# Preparing Your Community for Tsunamis

**A Guidebook for Local Advocates**

**Simeulue Island: Local Knowledge 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 over 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. These stories were known to most island residents from childhood. And on December 26, 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, which it did.

Source: McAdoo et al.

[insert photo from Simeulue]

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# Introduction: You can prepare 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 residents of your community about when and how to evacuate for tsunamis, helping government to be prepared to mobilize and coordinate evacuations, and working to change your community's development so tsunamis 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 could strike any coastal community, and some communities have a particularly high risk. While it is not possible to prevent tsunamis from occurring, there are many things communities can do to save lives and reduce their consequences.

Anyone can be an advocate for tsunami safety. Advocates can be government officials, business leaders, members of community organizations, or 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.

## *This Guidebook Shows How to Be an Effective Advocate*

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.

This guidebook begins by introducing you to the basic information you need to know about tsunamis: what causes them, how they behave when they strike the shore, and what kinds of damage they can cause. It then presents a step-by-step approach of things you can do to prepare your community for tsunamis. This starts with building a team and a strategy that sets you up for success, and covers how to create evacuation maps, prepare the public for tsunamis, improve community warning and evacuation capability, and reduce your community's vulnerability to tsunamis over time. Then, the guidebook discusses how to keep your community prepared for tsunamis long-term, even if no tsunami impacts your community for decades. Each section of the guide recommends sources that provide more in-depth information on topics that may be important to your community.

## *The Goal: Your Community Prepared to Survive a Tsunami*

Someday a tsunami is likely to strike your community. Scientists cannot tell you when this will happen, whether it will be next year or in your grandchildren's lifetime. When that day comes, hopefully your community will be ready.

The most important thing your community should do is be ready to quickly and safely evacuate all areas that could be flooded by the tsunami. This saves lives. Often there are some warning signs before a tsunami approaches shore. These warnings range from events that occur hours before a tsunami strikes, such as distant underwater earthquakes that international monitoring centers can identify, to events that occur seconds before water begins to inundate a community. Regardless of the type of warning, people in your community should know when and how to evacuate and the government should be prepared to mobilize and coordinate the evacuation.

Perhaps your community will also have taken steps to reduce damage to property, the economy, the environment, and other important resources. These steps tend to be long-term development decisions, including managing land use and building choices in areas that tsunamis could flood. Tsunami risk can never be entirely removed if your community is located in a low-lying coastal area. This risk is the cost of enjoying the many benefits of being close to the ocean. However, your community can make small and large choices that cumulatively, over time, make it likely to see less damage when a tsunami strikes.

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 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.

# Chapter 1. Learn the basics of tsunami behavior

To be a tsunami safety advocate, it is essential for you to know the basics of what tsunamis are, how they are caused, and how they impact communities. The physical characteristics of tsunamis have profound implications on 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.

[image: tsunami surge, what it looks like when the water approaches]

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

**Local Tsunamis Are Most Common Killers**

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

Source: Dengler

[image: map showing location and time of 2004 Sumatra eq and time various communities were hit by tsunami.]

Tsunamis can strike any coastal community, but some communities are at particularly high risk because large earthquake faults lie within a few hundred kilometers off their coasts. A map, below, identifies earthquake faults that are particularly likely to cause tsunamis.

[image: world map with subduction zones]

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

Not all tsunamis are preceded by natural warning signals, but in most cases people along the coast observe one of these phenomena before a tsunami strikes:

- 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.

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

On July 17, 1998, residents of the Wewak coast 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 50 or 100 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

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 further official warnings.

Strong earthquakes can cause tsunamis whether they occur underwater or on land. Tsunamis are most likely to be caused by earthquakes with strong shaking 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 strong shaking. This may result in some unnecessary evacuations, but will lead to the most saved lives.

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 trees or roofs during the first wave may allow people to survive, but they must continue to evacuate after the first wave recedes.

A tsunami brings many successive waves or surges that strike the

**The Wave That Eats People: A Legend Saves the Moken People**

The Moken, a nomadic fishing people living on islands off the coast of Thailand and Burma, have a legend about "laboon", the wave that eats people. It is brought by the angry spirits of the ancestors. Before it comes, the ocean recedes. Then, the big wave comes and floods the earth, destroys it, and makes it clean again.

On December 26th, 2004, Moken elders recognized the signs that laboon, or a tsunami, was coming. They warned everyone to head to high ground. Moken fishermen out at sea also knew to steer their boats towards deep water. Nearly all Moken tribespeople survived the tsunami, which completely destroyed their seaside villages.

