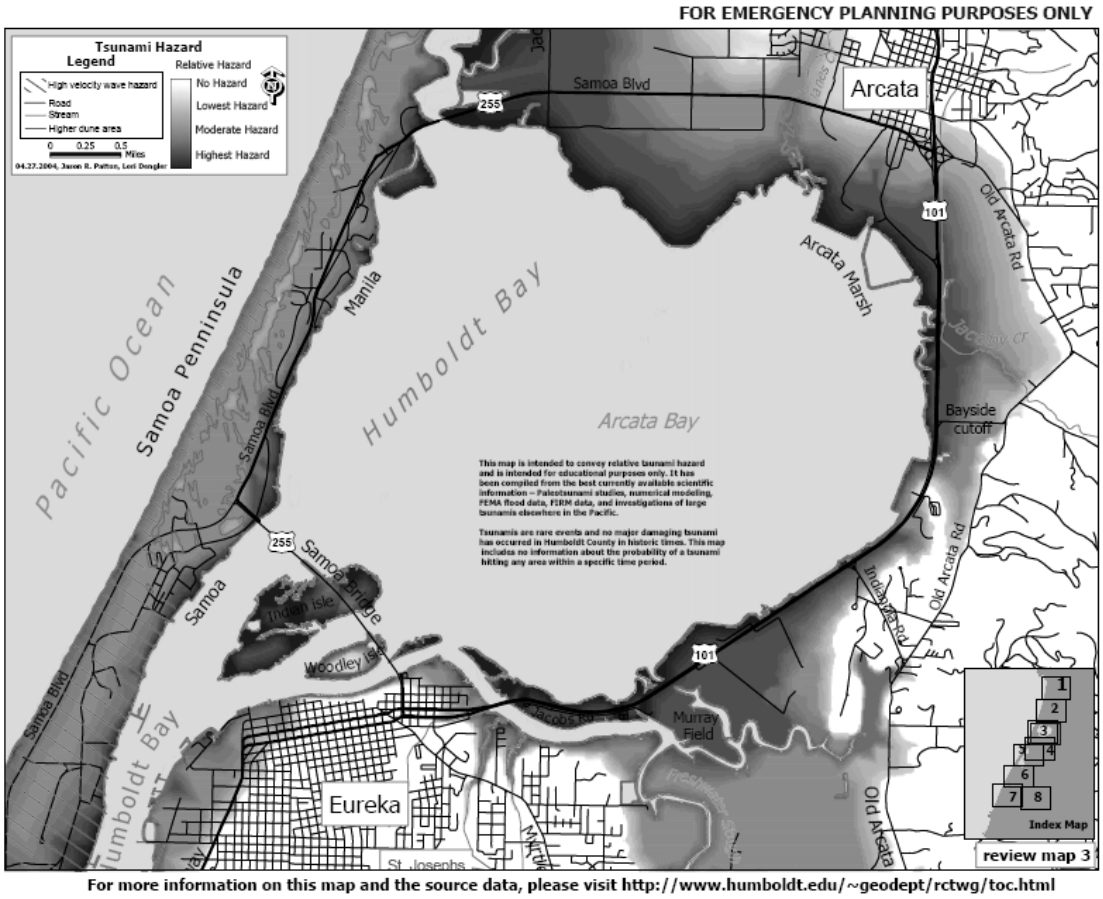
- Areas that are threatened by tsunami inundation,
- Locations that are designated "safe areas" where people should gather during a tsunami evacuation,
- Recommended routes for people to use to get to safe areas from different parts of the community,
- Community landmarks to help people identify locations, and
- Other information about how and when the public should evacuate.

Can People Outside the Government Make Evacuation Maps?

It is critical for government officials to be involved in developing evacuation maps. If they are not involved in your efforts, emergency responders may give the public advice during an emergency that conflicts with the content of your maps. This could cause life-threatening confusion.

People outside of government can lead efforts to develop tsunami evacuation maps, and should do so if the government is not taking this initiative themselves. Try to include government officials in every stage of the process, however. Government should ultimately take ownership of the maps.

If government officials in your community do not wish to participate in evacuation map planning, use hazard maps to educate them about the need to plan for evacuations.



Example hazard map for the cities of Eureka and Arcata, California, USA.

Source: Lori Dengler and Jay Patton, Geology Department, Humboldt State University

Step 1: Develop Tsunami Hazard Maps

There are a variety of approaches to identify areas at risk of tsunami inundation. These approaches vary in cost, accuracy, and in the technical skill and time required to produce them. Some communities will have a lot of information to guide them in this process, such as maps, topographical data, and information about potential tsunami sources. Other communities will need to start from scratch.

It is possible to develop a reasonable, life-saving hazard map for your community, whether or not significant technical and financial resources are available to you. It is most important to develop an evacuation map that is supported by the community and that focuses on the big picture: people need to evacuate low-lying areas. The technical accuracy of your map of the areas that will be inundated by a tsunami can be improved later when resources become available.

This section discusses two methods to determine areas that will be inundated by tsunamis: (A) hazard analysis conducted by experts and (B) simplified hazard estimation. The first method—hazard analysis conducted by experts—produces the most accurate results at the highest cost and takes the most time. The second method—simplified hazard estimation—requires very little expense and technical expertise and produces

acceptable information for evacuation maps, when more advanced options are not feasible.

Method A: Hazard Analysis Conducted by Experts

The most advanced way to know which areas of a community are at risk of flooding and damage when a tsunami strikes is to have specialists develop tsunami hazard maps for your community. There are various technical approaches to inundation mapping, some requiring more data, technical skills and resources than others, but all require the involvement of highly trained tsunami hazard mapping specialists. The data and technical expertise required for inundation mapping are expensive and can be difficult to access. This expense and effort will produce objective and professional results that can increase the reliability and acceptance of evacuation maps.

Tsunami inundation modeling identifies areas at high risk of being flooded by tsunamis by modeling possible sources that could cause tsunamis (e.g., offshore earthquakes or landslides), how the waves will travel from that source to land, and behavior of the wave once it reaches shore. This analysis requires high resolution topography and bathymetry data (elevation data on land and underwater, respectively), and information about potential regional tsunami sources. The outcomes of tsunami inundation modeling are to identify areas that could be flooded and to estimate water depths, current strengths, wave heights, and wave arrival times. Generally this analysis is conducted for a "worst case" tsunami, but it can also analyze the likelihood of tsunamis of various sizes. Emergency managers and decision makers receive detailed technical results that can then be simplified into tsunami hazard zones for evacuation maps.

Method B: Simplified Hazard Estimation

The technical skills and data requirements for hazard mapping by experts may be out of reach for your community at the current time. When this is the case, many communities have found that selecting a reasonable elevation and identifying all areas below that elevation to be tsunami hazard zones is an acceptable and useful way to create evacuation maps. There are a few possible approaches to selecting a reasonable elevation:

(1) Select 10 meters: Most tsunamis have serious impacts only at elevations lower than ten meters above sea level, although it is possible for very large tsunamis to be destructive above this elevation.
(2) Select 3 kilometers inland: The destructive power of a tsunami usually dissipates by three kilometers inland, even over flat ground. This method can be used for communities on flat coastal plains.
(3) Select an elevation based on a prior tsunami: This could be the maximum height of a large historical tsunami in the community or be based on geological evidence of pre-historic tsunamis.
(4) Base on the highest local ground: Identify the highest elevation local areas that people could reasonably reach during an evacuation. Evacuate areas below this elevation.

In addition to areas along the coast, low-lying areas along bays or inlets that connect to the ocean should be designated as hazard zones. Areas along rivers that connect to the

ocean should also be designated as tsunami hazard areas for at least three kilometers inland and as far as ten kilometers inland for large, flat coastal rivers.

If you choose this method to develop hazard maps for your community, it is important to use a process that builds trust and acceptance of the results. This simplified approach can feel subjective and unreliable to important community members if they do not understand the decisions used to define hazard zones, whereas maps produced by experts may be accepted more readily, although these also contain uncertainty and subjective elements. Stakeholders whose trust in and support for these maps is critical to their successful use include emergency responders and scientists or others viewed as expert on tsunami or disaster issues by the community. If these people give public support for the map, most other people will have faith in it. Without the support of key individuals, even the most carefully developed maps will not be trusted and used by the community. Use meetings and small working groups to develop consensus maps that can be supported by key stakeholders, emphasizing that the goal is to create a basis for life-saving emergency planning without the delay and expense required for expert results.

Step 2: Identify Safe Locations

Tsunami evacuation maps need to identify safe areas where people should go if a tsunami is approaching. The key goal of evacuations is to save lives, so any location that is unlikely to be inundated by tsunami waters is an acceptable evacuation location. However, particular locations in a community will be best suited for many people to gather during a tsunami evacuation. Recommended gathering areas should be:

- Out of reach of probable tsunami inundation,
- Reachable by foot by people in the community within a short time period,
- Capable of holding the number of people who will need to evacuate, and
- Easy to identify by community members, such as a school or public market area.

In some communities, there are no natural hills or high elevation locations nearby. Communities with this situation can recommend people evacuate to the upper

Vertical Evacuations

Tall buildings can be used for evacuation in tsunamis if they are well designed and constructed. This is referred to as "vertical evacuation" because people do not actually leave the area at risk of inundation by tsunami. Instead, they climb up to a high story, at least ten meters up, above the tsunami waters.

Vertical evacuation should be used as a last resort. It is always better for people to evacuate the tsunami inundation area and head to high ground. People who evacuate in tall buildings may be trapped after the tsunami in areas that are dangerous to evacuate because they are surrounded by flood waters polluted with hazardous substances and clogged with dangerous debris.

Buildings identified for vertical evacuation should have the following characteristics:

- Designed and built using modern structural engineering;
- Constructed of reinforced concrete or steel; and
- Well maintained, with building materials in good condition.

In areas at risk for earthquakes and tsunamis, it is important that buildings designated for vertical evacuation be designed to withstand earthquake shaking, as well as battering from tsunami waves. Most tall buildings worldwide are built of reinforced concrete, which can have a high risk of catastrophic collapse in earthquakes if not designed and built properly.

stories of tall, well-built buildings, generally to the third story or higher. This is referred to as vertical evacuation (see box on previous page). This strategy is also useful in densely populated cities where the number of people who need to evacuate would overwhelm roads. Building good quality, tall buildings can increase evacuation capacity one building at a time. Communities can also increase their evacuation capacity by constructing other types of evacuation sites, such as manmade hills. As a last resort, people may survive tsunamis by climbing sturdy trees.

In flat coastal communities with no tall buildings or other shelter sites, people should head as far inland as they can. Even if people do not climb in elevation, the impact of the tsunami will be less further inland and people will have a higher chance of survival. People should evacuate a minimum of three kilometers inland; further, if possible.

Step 3: Recommend Evacuation Routes

Evacuation maps and plans should recommend the best routes for people to use in evacuations. These routes should keep in mind where community members are likely to go during an emergency evacuation, and should guide people to the safest and fastest routes. If possible, evacuation routes should be wide streets that can accommodate many people. Avoid roads with traffic choke points, such as narrow areas or complex intersections.

People use common sense when deciding which routes to use to evacuate. Residents are most likely to use the roads that they normally use, those that are most familiar to them. Tourists or visitors to an area are likely to leave a community on the same routes they used to enter. When evacuating because of a tsunami, people prefer to go uphill rather than downhill. Generally this means they will avoid downhill routes even if they are part of the shortest route to a safe, high elevation location. People usually want to walk away from the ocean, even if there are safe, high-elevation locations near the ocean. All of these instincts are understandable, but they may not lead to the safest and most efficient evacuation routes in a tsunami warning.

Communities that face a high risk of tsunamis caused by local earthquakes need to take special care in recommending evacuation routes. Large earthquakes that generate tsunamis can also damage evacuation routes. Bridges

Walking is Best Way to Evacuate

In most communities, it is best if people evacuate by walking and do not use cars or other motor vehicles. When people evacuate by car, it often results in major traffic problems. At best, every person in the community is leaving at the same time, leading to unusually heavy traffic that can cause driving times to be much longer than usual. Traffic can be blocked if one car breaks down, causing gridlock that traps people in their cars in areas that could be flooded by the tsunami. Communities that allow people to evacuate by car need to allocate many emergency personnel to traffic management and should have tow trucks ready to move broken down cars.

There are occasions when evacuating by car makes sense. Evacuations with many hours of warning for a tsunami generated by a distant source may be safely conducted by car. Some small communities that are far from high elevation locations may choose to recommend that people evacuate by car. In every community, some cars will need to be used for evacuations, such as for the elderly or disabled. Buses and other passenger vehicles can be an effective way to move many people quickly out of high risk areas, particularly in densely populated areas.

can collapse and roads can be blocked by landslides. Buildings can collapse, blocking roadways, injuring people or trapping them in high risk areas. Power lines can collapse, blocking routes and causing hazardous conditions. Ideal evacuation routes in these communities have the following characteristics:

- Wide streets;
- No bridges, or bridges determined by structural engineers to be structurally sound to survive earthquake shaking;
- Away from landslide and weak soils; and
- Limited overhead power lines or similar hazards.

Before recommending evacuation routes, walk along those routes yourself to identify hazards and conditions that are not obvious on maps or to drivers but that need to be planned for in an evacuation. Communities can take steps over time to improve their evacuation routes, such as widening routes, removing overhead hazards and reinforcing key bridges.

Step 4: Hold Workshops with Community Leaders

A broad group of community leaders should participate in creating the evacuation maps for your community. This is an important step for several reasons. First, it creates a better quality map by utilizing the knowledge of a wide variety of people. Evacuation maps work best when they are built on community knowledge rather than dictated by people outside the community. Second, it builds understanding of and support for the resulting evacuation map among community leaders. By participating in creating the map, leaders in your community will understand the importance of evacuation maps and will help to make sure they are used. Third, it educates important community members about the tsunami threat and evacuation issues and makes them more likely to help you in other preparedness and public outreach activities.

The best way to discuss evacuation maps is to hold a workshop or meeting where as many important community leaders as you can gather discuss the topic as a group. This workshop might include the following types of people:

- Local emergency responders, such as firefighters and police,
- Neighborhood representatives,
- Representatives from institutions with vulnerable populations such as hospitals and schools,
- Representatives from tourism and hotel industries,
- Representatives of key local businesses, and
- Representatives of local government.

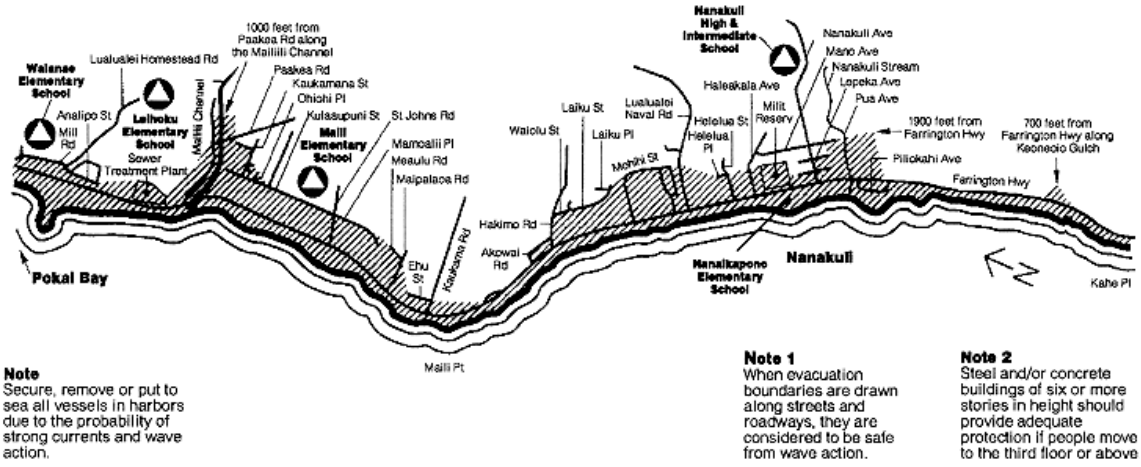
The purpose of this workshop is to present information about tsunami evacuations to a small, knowledgeable group of community members and to identify improvements before presenting maps to the entire community. At this workshop, you might:

- Briefly and without using technical language, present your analysis of areas to evacuate when a tsunami may be approaching;

- Explain characteristics of tsunamis that affect evacuation planning (multiple waves 10 to 60 minutes apart, first wave not the largest, waves cannot be outrun, walking is the best way to evacuate, etc.);
- Suggest possible safe gathering locations and evacuation routes;
- Have the group discuss inundation areas and evacuation issues for different neighborhoods in your community; and
- Reach consensus on evacuation routes and safe gathering locations to recommend to the public.

After this meeting you may be able to organize some members of this group to walk the recommended evacuation routes and further improve them.

Map 16: Pokai Bay to Kahe Point



Example evacuation map from Hawaii, USA. This map appears in the telephone book distributed free to all residents.

Source: City and County of Honolulu Department of Emergency Management

Step 5: Present Information on an Evacuation Map

The final step in creating an evacuation map is to put all of the information about tsunami hazard areas, safe gathering locations, and recommended evacuation routes together on a map. It is important to keep the key purposes of an evacuation map in mind when doing this. The map will serve as an education document for the public. It will also be a planning tool for emergency responders. Both groups should have a voice in how the map looks to make sure that it is useful and understandable to them.

Evacuation maps should be easy to read. The only information the map should show is tsunami hazard zones, safe gathering locations, recommended evacuation routes, and local landmarks to help people orient themselves on the map. Evacuation maps are often simple rather than detailed, precise maps.

The boundaries of tsunami hazard zones are the most important element of an evacuation map. The tsunami hazard zones identified in step one of this chapter probably have a complex, irregularly-shaped boundary. This boundary should be simplified to match recognizable landmarks, such as streets. When simplifying the boundary, it is best to make the tsunami hazard area slightly larger than the analysis indicates.

Tsunami evacuation maps are essential, but some people do not find maps easy to understand, particularly in cultures where maps are not commonly used. Therefore, it can also be helpful to create a description of what the map shows. For example, areas at risk

The state of Washington, USA presents its evacuation maps in pamphlets with basic information about tsunamis and disaster preparedness.

Source: Washington Military Department Emergency Management Division and Clallam County Emergency Management Division

can be described as areas on the ocean side of a particular landmark or major street. Safe areas can be described by landmarks or community names. Signs posted around the community can indicate hazard zones, evacuation routes and safe gathering spots.

Tsunami evacuation maps should be local, not regional. They should cover a small enough area that the landmarks used to identify hazard zones are easy to understand. Maps can include windows to show particular locations at greater detail, if needed. This is often useful for densely populated areas.

Draft evacuation maps should be shown to members of the public and different types of emergency responders for their feedback and improvements. Many communities choose to print their evacuation maps as part of a pamphlet that also includes basic tsunami awareness information.

Checklist: Making an Evacuation Map

Step one: Develop a tsunami hazard map

☐ Select method to identify tsunami hazard zone based on information and budget available

☐ Use your chosen method to identify locations likely to be flooded by a tsunami

Step two: Identify safe gathering locations

☐ Select locations out of the tsunami hazard zone where many people can gather

☐ Identify inland locations at least three kilometers from coast for flat communities

☐ Identify tall buildings within the tsunami hazard zone as evacuation locations of last resort

Step three: Recommend evacuation routes

☐ Identify best routes for people to evacuate the tsunami hazard area

☐ In areas with earthquake risk, identify routes likely to be safe and usable after an earthquake

☐ Recommend whether people should walk or drive to evacuate

☐ Walk along recommended evacuation routes to make sure they make sense

Step four: Hold workshop with community leaders to improve map and build support

☐ Create a draft map with tsunami inundation zone, safe gathering locations and evacuation routes

☐ Invite community leaders to a workshop

☐ Discuss the map and seek comments to improve it and make it more usable

Step five: Develop complete version of map

☐ Include easy-to-understand graphics of tsunami hazard areas, safe gathering spots, evacuation routes and community landmarks

☐ Include basic information on tsunami preparedness and evacuations, as appropriate

For web links to more information about tsunami inundation modeling, topography data resources, and hazard and evacuation maps from around the world, visit the GeoHazards International website at:
http://www.geohaz.org/contents/projects/tsunamiguide.html

Chapter 4. Educate the Community About Tsunami Preparedness

Tsunami preparedness education programs are an important way to save lives in future tsunamis. Education programs are the only way to make sure community members know to evacuate when they observe natural signals that a tsunami is approaching. They also help community members know what to expect from official government evacuation warnings and can encourage people to take steps to prepare for tsunamis. This chapter guides you through focusing your education efforts, creating materials, and conducting education activities that help people to prepare.