Source: CBS News

coast for hours. The first wave to strike is usually not the largest. The most damaging waves may arrive hours after the first one. This means that people should evacuate to the highest practical local area and remain there, even if early tsunami waves are small. Waves usually come between 10 and 60 minutes apart. 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.

## *Impacts 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. Tsunami waves push inland and then recede back to the ocean with great force. Damage can occur in both the ebb and flow of the wave. When the waves recede, the water will be filled with debris—parts of buildings, cars, boats, 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.

[image: tsunami damage to community]

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 may flood areas of the community for a long time, often contaminated with human waste and hazardous materials, such as chemicals and diesel fuel, that were spilled by the strong currents. 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 subsidence of the ground. This means that lands that used to be dry are now 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 forms of employment may also be destroyed: farm lands may be unusable, fishing boats destroyed, factories and offices damaged, tourism 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 migration caused by the lack of opportunity in its aftermath.

**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 to get free of it. 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. The only thing left is a plastic toy I bought as a joke.

Source: National Public Radio, story of Paul Landgraver NEED PERMISSION IF WE WANT TO USE

## *More resources about the basics of tsunami risk*

[This section incomplete]

### General Information

- Tsunami Teacher
  This web resource covers many topics about tsunamis, including basics of tsunami risk.
  http://ioc.unesco.org/TsunamiTeacher
- The International Tsunami Information Center
  This website contains information about the basics of tsunami risk and links to many other sources of information.
  http://www.tsunamiwave.info/
- Tsunami: The Great Waves
  This web page (also published as a flier) describes the basics of what tsunamis are, how they behave, and ways to prepare.
  http://www.nws.noaa.gov/om/brochures/tsunami.htm

### Videos, Animations and Photographs of Tsunamis

- University of Southern California Tsunami Research Center
  This website includes videos and computer simulations of past tsunamis.
  http://www.usc.edu/dept/tsunamis/2005/video/video.html
- Tsunami Visualizations
  This website links to various animations and photographs of past tsunamis.
  http://serc.carleton.edu/NAGTWorkshops/visualization/collections/tsunami.html
-

Tsunami damage

Past tsunamis

Personal stories from tsunamis

- Surviving a Tsunami—Lessons from Chile, Hawaii, and Japan
  This booklet, based on personal stories from the 1960 tsunami generated off of the coast of Chile, discusses how to survive a tsunami.
  http://pubs.usgs.gov/circ/c1187/
- Recovering from tsunamis

http://www.tsunami.org/survivors.html

# Chapter 2. Plan Your Approach

The most important and urgent thing your community can do to save lives in a tsunami is to become ready for quick and safe evacuations when tsunamis may be approaching. This requires the public to know when, where and how to evacuate, and it requires local emergency responders to be ready to mobilize and coordinate evacuations. This guidebook recommends three major categories of activities to accomplish this:

- Prepare evacuation maps,
- Involve the public in tsunami preparedness activities, and
- Plan for tsunami warnings.

These activities, discussed in depth in following chapters, are based on experiences from communities around the world and the lessons they have learned about what activities are effective. After your community is prepared to evacuate, people may be ready to consider longer term activities related to reducing the damage tsunamis can cause, such as strengthening infrastructure or land-use planning.

**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 prepare people for tsunamis. It may make sense to focus on preparing your community for all types of disasters it could face. This can help you get the attention of the public and government officials and may increase your ability to get resources. It's important that your community be resilient to any hazard event that occurs.

These activities are important components of preparing your community for tsunamis, but it is not the activities that make the community safer. No amount of maps, warning sirens, or education pamphlets on their own will make your community prepared to evacuate. These activities are tools you can use to reach the ultimate goal of all tsunami preparedness efforts: to change what people know, think about and do relating to tsunamis. Stating this goal clearly is important. It makes it clear that the real challenges of tsunami preparedness are social, not scientific. This guidebook discusses how to influence and motivate people in your community.

Influencing what members of your community know, think about and do relating to tsunamis requires understanding what their current knowledge, beliefs and actions are, the process they use to change, and the factors that most effectively influence them to change. Then you can use the activities recommended in this guidebook with the most success.