Purpose of Community Education

When a tsunami is coming, people may find out about it in a variety of ways. The first signals that a tsunami may be approaching could be natural phenomena, such as strong earthquake shaking or the sea withdrawing to abnormally low levels. Or they may come from emergency responders in the community providing an official warning that a tsunami is likely to hit the coastline (see Chapter Five). Sometimes warnings come from unofficial sources, such as phone calls or news broadcasts.

Disaster Education Does Not Harm the Local Economy

Community leaders often express concern that acknowledging disaster risk and educating people about preparedness will scare businesses away, reduce tourism and lower land values. There is no evidence that this is true. Investors and travelers can find out that your community faces tsunami risk from many sources. Addressing it is likely to reassure them, not to cause fear.

There is ample evidence that disaster preparedness helps communities rebound more quickly economically and socially after a disaster. Avoiding the topic can cause rumors to spread in place of facts.

Public outreach programs are a critical component of efforts to get a community ready to evacuate before a tsunami strikes. The many different ways in which people can be warned about a tsunami can be confusing to officials and the public alike. Education and outreach programs can give people in your community the knowledge and confidence to make good choices about when to evacuate.

Public education planning should be customized for every community. The approach you plan for your community will depend on many things, such as the size of your community, the diversity of its population, the types of people who live and activities that occur in tsunami hazard areas, the current level of community preparedness, and the resources you have available.

Step 1: Focus Your Efforts

Many people and activities in your community are at risk from tsunamis, but you should not try to educate the entire community at once. Education programs are only worth your effort if people listen and respond to them. You

Educating Women Educates a Family

In general, women are more likely to respond to disaster preparedness education than men, especially if they are caring for children.

Source: Enarson, et al.

will have the greatest success in preparing your community for tsunamis if you select one group of people and focus on educating that group effectively. Over time, you can move on to communicate with other parts of your community.

It is important to keep the size of the audience that you hope to educate realistic. Even the best education campaigns will not impact everyone in the community. Focusing on making a real difference within a small fraction of the population is a better approach than spreading efforts too thin trying to reach everyone. The people who learn from your outreach campaigns can encourage others to evacuate during an emergency.

Your public outreach activities can focus on different groups in your community. For example, you may want to focus on educating people who live in tsunami hazard areas, people who work there (such as fishermen), or important businesses that are located there (such as hotels or other businesses catering to tourists). You may want to focus on one hazardous neighborhood.

Focus on People with Influence in Your Community

When respected and influential people in your community take tsunami preparedness seriously, others are inspired to get prepared. It's a good idea to get this type of "inspirational" person involved in your outreach efforts. Who are these people? They're different for every community and social group, but they usually share these characteristics:

- they test lots of new products, approaches and ideas but make careful choices before wholeheartedly adopting them
- they travel to or communicate with places and people outside your community more than most
- they are better off financially than their peers
- they are well-connected with many different groups and people locally
- community members trust them and seek their advice

Source: Everett Rogers

Who should you focus your education efforts on first? Three factors that should help you choose are (1) your ability to influence a group, (2) the ability of the group you educate to influence others in the community, and (3) the tsunami risk faced by the group.

- Your ability to influence the group: Use your energy and time to educate those community members who are most likely to listen to your message. Your ability to influence a group can depend on their beliefs about tsunamis (do they already think tsunamis are a threat?), their cultural beliefs (are there behaviors or beliefs that will make people resist your evacuation advice?), the budget and resources for your outreach programs (can you communicate with this group adequately given the funding and people available?), and their relationship to you (you will be able to communicate most effectively with people if you are part of their group already or if you already have their trust).
- The ability of the group to influence others: Your public outreach efforts will be most influential if they focus on people who, once they decide to evacuate, will be in a strong position to influence others around them to evacuate as well. In every community and social setting these people will be different. These could be

mothers or fathers, community leaders, authority figures, religious leaders, employers or supervisors, or others.

- The group's tsunami risk: People living and working in the highest risk areas—right on the waterfront—are most likely to be harmed by a tsunami. Educating these groups should be a priority.

Step 2: Learn About Your Audience

Your outreach efforts will be most effective if you understand the lives and attitudes of your target audiences. This includes learning about who they are, what their lifestyles are like, what is important to them, and what they believe. Learning about the group you want to educate will allow you to make educational materials and to conduct activities that your audience pays attention to and learns from effectively.

Things to Learn About Your Audience

- Size of and roles in a typical family or household
- Household and work routines and habits
- Levels of education and wealth
- Types of employment
- Ages
- Cultural backgrounds
- Literacy levels
- Volunteer networks or social groups active in the area
- Trusted sources of information, such as television, newspapers, religious leaders, neighbors, etc.
- Information sources they do not use or trust
- How much they know about tsunamis
- What they believe causes tsunamis
- How much they know about when, how and where to evacuate because of a tsunami
- What incorrect information they believe
- How likely and how serious they think tsunamis are in your area
- Whether they have taken steps to prepare for tsunamis or other disasters, such as discussing evacuation issues as a family
- Issues related to tsunamis and evacuation that cause worry or confusion
- Cultural characteristics that make preparing for evacuations difficult, such as religion, gender roles, family structure, hierarchy, fatalism, routines, etc.

When planning public outreach activities, it is helpful to understand that you are asking people to absorb a new idea (tsunami preparedness) and to take action on it. Most people are slow to absorb new ideas and to change how they do things. This involves many steps. First, people learn about a new idea (tsunamis are dangerous). Then they recognize its consequences for their life (a tsunami could hurt *my* family and friends). Then they decide whether to take steps to change, in response to this idea (is it worth my effort to learn about evacuation routes?). If they do change, they evaluate later whether these new changes should become a permanent part of their lives (There was no tsunami this year; is it still important to remember evacuation routes?). When you conduct education programs, your job is to guide people through all of these steps towards accepting a new idea.

People are influenced by different types of outreach approaches at the various stages of adopting a new idea. The most effective way to encourage people to act on new ideas is through personal meetings and discussions with people they respect, such as family members, community leaders, peers, and neighbors.

It is also important to identify the ways that people living in the risk areas use language. Different segments of the population use different words to describe the same things, even if they speak the same language. The words that you use may be different from those used by the audience you want to communicate with. Make sure you use words that everyone understands in the same way for concepts such as *tsunami*, *tsunami waves* or *surges*, *hazard zone*, *safe areas*, *warning*, *evacuate*, etc.

There are many ways to learn more about your audience, including to:

- Conduct interviews: talk with different types of people living in high risk areas (women and men, different social groups, different levels of wealth, levels of education, etc.)
- Observe people: understand their routines, practices, who makes decisions within the group, etc.
- Use questionnaires: Questionnaires provide a structured and consistent format for interviews.
- Speak with people who have conducted other types of education programs in the community, especially successful ones. These people could be in very different fields, such as health or sanitation, but their insights about how to get people to pay attention to education programs have value.
- Conduct focus groups: Get a small group (8-10 people) of people in your target audience together and have a moderator guide them through a discussion about issues you want to understand better.

Step 3: Make Basic Outreach Materials

You will need some materials explaining the basics of tsunami preparedness to use in your public outreach activities. You might want to present this information in a variety of forms suited to the different activities that you conduct. Many communities have found a versatile public outreach tool to be a pamphlet or flier that contains your community's tsunami evacuation map, along with basic information about tsunamis and evacuations. This pamphlet can be adapted into many other forms—presentations, web pages, etc—as needed.

Use a Group to Create Materials

Developing your outreach materials with a group, such as an advisory committee, has many benefits. It:

- Creates a better product by including the viewpoints of people with knowledge of different aspects of the community
- Helps educate all group members about tsunamis and evacuations and builds their enthusiasm for educating the broader community
- Builds group cohesiveness that can help in all of your tsunami preparedness activities

Outreach materials should be developed for each community you focus on. People will pay most attention to local information. The goal of the materials should be to get community members discussing tsunami issues and thinking about how they relate to their lives.

To develop outreach materials, you need to decide on the information that you want to share with people and how to present that information so that people will respond to it. After developing your materials, it is helpful to test them on a small portion of the audience, to see if people understand and respond to them in the way that you intend.

The Substance of the Message

The most important information to share with your community members is which areas have high hazard of being flooded in a tsunami. People are most likely to evacuate if they believe they live in a high hazard location. This factor seems to be more important than how much people know about disasters or how well they have prepared. This is why community maps showing areas that are most likely to be flooded in a tsunami are an important part of any outreach campaign.

Another critical piece of information to share is a list of natural tsunami warning signs. Natural warning signs are often the *only* warning of a tsunami that communities receive.

It is also important to include basic information about tsunami evacuations: who should evacuate, when they should evacuate, how they should evacuate, where they should evacuate to, and what they can expect next. Other information, such as the causes of tsunamis and ways to reduce tsunami damage may make sense to include, as long as the information does not distract people from the critical information about evacuations. See the box on page 28 for an overview of basic information that the public should know about evacuations.

Your outreach materials must include local information, such as local maps of areas that could be inundated and identification of important community buildings and infrastructure in these areas. Recommendations about evacuations should mention as many local locations and concerns as possible. Focusing on local information, rather than tsunami issues in general, will make people pay attention to your outreach materials.

Some additional information useful for specific audiences is described below.

- Families: Tsunamis can happen at any time of day or night, and it is critical that all family members know exactly what to do if an evacuation warning occurs when they are at home, work, school, shopping or anywhere else. Family members need confidence that their loved ones know what to do during an evacuation, before they can focus on their own safety. Families should be encouraged to develop a family emergency plan. This should include choosing a specific safe location where everyone will meet if they are separated at the time that the evacuation occurs. Parents need to know whether their children in school will evacuate on their own, or if they need to pick them up and evacuate with them.
- Tourism Industry: Many seaside towns have lots of tourists. These out-of-town visitors will know nothing about local tsunami warning systems or how to reach high ground and safe areas. The staff at hotels, tour companies, beachside restaurants and other businesses that rely on tourists should be trained to mobilize tourists when a tsunami strikes.

- Fishermen and Boaters: Tsunamis are barely noticeable in the deep ocean and only become destructive near shore. Boats that are at sea when a tsunami is coming should stay in water at least 100 meters deep until the tsunami is over and currents have calmed in harbor areas. Boats in harbor may want to head out to deep ocean if there are hours of warning before the tsunami strikes. If a tsunami is caused by a nearby source, such as a locally felt earthquake, there is no time for boats to launch to safety in the deep ocean.
- Schools and children: Teaching schoolchildren about tsunamis and tsunami preparedness can be an excellent way to reach a large portion of the population, particularly if programs are continued for many years. Schools should make their own evacuation plans, and teachers and administrators must know about warning signals to evacuate for a tsunami. Schools should inform parents about what the school will do in case of tsunami. Schools can play a useful role in educating the broader community about tsunamis by involving parents and others in discussions about school evacuations. Tsunami education programs can be incorporated into other safety education programs, such as preparing for fires, earthquakes, or floods.
- Foreign language speakers, minority culture groups and the illiterate: Education materials should be presented in all of the major languages spoken in the community and should cover immigrant populations as well as locals. Picture-based materials can be used to communicate with groups with low rates of literacy. Non-native language speakers especially need to be educated about warning signals for evacuation because they may not understand evacuation warnings that are communicated in the local language.
- Elderly, Disabled or Ill: Many people in the community may need help from family members, neighbors, or officials to evacuate. They may suffer from hearing loss that makes it difficult to hear evacuation signals. They may require medical equipment or medicines to survive, and those things need to brought with them during an evacuation.
- Hospitals, Jails, and Other Institutions: Institutions such as hospitals, jails, homes for the elderly, mental hospitals and other facilities that house people who are not able to be responsible for their own evacuation in a tsunami need to make special preparedness arrangements. Education campaigns geared towards these groups should focus on training management and staff. The goal should be to get these institutions to create facility-specific disaster plans and to practice evacuation exercises regularly.

School Lesson Saves Lives: Tilly Smith's Story

Tilly Smith, an eleven-year-old from England, was vacationing with her family in Thailand in December, 2004. Just weeks before this trip, she had learned about tsunamis in geography class and her teacher had shown the class a video of a tsunami striking Hawaii. On the morning of the 26th, she noticed that the sea was behaving strangely and was reminded of the video she had seen of a tsunami in Hawaii. She became very concerned and convinced her family to evacuate the beach. Her father told a local security guard about Tilly's concerns and many other beachgoers were convinced to leave the beach before the tsunami struck minutes later. Tilly's memory of her geography lesson, and her ability to convince her parents to believe what she had learned, saved about 100 lives.

Source: BBC

Basic Information the Public Needs to Know About Tsunami Evacuations

Who Needs to Evacuate?

- Anyone in a tsunami hazard zone as identified by local maps or officials needs to evacuate.
- People not in a hazard zone should stay where they are.
- Families should discuss evacuation so that every member of the family knows to evacuate, even if the family is not together at the time a tsunami warning occurs. Families should identify a safe location where everyone will meet after they evacuate.
- People should not stay in hazard zones to watch the tsunami. Even the strongest swimmers cannot swim against currents in tsunami surges. The waves travel at speeds faster than the fastest runners. Tsunamis cannot be surfed.

When Should You Evacuate?

- If a natural tsunami warning signal is observed, evacuate immediately without additional warning. A tsunami surge could arrive in minutes. Natural tsunami warning signals include:
  - Strong earthquake shaking that makes it difficult to stand and/or that lasts more than thirty seconds.
  - The ocean rapidly withdraws to abnormally low levels, lower than the lowest tide.
  - A loud noise or roar from the ocean like a jet airplane, a sudden downpour of rain, or explosions.
- Evacuate when warned to do so by your community's official tsunami warning system. Know the signals that officials in your community will use to warn about an approaching tsunami.
- If you hear a tsunami warning from an unofficial source, such as the media or family members, know where to go to get more information to confirm that evacuation is necessary.
- Listen for and follow instructions from local authorities.

How Should You Evacuate?

- Usually walking is the best and fastest way to evacuate. Know what types of transportation local authorities recommend.
- Wide routes are the best choices for evacuations. Know whether local authorities recommend specific routes.
- People with special needs, such as the handicapped, elderly or ill, need to make special plans for their evacuations.
- Bring only immediate essentials (e.g., medicine) that you can carry.

Where Should You Evacuate To?

- Evacuate to the highest available ground nearby, outside of the tsunami hazard zone. Know locations that local tsunami hazard maps identify as safe gathering spots.
- Some communities will designate the upper stories (third or fourth floor and higher) of certain tall, well-built buildings in the tsunami hazard zone as last-resort evacuation sites. It is always better to leave the tsunami hazard zone entirely, if time permits.
- If there is no high ground nearby, evacuate as far inland as possible. Even without climbing in elevation, it is safer farther from the coast.
- Tsunamis bring many successive waves, and the first wave is usually not the largest. Continue to evacuate to high ground even if the first tsunami wave is small.
- If you cannot reach a safe location in time, people have survived tsunamis by climbing tall, sturdy trees, climbing onto rooftops, or riding on a floatable object.

What Happens After You Evacuate?

- Stay in a safe location until authorities say it is safe to return. Tsunamis can last for many hours.
- Areas flooded by tsunamis can contain lethal debris and be contaminated by hazardous materials. Do not enter flooded areas.
- If no tsunami occurs after you evacuate, wait until authorities say it is safe before you return. There are no unnecessary evacuations. It is always best to evacuate if you observe any type of warning signal.

Presenting Your Information

The way that information is presented affects how people respond to it. Your materials should be simple and easy to understand. They should use language that anyone can understand, not technical language or jargon. Your materials should use a simple design. Use photographs, drawings and maps to make them attractive and leave some empty space on pages to make them easy to read. The most important information in your materials should be easy to find. Limit the amount of scientific and technical information included in basic education materials, to avoid overwhelming people.

Borrow and Adapt Materials from Elsewhere

Many countries and communities have tsunami preparedness materials that could be a good starting point for materials for your community. It is critical to adapt these materials to reflect your local culture, making changes such as changing illustrations to look like people in your community and carefully editing the language to reflect local beliefs, behavior, and conditions.

Outreach materials should focus on motivating people to prepare for tsunamis. They should focus on telling people what they can do to protect themselves. Tsunamis are frightening, but scaring people is not an effective way to motivate emergency preparedness. Avoid using descriptions of large death tolls or photographs of frightened people.

The way you design your outreach materials can impact how credible people find them to be and, therefore, whether they believe and respond to them. Highlight the involvement or endorsement of trusted community groups and individuals in your tsunami preparedness efforts. Make sure the information that you present is accurate. There will always be uncertainty in tsunami information, including where and when a tsunami will hit. Be straightforward about exactly what is known about tsunami risk and what is not known. Most people will accept that information is imperfect. Do not make the risk sound less or greater than it is. Keep the information you present as consistent as possible. If people hear multiple, differing messages—especially if they hear conflicting stories among "experts"—they may become confused and disregard all of the information.

Testing Your Materials

When you have draft outreach materials, show them to potential members of your audience to get their feedback. Some questions you might ask include:

- Do people understand the words you are using in the way that you intend them to?
- Do they understand the main points you are trying to make?
- Does anything in the materials confuse them?
- Do they react to the message positively?
- Do they find it credible?
- Do they find it interesting?
- Can they remember what the message was about later?
- Do they find the message relevant to them?

Adjust your materials based on how people respond.

Step 4: Conduct Community Outreach Activities

The most important things to remember when designing community outreach activities are to keep events small and focused on local concerns. Encourage community members to participate through providing a range of activities, questions and discussions. People learn better through activities and tend not to learn much from lectures. Activities should be led, whenever possible, by people who are from or who are well-known in the local community where you are focusing.

There are many ways to educate members of your community and to involve them in tsunami preparedness activities. It often makes sense to combine discussions of tsunami preparedness with discussions of other types of natural hazards, particularly the most likely ones to strike your community. Some examples of activities or methods you could use to educate your community and motivate them to prepare include:

- Community meetings
- Workshops for tourism-based businesses
- Workshops for the fishing industry
- Workshops for media
- Emergency planning for schools
- Emergency planning for hospitals
- Emergency training for employees the tourist industry
- Community evacuation drills
- School evacuation drills
- Student safety clubs
- Neighborhood preparedness teams
- Rallies or marches for preparedness
- Displays or programs at community fairs and festivals
- Presentations to community clubs and organizations
- Street theater/puppet theater
- Discussions/lectures by tsunami survivors
- Tsunami signs
- Memorials to past tsunamis
- Door-to-door education campaigns
- Publicly visible evacuation maps
- Newspaper articles
- Radio or television documentaries or news features
- School curricula covering tsunami preparedness
- Web pages
- Disaster risk information center

This section describes a handful of activities that have been used in communities around the world. Some of these ideas focus directly on educating the public about tsunami evacuation procedures. Others are more subtle approaches to remind people continually that tsunami preparedness should be an ongoing part of their lives. All of these activities can spark community discussions that encourage people to understand the tsunami threat in their community and be ready to respond to it. These activities can include many types of community members: children, the elderly, women and men. Involving a wide cross-section of people will help everyone in the community to understand and take ownership of their neighborhood's risk and what they can do to be ready for it.

Sample Outreach Activity: Community Meetings

Public meetings or forums are a good way to introduce the topic of tsunamis and evacuations to people in your community. Organize a number of these events in different parts of the community. Invite a panel of knowledgeable speakers to present information to the public, such as a geologist who can explain the tsunami threat and local emergency responders who can discuss evacuation issues. Present basic information on what tsunamis are, where the hazardous areas are located in your community, and what the public needs to know about evacuating (see box on page 28). Make sure these events are not lectures. Actively engage the community with questions, discussions, and activities, such as figuring out a safe evacuation route from their homes, businesses and schools. Distribute evacuation maps to everyone who attends.