This chapter guides you through the steps to get started on a successful tsunami preparedness program. The first step is to learn about the issues in your community that influence tsunami preparedness or, in other words, to identify the current knowledge, beliefs and actions related to tsunamis. This step shapes how you plan and approach all preparedness activities, clarifies who needs to be involved for you to succeed, and identifies areas that will be most challenging. The second step is to build a team or network of people to help you. As this guidebook will discuss in greater depth, one of

the most effective ways to influence people's preparedness for tsunamis is for people to observe community members they respect—community leaders, esteemed peers, authority figures—preparing for tsunamis. It is important to get these people involved in your efforts. The third step is to find the resources you need to do this work, such as volunteers, technical specialists, meeting space, and funding. These resources will allow you to get to work on the activities discussed in the following chapters.

**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 overly complex for your community, you should modify them or focus on other activities.

## *Step 1: Learn About Your Community*

Undoubtedly, you know a lot about your community already. But no matter how much you know, it is important to begin your efforts by learning about the community through the lens of tsunami preparedness. This information will help you undertake tsunami preparedness activities in the most effective ways. It will also help you communicate to your partners, officials and the public why and how the activities you want to do are important.

There are four categories of information you may find useful to learn about in your community:

| *Category of Information* | *Why this Information Is Useful* |
|---|---|
| Existing programs related to tsunami and disaster preparedness | You may be able to build on existing disaster preparedness programs or learn from the problems previous efforts have encountered. |
| Current community knowledge of, attitudes towards and levels of preparedness for tsunamis | Understanding what people know, think and do currently will help you identify the changes people need to make to be prepared for tsunamis. |
| Barriers to tsunami preparedness | Identifying cultural, social and political issues that make tsunami preparedness challenging will help you design programs and allocate resources that meet those challenges. |
| Institutions, organizations and people who are trusted and respected in community | Working with respected community voices will help you succeed in preparing your community. You will also want to know which institutions or people could have negative impacts on your efforts. |

Specific issues to learn about in each of these categories appear in the box on page XXX.

The way you learn about issues that influence tsunami safety in your community can be informal or highly structured. One approach that many people have used successfully is to conduct a series of open-ended discussions or interviews with many types of people in

the community. These discussions should ask people about subjects relating to tsunami preparedness and encourage them to speak freely on any subjects they feel are relevant. The focus of this approach is listening to what people think and believe, rather than trying to educate people about tsunamis or steer the conversation in directions that seem relevant or important to you. The goal at this point is to find out what people know and believe, not to influence that knowledge or those beliefs.

Learning about your community is a process that will continue throughout all of your tsunami preparedness efforts. As you work, you will continually learn more about people and institutions and make changes to the way you approach things in big and small ways. This step, at the beginning of your work, is merely the start.

**Issues to Learn About Your Community Before Starting a Tsunami Preparedness Campaign**

Existing programs related to tsunami and disaster preparedness:

- What previous or ongoing efforts have been made in the community to prepare for tsunamis?
- What efforts are made to prepare for other types of disasters, including earthquakes, floods, cyclones/hurricanes, fires, etc.?
- What preparedness exists for evacuations?
- How successful are these efforts at preparing people for tsunamis or other disasters?
- What has helped and hindered these programs?

Current community knowledge of, attitudes towards and levels of preparedness for tsunamis:

- How much do people know about tsunamis? What do they believe causes them?
- How much do people know about when, how and where to evacuate because of a tsunami?
- What information that they "know" is incorrect?
- How likely and how serious do people think tsunamis are?
- Do they think of tsunami risk as something they can influence?
- Have people taken active steps to prepare for tsunamis, such as discussing evacuation issues as a family? Have they taken steps to prepare for other types of disasters?
- What issues related to tsunamis and evacuation cause worry or confusion to people?

Barriers to tsunami preparedness:

- What cultural characteristics will make preparing for evacuations difficult, such as religion, gender roles, family structure, hierarchy, fatalism, routines, etc.?
- Are there political barriers to tsunami preparedness, such as unsupportive political leadership or opposition of influential figures?

Institutions, organizations and people who are trusted and respected in the community:

- Which institutions and people have the most respect and trust in the community on issues relating to safety, disaster and community welfare?
- Which are not respected?
- Are there any experts or specialists on tsunamis or disaster issues that are recognized by community members?

## *Step 2. Enlist Partners*

The energy and commitment of individual advocates are essential elements of preparing your community for tsunamis, but the task is too big for one person. Advocates need

others to help them do their work. The right partners can give your tsunami preparedness efforts many advantages:

- *credibility*, by involving respected individuals and institutions whose involvement or endorsement gives respect to tsunami preparedness efforts;
- *influence*, by involving individuals who have the power to change or influence community thinking or policies;
- *access*, by involving individuals with ties to centers of power;
- *ideas*, by involving individuals with expertise on specific topics or particular groups in the community;
- *help*, by increasing the number of people who can work on activities; and
- *sustainability*, by building a support network that survives even when individuals retire or need to turn their attention elsewhere.