This type of event educates the public and builds relationships and trust between the public and people working for tsunami safety in your community. You may identify people at these events who want to join your efforts to help prepare the community.

Make Evacuation Maps Easy for the Public to Find

Evacuation maps should be readily available to anyone in your community who wants one. Fliers with evacuation maps can be left in public places, government offices, or local businesses, free for people to take. Posters of evacuation maps can be put in central locations. If your community is computer-savvy, put the map on the World Wide Web. In Hawaii, community evacuation maps are printed in the telephone directory, which is distributed free to everyone with an address.

Sample Outreach Activity: Community Evacuation Exercises

In evacuation exercises people practice what they will do during a tsunami warning. Evacuation exercises range from "table-top" exercises (described below) for emergency responders to community events that have residents practice moving to higher ground, just as they would during a real tsunami evacuation. Different types of exercises have different advantages and risks, and not all types will make sense for all communities.

Type of Exercise	*Does it Make Sense?*
"Table Top" exercise for emergency responders	Recommended for all communities
School or specific facility evacuation exercise	Beneficial in almost all communities
Community evacuation exercise of a small community	Often beneficial: many communities have done successfully
Community evacuation exercise of a small neighborhood in a large community	Often beneficial: many communities have done successfully
Community evacuation exercise of a large community	Risks may outweigh benefits: challenging to organize, only worth doing after extensive education programs and with a motivated population.

Evacuation exercises involving the public are very visible events and attract a lot of community and media attention. They provide education about tsunamis and the need to prepare for them even for those who do not participate. For those who do participate, they allow people to visualize what they will need to do during a real disaster and to work through problems they may encounter in advance. People who participate in exercises are more likely to take on leadership roles in helping their neighborhood evacuate during a real tsunami warning.

Evacuation exercises are complicated to organize well, so it is critical to plan for them carefully, or they can make plans and officials look bad. A poorly run exercise can create a negative public impression of emergency planning that may be difficult to overcome. Community leaders may worry that an emergency exercise will scare residents, tourists and investors. In reality, people generally feel safer and more prepared for disasters after a well-run evacuation exercise. Evacuation exercises can be organized by the government or can be conducted by other groups, as long as officials are informed and do not object.

Communities should conduct "table-top" exercises for emergency officials before holding one that involves the public. A "table-top" evacuation exercise brings together emergency responders from different agencies in your community to practice how they receive tsunami warnings, communicate with other agencies, alert and warn the public, and mobilize to assist an evacuation, without actually involving the public. This type of exercise is called a "table-top" exercise because usually all participating emergency officials sit around a table simulating an emergency, rather than being out in the community. This type of exercise will help to identify major problems in evacuation planning and will train personnel. It is a valuable activity, whether exercises involving the public are planned or not. Table top drills should be practiced regularly, preferably once a year, as personnel and ways of communicating can both change.

It is not a good idea for hospitals and the elderly to participate in evacuation exercises, because of health risks. Emergency officials will be blamed for any injuries that occur during an exercise, whether they were related to the event or not. Hospitals and institutions caring for vulnerable populations should be encouraged to do exercises in which their staff practice what they would do during an evacuation, but the vulnerable population should not participate.

School evacuation exercises are a good first step towards involving the community. These exercises help to reassure parents that their children will be safe during a real tsunami emergency. They can convince parents that they do not need to go to their child's school during an actual evacuation, which could cause significant traffic problems and could delay the parents' own evacuation to safety. Schools should involve parents in planning exercises so that they understand exactly what will happen to their child during an emergency. Before conducting an exercise, schools should develop emergency evacuation plans.

Tips for a Successful Community Evacuation Exercise

- Plan for the exercise with many community groups. Involve emergency officials from every relevant agency in the planning, as well as elected officials, the media, the business sector, the tourism industry and relevant community groups and NGOs. A large planning group will build support for the event, as well as contribute ideas that make the exercise more effective.
- Schedule the exercise when there are no other large community events. Avoid dates that will have heavy traffic or large numbers of out-of-town visitors. Use anniversaries of past disasters.
- Publicize the exercise widely. Everyone in the community should know that the event is an exercise. Work with media and community groups to inform people about it, both to encourage participation and to reduce surprise during the event. Distribute fliers, banners or posters widely advertising the event.
- Develop a plan to manage traffic. Post traffic control officers or volunteers at all busy intersections or major crossings. If evacuees need to cross busy streets, have a plan to disrupt traffic as little as possible while still conducting the exercise effectively. Traffic control officers should stay in place for awhile after the exercise ends, while people slowly return to their homes, schools or offices.
- Make the warning as real as possible. To trigger the exercise, make the alert signal as close as possible to the way it will occur in a real tsunami warning. People will expect a real evacuation to happen in the same way as the exercise did.
- Provide information about what to do in the exercise. Prior to the event, use as many methods as possible to tell people what to do in the exercise, including what time the exercise will occur, what alert signal to listen for, where to go, what routes to use, whether to go by foot or by car, what to expect when they arrive at evacuation locations, and what to do after the exercise.
- Train volunteers and emergency officials before the exercise. Volunteers and emergency officials should know what to do, what to say to the public, and should wear identifiable clothing. Have water and medical assistance available for participants.
- Actively work with the media. Media can mobilize people at the time of the exercise, can make sure people know it is a exercise and not a real emergency, and can cover the event to educate people who do not participate. Use the event to train the media in their role during a real tsunami.
- Involve local businesses. Businesses may designate a small number of employees to participate in exercises that happen during work hours. These employees can report back to their workplace about what to do.
- Involve the tourist industry. Hotels and other tourism-related businesses should have signs or employees informing visitors about the exercise to avoid confusion. Tourists need not participate.
- Distribute evacuation maps. Before and during the exercise, distribute evacuation maps widely.
- Place volunteers along the evacuation route. Volunteers or emergency officials should be stationed along major evacuation routes at regular intervals to answer questions, provide help and make sure that everything is going smoothly.
- Time how long it takes people to evacuate. Have volunteers at the end of the evacuation routes to greet people, count participants and time how long it took people to reach safety.
- Have emergency officials ready to answer questions. Emergency agencies should be ready to receive phone calls or other queries about what is happening. Have adequate staff ready to inform and reassure people.
- Ask people about their experiences in the exercise. Ask people who evacuate in the exercise to complete a written survey or to speak to a volunteer interviewer and talk about their experience. This is a great opportunity to learn how to improve emergency plans.
- Have a public discussion about the exercise after it is over. A community discussion, open to the public and media, of what was learned during the exercise is a good way to get opinions, improve emergency plans, and make the public feel that their concerns are being heard.

Checklist: Organizing a Community Evacuation Exercise

- ☐ Decide whether an evacuation exercise makes sense in your community
- ☐ Conduct a "table top" exercise with emergency responders to practice the procedures involved in an evacuation and to identify potential problems
- ☐ Develop plans for the evacuation exercise with leaders from every part of the community (see box on previous page for planning ideas)
- ☐ Identify and train volunteers to help
- ☐ Inform media, local businesses and the public about the exercise in advance
- ☐ Conduct the exercise
- ☐ Evaluate the experience and identify aspects of the evacuation plans that could be improved

Sample Outreach Activity: Neighborhood Preparedness Teams

Many communities have had success with organizing neighborhood or community emergency response teams. These teams can be focused on all types of disasters that could affect your community, including tsunamis. The basic idea is to organize volunteers in a neighborhood to take responsibility for specific tasks to prepare their neighborhood for a disaster and to help their neighbors survive and cope during an emergency. These teams should coordinate with official emergency responders. In some communities, emergency officials help to organize and train neighborhood groups. In other places, neighbors form these groups themselves and advocate for government agencies to be better prepared for disasters.

Mother Develops Program to Help Her Community's Vulnerable to Evacuate

Betty Johnston from Yachats, Oregon, USA, a small seaside town, has an adult daughter with mental disabilities. Her community experienced a tsunami evacuation warning one evening when her daughter was not at home. Luckily, no damaging tsunami actually hit her town, but the experience made Betty realize that her daughter would need help evacuating, and that many other people in the community—which houses many older residents—would, too. She organized a campaign she called "Neighbor Helping Neighbor" to help disabled, elderly and ill residents of her town in case of a tsunami evacuation or any other type of emergency. She knocked on doors throughout her neighborhood to find out who would need help in case of an evacuation. She helped to pair people with neighbors who volunteered to check on and help them during disasters. She also worked with the local emergency officials in her town to develop special placards that people with mobility problems could put in their cars during an evacuation. Residents of Yachats were told to evacuate by foot during a tsunami warning to avoid traffic jams, but people with these special placards would be allowed to drive by emergency officials.

Source: Betty Johnston

Neighborhood teams can take on many types of activities, including these ideas specifically related to tsunamis:

- Develop neighborhood-level tsunami evacuation maps that show tsunami hazard, evacuation routes, and safe areas at a small scale.
- Conduct door-to-door campaigns in which volunteers approach every household, give them a tsunami evacuation map, and explain evacuation issues.
- Identify people in the neighborhood who will need help evacuating, such as the elderly, sick or disabled, and match them with a neighbor who will help them to evacuate during an emergency.
- Develop neighborhood-level systems, such as bicycle messengers, to spread tsunami evacuation alerts and warnings and to make sure everyone evacuates.
- Conduct neighborhood-level evacuation exercises.

Door-to-Door Visits Make People Listen

Seaside, a small town in Oregon, USA, conducted a door-to-door campaign to talk with residents about tsunami risk. The city was divided into 88 neighborhood blocks, each with about 40 households. A map of these blocks was posted at a central location and volunteers were asked to "adopt" a block. Volunteers were recruited through newspaper, radio, fliers, and announcements at public meetings. Sixty of these blocks were adopted; time constraints limited the search for volunteers to adopt the rest. Blocks were adopted by civic-spirited residents, local officials, city staff, high school students and others. The program conducted a one-hour training session for all volunteers, and gave them information packets to distribute to each household with tsunami hazard maps and guidance on what to do during a tsunami. Volunteers found that most households welcomed their visits and that they were able to contact nearly all households in their block within one weekend. The town conducted a survey after this and other tsunami preparedness programs and found that 60 percent of survey respondents reported that they received information through the door-to-door campaign and thought it was very helpful. Following this program, Seaside experienced a real tsunami warning, which did not generate a damaging tsunami but did cause residents to evacuate. The community found that the volunteers who participated in this outreach program acted as community leaders during the tsunami warning.

Source: Darci Connor

Sample Outreach Activity: Tsunami Signs

Tsunami signs can be used to mark areas with high tsunami hazard, routes to use to evacuate, and safe community gathering spots. They guide people out of hazard zones during an evacuation and serve as constant reminders that a community could experience a tsunami. They are a cost-effective public education tool because they remain in the community for years, visibly marking key locations the public needs to remember, related to tsunamis.

It is important to install tsunami signs after conducting education efforts. Some communities report that tsunami signs are stolen by people who fear that highlighting their community's tsunami risk will scare away investors or tourists. After education

efforts, most community members and businesses welcome tsunami signs and the preparedness that they symbolize.

Example tsunami signs from the state of Oregon.

Image source: State of Oregon, Department of Geology and Mineral Industries

Sample Outreach Activity: Memorials to Past Tsunamis

Memorials or activities that remind people of past tsunamis can be powerful educational tools, if your community has experienced a tsunami in historic or prehistoric times. These memorials can be high water marks, showing the depths of tsunami flooding in a past event on buildings or other structures. They can be monuments that show the height that flood waters reached, or photographs or paintings showing the effects of the tsunami on the community. If there are no historical records of tsunamis in your community, prehistoric tsunamis can be identified by geologists looking at layers of sediments deposited in the ground. Memorials can help people to visualize damage from future tsunamis. Stories or legends about past tsunamis can also help people to connect to lessons learned by their ancestors.

Inamura No Hi: Fire Saves a Village from Tsunami

This story is based on actual events from the Japanese village of Hiromura, now Hirokawa town, Wakayama Prefecture. In 1854, an earthquake caused a tsunami that destroyed the town, but many villagers were saved by Hamaguchi Goryo (Gohei) when he lit his rice harvest on fire. This story was part of the national Japanese elementary school curriculum for years. It has been translated into many languages. A statue of Hamaguchi Goryo reminds townspeople of his heroic actions.

A big earthquake occurred in the evening. Gohei, the village chief, felt the shaking. From his house on a hill above the village, he saw the sea receding unexpectedly, exposing sand and rocks. He thought a tsunami might come. All of the villagers were near the beach preparing for a festival that night. He had to warn them.

Gohei had just harvested and dried the rice from his fields. He grabbed a torch and set the sheaves of rice on fire. Down below, villagers saw the fire burning on the hillside. They rang the fire bell and everyone began rushing up the hill to help put out the fire. When the first villagers reached Gohei's rice, he told them not to put out the fire but to help their fellow villagers up the hill. More and more people made it up the hill. And then the tsunami struck. Waves struck the village again and again, destroying the town. But the people were safe because of Gohei's quick and selfless actions.

Source: Asian Disaster Reduction Center

Step 5: Evaluate and Improve Your Efforts

Some of your outreach efforts will make a big difference in the preparedness of your community. Others will not. Evaluating the success of your programs in preparing community members will allow you to learn from your mistakes and to increase the effectiveness of future programs. Some ideas on how to evaluate your programs include:

- Distribute questionnaires at events such as community meetings or evacuation exercises. How did people learn about the event? Did people learn from it? What aspects did they find most useful?
- Collect informal feedback from people working with you. Everyone who attends community meetings, knocks on doors, or interacts with the public in other ways will have thoughts about how people are responding to your efforts, what they understand and misinterpret, and whether people will be ready to evacuate when the next tsunami is approaching.
- Conduct formal polling on awareness and preparedness rates in your community before and after your outreach efforts. This approach, while most expensive, gives the most objective feedback on how successful your outreach has been.

Checklist: Educating the Community About Tsunami Preparedness

Step one: focus your efforts

☐ Select which part of your community you want to focus on (your audience)

☐ Learn about your audience: what is important to them, how much do they know about tsunamis, what are good ways to communicate with them, etc.

Step two: make basic outreach materials

☐ Decide what specific information your audience should receive about tsunami preparedness

☐ Decide how that information should be presented so your audience will respond to it best

☐ Develop pamphlets, presentations, or other educational materials that will serve your audience.

☐ Test those materials on a small group and improve them based on feedback.

Step three: conduct community outreach activities

☐ Select an outreach activity that has a local focus and encourages the community to participate

☐ Conduct activity

Step four: evaluate and improve your efforts

☐ Find out how well people responded to your tsunami preparedness outreach activities

☐ Identify things that could be improved

☐ Plan your next outreach activity

For web links to more information about public education for disasters, tsunami preparedness information for specific audiences (schools, tourism industry and fishing industry), neighborhood preparedness teams, tsunami folktales, and tsunami signs, visit the GeoHazards International website at:
http://www.geohaz.org/contents/projects/tsunamiguide.html

Chapter 5. Learn About and Improve Official Tsunami Warning Systems

Scientists can sometimes predict when tsunamis will strike coastlines around the world. This enables governments to develop official warning systems that warn people in areas that might be struck by a tsunami to evacuate in advance. Since the 2004 Indian Ocean tsunami disaster, considerable effort has gone into developing warning systems for countries throughout the world. These warning systems have the capacity to save many thousands of lives in future tsunamis.

Official warning systems are not perfect, however, even in the most prepared communities, and might fail to warn people adequately to evacuate when a tsunami is approaching. This is partly because official warning systems are complex, and if one part of the warning system works improperly, the whole system can fail. It is also partly because official warning systems usually do not have time to warn communities about locally-generated tsunamis, which can strike minutes after they are triggered by an earthquake or other underwater disturbance. While it is important for communities to build reliable official tsunami warning systems, it is equally important for residents of coastal areas to be educated about natural warning signals. The best prepared communities are those that both educate their residents about natural tsunami warning signs and develop and maintain official tsunami warning systems.

Official tsunami warning systems are typically developed and maintained by governments. As an advocate for your community's tsunami safety, you can play an important role in making the official warning system more effective, whether you are a government official or working from outside the government. This chapter presents three steps you can take to do this:

- **Step 1. Learn about effective official warning systems.** A reliable and effective tsunami warning system requires considerably more than installing alert sirens. Learning about the elements needed for a reliable system will allow you to understand the quality of your local system and to advocate for improvements.
- **Step 2. Learn about your community's official warning system.** Your public outreach efforts should inform people about what to expect when an official tsunami warning is issued, which requires you to know how your local system works. It is also important to have perspective on the quality and reliability of your community's official warning system, so that you can identify weak links that need improvement.
- **Step 3. Advocate to improve your community's warning system.** You may be able to encourage improvements to your community's warning system through a variety of activities.

Step 1: Learn About Effective Official Warning Systems

An effective official tsunami warning system needs to have the following elements:

A. An institutional system defining roles of all involved agencies,
B. A decision process for when to issues warnings,
C. An alert system to get the public's attention,

D. A system to spread warning messages, and
E. Ongoing maintenance and testing to make sure the system works in an emergency.

A. Institutional System for Warnings

An institutional system defines the relationships between all of the organizations that need to cooperate to communicate a tsunami warning to the public. It defines the following things:

- the roles and responsibilities of each organization and of people within each organization;
- the paths of communication between organizations, including which organizations communicate with others and how the communication is conducted (e.g., special telephone lines);
- the hierarchy of decision makers for whether, where and when to call for evacuations, and a back-up hierarchy of decision makers, in case key personnel are not available during a fast-moving emergency event; and
- the path to transmit technical information about the tsunami threat from international or national scientific warning centers to emergency managers and political decision makers.

The International Tsunami Warning System

A network of international tsunami warning centers monitors the world's oceans for potential tsunamis. These centers identify earthquakes that could cause tsunamis and watch tide gages around the world for signs of tsunamis. They also monitor tsunameters, instruments that can detect tsunami waves while they are still in deep ocean water.

These tools are used by the international centers to develop tsunami warnings, watches, advisories and bulletins. This information is distributed to governments and others through many channels, including publicly accessible websites. A tsunami *warning* indicates the highest risk of tsunami occurrence and is issued when a tsunami has been detected or a large earthquake is measured that could have generated a tsunami without time to detect a wave. Officials are given estimates of approximate arrival times at different world locations. A tsunami *watch* indicates a potential risk of tsunami and provides advance notice that a tsunami warning is possible. *Advisories* are issued to areas currently assessed as outside of tsunami warning and watch areas. *Bulletins* report when there is no threat of a destructive tsunami after an earthquake.

Information from international warning centers reflects ocean-wide risks, and the risk of a destructive tsunami may be higher or lower in specific locations due to local conditions.

Institutional miscommunication is a common cause of warning system failure. It only takes one error in the communication chain for information not to get to the local level where evacuations are mobilized. In many cases, communication with the local level is a weak link. Communication equipment for decision makers must function reliably during an emergency, such as following a major earthquake when electricity and telephone services may not work. Communities in remote locations may need special equipment to link them with other locations.

B. Warning Decision Process

When officials become aware that a tsunami might be heading towards their coastline, many decisions need to be made quickly. These decisions include:

- Does the potential tsunami pose a serious risk to the safety of coastal communities?
- Does the public need to evacuate?
- Which locations need to evacuate?
- When does the public need to evacuate?

The information that officials have to make these decisions may be confusing, contradictory and sparse.

It is important that officials plan for these decisions in advance. Officials should identify possible scenarios that could occur, with limited and imperfect information, and make a framework for how to make decisions during a disaster. Decision makers should know that if a certain type of message arrives, they should respond in a certain way. This allows these critical decisions to be made in a logical and consistent way that maximizes community safety. Decision makers should not need to have specialized technical knowledge to interpret the risk information they are receiving from scientists.

If individual officials need to make evacuation decisions during an emergency without this advance preparation, they are likely to make inappropriate choices. Their decisions will vary widely based on the personality and knowledge of the individual who is on duty at that particular moment.

People Will Not "Panic"

Authorities are often worried that people will "panic" when they are warned of a disaster. Experience shows that people do not panic when they are given a warning that clearly tells them what to do. People may be frightened, but they act rationally in emergency situations when well informed.

Public officials who are worried about preventing panic may withhold important information from the public. This can cause people to behave in inappropriate ways. It is essential to share all important information with the public during an evacuation warning.

More likely than panicking, people may not respond to a warning when they should. It is important that warnings include all known information so that people believe they are actually at risk and need to go to the trouble of evacuating.

When No Tsunami Comes…

Tsunami warning signals are imperfect. Sometimes scientists believe that the risk of a tsunami striking the coastline is so high that they recommend evacuation. No tsunami may result, or perhaps only a very small and harmless tsunami will occur. Officials often fear that such "unnecessary" evacuations will lead people not to evacuate on future occasions when a large tsunami may be approaching. This fear can lead officials to delay warning people to evacuate until too late. In fact, there are no unnecessary evacuations: it is always necessary to evacuate if any warning signs indicate a high risk of tsunami. Experience shows that most people who evacuate during false alarms will also evacuate in the future when warned to do so. After an evacuation that was not followed by a tsunami, officials can build confidence among community members by explaining why an evacuation was called for and what criteria are used to call for evacuations.

C. Alert System

Sample Types of Alert Signals

- Sirens
- Radio and television break-in announcements
- Loudspeakers (e.g. on mosques)
- Mobile loudspeakers/megaphones
- Telephones
- Cellphones/pagers
- Knocking door-to-door
- Bells (e.g. church bells)
- Flares
- Aircraft with banners or speakers
- Banners/signs

An alert system allows officials to interrupt people's daily lives and to get their attention during an emergency. The goal is to alert people so that they either seek more information, such as turning on their radio or television or asking others, or evacuate immediately, if trained to do so. Ideally, alert signals should be something that people notice during all the various activities they do day and night. Effective alert signals are loud and difficult to ignore. Some groups may need special systems to get their attention, such as people in remote locations and people with hearing disabilities.

Generally, the most successful warning systems have the same alert system for all types of disasters. Tsunami alert systems should use existing equipment and community networks as much as possible. The more use a system receives, the more likely it is to be functional when it is needed for a tsunami warning. Alert equipment should also be appropriate for the level of wealth and technical capability in each community. Complex equipment requires highly-skilled repair people and is worthless if the community cannot afford to maintain it or cannot find qualified people to do so. Expensive equipment can also be a tempting target for theft in poor communities.

Communities can select from a variety of attention-grabbing techniques for their alert system. It is best to have multiple alerting techniques. Selection of the best alert techniques for each community should consider the types of people in the community who need to be alerted, where those people may be during an evacuation warning (e.g., at home, driving in the car, shopping), what they might be doing during the alert (e.g., sleeping, working in the fields, fishing), and any special needs they may have. Communities also need to consider issues such as ease of use, cost of equipment, cost of maintenance, technical requirements of maintenance, and ongoing training requirements for users. For most communities, the most technically advanced alert options do not make sense. The most important aspect of selecting the best alert system for each community is choosing techniques that will reliably function during an

Hilo, Hawaii's Experience: Alert Signals Are Not Enough

On May 22, 1960 a large earthquake off the coast of Chile generated a tsunami that sped across the ocean towards Hawaii. Officials in Hawaii recognized the risk of a tsunami in the city of Hilo and sounded alert sirens at about 8:30pm. The sirens blared intermittently for about twenty minutes. Almost everyone in Hilo heard the sirens, but many people did not understand what they meant. Some people waited for further information, which never came. Others evacuated but returned home within a few hours after seeing no tsunami. Just after midnight, a large tsunami struck the city, causing major damage, killing over sixty people, and injuring many more. Despite over five hours of warning and working alert sirens, the community's official warning system did not successfully communicate to the population to evacuate.

Source: Atwater et al

emergency in the years to come.

Whatever method or technology a community uses for alert signals, it needs to be tested regularly to make sure it works. This includes both testing the functioning of equipment and practicing any actions that people need to take to make the system work.

D. Warning Messages

After being alerted, the public needs an evacuation warning message that clearly tells them what to do. The effectiveness of this message at mobilizing people to evacuate depends on what the message says, how it says it, whether the message reaches people, and whether people then believe it and follow its advice.

Example Warning Message

This warning message is used in Washington State, USA:

"This is not a test. A tsunami warning has been issued for the coastal areas of Washington. A tsunami can cause dangerous flooding. If you are in a low coastal area you are at risk and must move to higher ground or inland now. Do not return until directed to do so. Closely monitor local radio stations for additional information. This is not a test. A tsunami warning has been issued for the coastal areas of Washington. Move to higher ground or inland now."

The most important thing to include in an evacuation warning message is to tell people exactly what they should do. This typically means evacuating to a safe location, either by foot or by car. Messages should explain what evacuation means, who should evacuate, when and where people should go, and how they should get there. Very specific and simple language should be used.

It is important to keep warning messages consistent. When warning messages are inconsistent, people listen to the information that they like best, rather than the information that is most accurate. There are likely to be some inconsistencies in every warning message because disasters are fast-moving events and people get information from a wide variety of sources. The following steps help to manage inconsistency in warning messages:

- Refer to and repeat what was last said,
- Acknowledge what has changed, and
- Explain why changes occurred.

It is also important for officials to monitor other information sources to the public, including television, radio, text messages, etc., to be aware of what they are saying and correct any errors. The public may have trouble distinguishing between official and non-official sources.

Evacuation warning messages should be written in advance. Officials should then customize the message for each specific event. Evacuation warning messages can be tested on diverse members of the public before an emergency event to make sure that they understand it properly and to get their feedback on how to make it clearer.

A warning message should be spread using as many different methods as possible. This will increase the number of people who hear and respond to it. All of the distinct groups of people and places in your community should be evaluated to determine which methods of communicating a warning would be absorbed best by each group and location at each

time of day. The public should know where to go to get a warning message. For example, many communities instruct the public to turn on a radio or television if they observe an alert signal.

Ways to Transmit Warning Message

- Radio and Television
- Door-to-door Visits: If time allows, local police, community volunteers or others can visit every home and business in high risk areas and tell them to evacuate. This method spreads the warning and can help persuade people to heed it.
- Foreign Language Radio and Television
- Telephone and mobile phone: Undoubtedly, many people will receive unofficial warning from friends and family through the telephone system, but phone may be unreliable for official use. During an emergency phone systems may become overloaded due to heavy use. After an earthquake, land-based and mobile telephone systems may not function.
- Loudspeakers / Public Address Systems: Messages from these systems can be difficult to understand and hear. Typically, pre-recorded messages that are very clearly spoken work best.
- Message Boards and Banners: A written evacuation message can be posted in a visible location, such as along major roads or in busy public areas.

E. Maintenance and Testing

Tsunami warning systems are complicated. If one small element of the warning system does not work, the entire evacuation warning may fail. It is essential to regularly test, practice and maintain all parts of the system. Officials at all levels should regularly be trained in all procedures, including regular re-training programs and training programs for all new employees. Equipment should be tested and maintained frequently; for example, many communities test sirens weekly. Any volunteers should regularly be trained, given training refresher courses, and practice their roles. Emergency officials should conduct regular evacuation simulations, where all portions of the warning system and evacuation procedures are practiced in a simulated environment, often called a table-top exercise. Plans and procedures should be updated based on what is learned in these simulations. No matter how well-planned the official warning system in your community is, it will not be reliable unless maintenance and testing are an ongoing task of emergency responders.

Step 2: Learn About Your Community's Official Warning System

It is important to learn how your community's official warning system works for these reasons:

- Your public outreach activities need to inform people about what to expect in an official warning, such as what alert signals to listen for and where to seek more information.

- If your public outreach efforts emphasize natural warning signals, you need to be able to explain to the public why official warnings are not always reliable, even in the best prepared communities.
- Identifying areas that need improvement in your community's official warning system will allow you to advocate for these improvements.

When Is It Safe For People to Return?

If a tsunami strikes your community, it will bring a series of waves that can last for many hours. Generally these waves come every 10 to 60 minutes. The public should wait for an official "all-clear" announcement before returning to low-lying areas. It is advisable for the public to remain evacuated after a tsunami for at least two hours after the last observed tsunami wave. If the tsunami has caused significant damage, it may not be safe or advisable for people to immediately return to their homes even after the risk of tsunami waves is over. There may be unstable buildings, and areas may be flooded with water filled with dangerous debris or contamination. If the public needs to remain evacuated from their homes for a long time, officials need to communicate why this is necessary. Without information, people may return home before it is safe to do so.

The best way to learn about your community's official warning system is to build positive relationships with government officials in various positions of your community's emergency response hierarchy, who can inform you about it. This can include officials at provincial and national levels and technical specialists involved in analyzing tsunami risk. Let these people know why you are interested in learning about your community's system: to improve the safety in your community by working with the public and by providing help and support to the government. Many of the techniques discussed in Chapter Two for involving busy people in your efforts can work to build relationships and trust with officials involved in the warning system—having them participate in an advisory committee, inviting them to speak at meetings, giving them awards, providing them with regular briefings, giving them travel opportunities, etc. These relationships may take time to build, but they will provide an important source of strength for future tsunami safety activities and are worth the investment.

Step 3: Advocate to Improve Your Community's Warning System

Designing and maintaining an effective tsunami warning system at the local level is a challenge even for communities with significant resources. It is likely that the official warning system in your community, if one exists, has aspects that could be improved. As an advocate, you can take steps to encourage improvement of this system, whether you work within the government or are a concerned citizen outside it.

Some steps you can take to advocate for a better official tsunami warning system include:

- **Educate local officials about all elements required for a reliable warning system.** Local emergency responders and officials in your community are probably busy people with many responsibilities. They may not have time or resources to learn about tsunami warning systems. You can help them to learn about what makes a system effective and reliable through individual discussions, introducing them to specialists in this topic, making them aware of references and training courses, and organizing educational seminars and workshops with them.

- **Help conduct research that will improve warnings and evacuations.** You can collect and study a variety of information about your community's characteristics that will help officials to make good decisions about warnings and evacuations. This includes identifying hazard zones and developing evacuation maps, as discussed in Chapter Three. Other issues that advocates can help to research include these:
    - Studying the types of alert systems that could work in high hazard neighborhoods, such as identifying existing community institutions (e.g., crime watch groups) that could help spread alerts and warnings;
    - Identifying communication issues that need to be considered in warning messages, such as populations living in high hazard areas that would need warnings in a different language;
    - Identifying issues that could affect how people respond to warnings and suggesting solutions, such as ways to assist children, disabled people or elderly people during an evacuation.
- **Advocate for trainings, drills and table top exercises.** A key component of local readiness for tsunami warnings and evacuations is training emergency responders and testing the warning system regularly. Developing good training curricula and holding training sessions can be both difficult and expensive for local governments. Sometimes outside groups can help to plan, conduct and fund these critical activities.

For web links to more information about official warning systems, alert systems, and international tsunami warning centers, visit the GeoHazards International website at:
http://www.geohaz.org/contents/projects/tsunamiguide.html

Chapter 6. Prevent Tsunami Damage

Evacuations save lives, but all of the buildings, roads, property and everything else in your community that get hit by a tsunami are likely to be damaged or destroyed. Tsunamis can cause devastating economic harm that is difficult to recover from. There are some activities your community can do to reduce the physical destruction of tsunamis. Many of them are expensive and politically challenging to do before a disaster, but they may make sense in your community, especially if spread over many years. This chapter examines the types of activities that can reduce tsunami damage in your community and methods to make these activities happen.

Activities that Prevent or Minimize Tsunami Risk

Improve Evacuation Routes

Evacuation planning may identify neighborhoods that do not have adequate routes to safe, high elevation locations for their populations. As your community upgrades its road networks, changes can be made to improve their evacuation capacity. Existing roads can be widened or improved. Direct routes can be built to shorten travel distances to safe locations. In areas where local earthquakes could generate tsunamis, bridges and other infrastructure that evacuees will need to use can be evaluated for their ability to withstand earthquake shaking and, if necessary, can be strengthened.

Build Evacuation Sites

Evacuation capacity in dense or flat areas can be increased by building sites for vertical evacuation in the tsunami hazard zones (see box on page 15). These sites can include well-built tall buildings, sturdy platforms (free-standing or in well-established trees), and artificial hills.

Minimize Building in Highest Risk Areas

The most effective way to save lives and minimize financial loss is to avoid building homes, businesses and other structures in locations that face the highest hazard from

Ladders in Java Help People Climb Cliffs

The southern coast of Java, Indonesia, has a number of isolated beaches that tourists and locals flock to for weekend swimming and relaxing. These "pocket" beaches are surrounded by steep cliffs and mostly reached by boat.

Areas of Java were hit by a tsunami on July 17, 2006, making locals recognize the danger of these beaches. If people felt earthquake shaking, or observed other natural tsunami warning signs, there would be no way to escape tsunami waves. In response, the community built ladders up the rough cliff sides to help people climb to high ground.

Source: Costas Synolakis, Tsunami Research Center, USC

destructive tsunami waves. Low lying areas can be designated for low-density uses, such as agriculture, public parks or nature reserves.

However, in many communities these areas are already fully developed. In communities where open space still exists along the coast, development restrictions can be politically difficult because of the value of coastal real estate for tourism or other purposes. These communities can avoid constructing buildings that are essential for emergency response, such as hospitals, or buildings with vulnerable populations, such as schools or jails, in tsunami hazard zones. Communities can discourage dense developments in these areas. They can also encourage landowners to build on higher elevation locations within their land parcels or to build structures appropriate for vertical evacuation.

Redevelop Built Up Areas Safely

Existing built-up areas change with time. Many older buildings become obsolete or run down and need replacing. Building uses change; industrial buildings may switch to residential use, or vice versa. Planning and zoning policies can prevent construction of more vulnerable buildings and can encourage or provide incentives for relocating critical activities, such as schools and hospitals, to higher ground. Replacement buildings can be built to better withstand tsunami forces and, possibly, serve as vertical evacuation sites. Consistent policies over time can add up to reduce tsunami risk significantly in the long-term.

Enforce Building Codes

Tsunami waves put a variety of forces on buildings, ranging from strong currents to battering by large pieces of debris. Well-constructed buildings survive tsunami forces better than poorly-constructed buildings. Reinforced concrete and steel buildings are believed to survive better than buildings made of lighter materials, such as wood. This can lead to difficult choices in areas with both earthquake and tsunami risk because lighter, wooden buildings often experience less damage and cause fewer deaths in earthquake shaking. Enacting and enforcing building codes that require high-quality design, construction and materials will help buildings to survive a tsunami, as well as providing safety from many other hazards.

Maintain or Restore Natural Coastal Vegetation and Landscape

Some natural coastal features, such as sand dunes and coral reefs, provide protection against tsunamis. Communities will benefit if they prevent development from removing dunes and other natural roughness in coastal areas. In many communities, there can be strong pressure to change coastal areas to improve beach access.

There is disagreement among specialists about whether vegetation barriers protect communities from tsunamis, despite widespread reporting in the media that they do provide protection. However, having an undeveloped buffer zone between the ocean and the community clearly makes the community safer by keeping development out of the highest hazard areas adjacent to the shore. A vegetation barrier is an area of dense bushes, trees or mangroves between the ocean and a settled community. Possibly dense vegetation can protect communities from small tsunamis by absorbing the energy of

incoming waves. They may, however, lead to additional damage in large tsunamis because trees and branches become part of the debris carried by the tsunami waves that strikes people and buildings. Clearly mangroves and coastal vegetation provide many other types of benefits to communities, such as limiting beach erosion and providing habitat for valuable species.

Protect Existing Buildings with Site-Specific Walls or Berms

Walls or berms (earthen walls) can be built to protect structures. This is one of few options available to protect existing structures in areas where tsunami risk is high. Walls can either be designed to guide tsunami waters around a building or to block the water entirely. This strategy is risky because its effectiveness depends on the size and strength of tsunami waves that hit, which will vary in every event. In some cases, walls could increase damage by amplifying waves that bounce off of them.

Communities can also build seawalls to protect large areas of their coast by blocking tsunami waves. Seawalls are expensive, highly engineered structures that are not always effective at protecting a community: if a tsunami wave is taller than the community's seawall, the damage can be increased. In many communities seawalls are politically unpopular because they completely change the look of and access to the waterfront. They can also cause unintended environmental changes, such as erosion of sandy beaches.

Steps You Can Take

Reducing damage through changes in your community's built environment can be a difficult and lengthy process. Some approaches you can pursue to make these changes happen include the following:

- **Educate the public and officials.** Informing building owners, builders, and government officials who regulate construction about ways to reduce tsunami risk may encourage some to take action on their own. Education efforts also lay the groundwork for changes in regulations.
- **Advocate for regulation changes.** Changes to land use plans, zoning codes, building codes and other regulations can require people to make choices that minimize risk of damage in tsunamis and other hazards. These changes may make sense at local, provincial or national levels, depending on how development is regulated in your community. Advocate for these changes by working with lawmakers, drafting proposals for them, speaking with decision-making committees or individuals, and mobilizing support among the public for the changes.
- **Enforce existing regulations.** Your community may already have regulations to manage development in ways that would limit tsunami risk,

Include Everyone in Discussions on Safe Beachside Development

Development of beachside areas may be politically charged, and some people may not support tsunami risk reduction activities that involve changing land use and building practices. Identify people who oppose these approaches and try to include them in early planning for tsunami risk reduction. By including them in discussions, it may be possible to identify compromise approaches that work for everyone.

although these regulations may not have been aimed at tsunami risk when they were enacted. Encourage officials to enforce these regulations through education, training programs, publicizing lack of enforcement, and building public support for enforcement.

- **Influence choices made by private developers.** If a large coastal development is planned for your community, meet with developers to encourage tsunami-resistant features. Inform neighbors of the development about implications of the project to their tsunami safety.

For web links to more information about tsunami damage mitigation, visit the GeoHazards International website at:
http://www.geohaz.org/contents/projects/tsunamiguide.html

Chapter 7. Keep Preparedness Going Over the Long-Term

Convincing people to take steps to prepare for tsunamis takes time. A program to truly change the preparedness of your community for tsunamis will require years to implement, even decades, not months. And the need for ongoing tsunami preparedness planning will never end. Even after learning about tsunami preparedness and taking steps to prepare, people, governments and other groups need to be continually reminded to keep their preparedness efforts up-to-date and ongoing. Families should update their evacuation plans based on changes in where they work, live or go to school. Governments need to update their plans to accommodate changes in the community's growth. In addition to making sure that current members of your community persist in their tsunami preparedness efforts, new members will enter your community who need to be prepared for tsunamis, too.

Many communities use a large initial tsunami preparedness campaign to build a base of awareness about tsunamis and support for preparedness activities. Then, annual events, such as a week with extensive tsunami media coverage and community outreach, keep the subject current and part of the public dialogue on an ongoing basis.

Some approaches that communities use to keep disaster preparedness activities ongoing include:

- Create an organization to focus on disaster preparedness issues. The structure of an organization spreads the momentum for preparedness activities away from individuals or temporary groups to a permanent entity.
- Integrate tsunami preparedness into government programs. Government officials can incorporate activities such as distributing evacuation maps, testing warning systems, or making sure development is tsunami-resistant into their ongoing work.
- Integrate tsunami preparedness into programs of other institutions, such as schools and businesses. Schools can add tsunami preparedness to their curricula. Schools or businesses can involve the community in planning for emergency evacuations on a regular basis.

Many different issues will affect how effective your efforts are at preparing your community for tsunamis. Some of these issues are directly in your control, such as how you plan and implement your activities. Many more issues may be largely out of your control, such as how important the public and policy makers feel tsunamis are at any given moment. This will fluctuate over time, based on world events and many other issues. As an advocate, you should be ready to take advantage of events that raise the public's interest in tsunamis. These events could be large tsunamis elsewhere in the world, a small tsunami or a tsunami warning with no destructive waves in your community, or other types of natural disasters. Be ready to use these events as opportunities to speak with the media and to conduct community awareness events.

Communities can survive tsunamis if they prepare. Someday a tsunami could strike your community, although no one can predict when. It may be years, decades, or generations

before it comes. When it does come, the families, businesses, government, and everything else that matter in your community should be ready not only to survive but to rebound to be more vibrant than before. This is the goal that makes all of your efforts worthwhile.

For web links to more information about keeping disaster preparedness campaigns going, visit the GeoHazards International website at:
http://www.geohaz.org/contents/projects/tsunamiguide.html

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