Respected community members with influence over opinions or policies are usually busy, and it may be challenging to get them interested in tsunami preparedness or involved in activities. Some strategies that can work to encourage involvement of good people include the following:

- Invite them to be members of an advisory committee: Including them in an advisory committee allows programs to benefit from their experience and connections, educates them about tsunami preparedness, is an efficient way to use their time, and allows them to interact with people from different fields on the committee.
- Invite them as keynote speakers or give them an award: These are honors that encourage people to participate in events while also educating them about tsunamis and efforts to prepare.
- Provide them 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

**Resistance to Tsunami Preparedness**

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. Hundreds of communities can point to experiences where openly focusing on how to reduce disaster risk built confidence in their population and business community rather than causing panic. Poor communities from around the world have focused on disaster preparedness: many risk reducing activities require people-power rather than financial resources. And every community has numerous short-term priorities. It is important to keep in mind that disasters like tsunamis destroy all of the progress a community has been making in every area.

These arguments should not be a deterrence for action. 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 survival.

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 out of their normal schedules and allows them to focus on this issue.
- Share credit: Programs that gain significant recognition through the media, or national or international bodies are programs that others want to associate themselves with so they can share credit for the project's success. Whether they deserve credit may not be important if this motivates better planning and preparedness in the community.

People often think of emergency planning and preparedness as the role of government, but the best prepared communities involve every sector of society in disaster planning. Residents, businesses and community groups have tremendous resources and knowledge that should be used to make people safer. Successful community evacuations and other aspects of preparedness require every person in a community to respond appropriately when a tsunami is approaching. Designing programs that have the potential to affect everyone in a community requires involving a wide range of stakeholders from every element of society. This includes people that represent the most vulnerable segments of society; women, the poor, and disabled people, though often neglected in disaster planning efforts, have important perspectives to contribute. Some groups may be involved in all of your efforts, while others may participate in limited activities.

**Possible Stakeholders for Tsunami Preparedness**

- Local emergency responders: police, fire fighters, medical personnel, 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 highly affected by tsunamis (poor, foreign language speakers, disabled, elderly, schools)
- Respected local leaders: religious leaders, professors, representatives of professional associations (engineering, architecture, medicine), etc.
- Businesses leaders and representatives from tourism and hotel industries
- NGOs active in the community

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. Start by gathering like-minded people and develop a structure that makes sense for your community and the resources available to you.

## *Step 3. Find Resources*

You will need resources—people, skills, and money—to prepare your community for tsunamis. Tsunami preparedness campaigns do not need to be expensive, but they require different kinds of people to spend time thinking about and working on the issue. In a best case scenario, your tsunami preparedness program will have at least one full-time person who can make organizing a whole range of activities his or her focus, but this is not always possible. 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 duties for that position. With guidance, volunteers can accomplish a lot. Many groups have found that it is easiest to start with a small program, perhaps all volunteer, and build some early successes that can be shown to potential supporters of future work.

Funding to support this type of work can be hard to find, particularly at first. Potential places to seek funding include local businesses; local and international NGOs; local and international professional organizations that focus on science, engineering or emergency planning; international foundations and aid agencies; and government agencies. It is usually easier to get funding to pay for a specific product, such as printing evacuation maps, than to support ongoing staff and planning efforts.

Non-financial support is easier to get. Many people are willing to volunteer for a cause they believe will help their community, including skilled professionals and international specialists in tsunamis and emergency management. Businesses may offer free meeting space or donate supplies and equipment. Government agencies may be willing to provide many types of support for your programs. Enlisting good partners will help you find all of these types of support.

**KOGAMI: A small group of volunteers makes a different 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, XXX kilometers to the north, but the same fault that generated the mega-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, 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 gave more support for their efforts. Their work to prepare residents of Padang continues and is growing.

## *More resources for Planning Your Approach:*

[This section incomplete]

- Ways to research your community
- Organizational structures
- Finding resources

## Guidance for Advocates

- Promoting Seismic Safety: Guidance for Advocates
  This guidebook aimed at encouraging earthquake safety advocates contains advice that is also relevant for advocates for tsunami safety.
  Available online??

# Chapter 3. Make Evacuation Maps

Most communities find that making tsunami evacuation maps is the best first activity for preparedness efforts. Tsunami evacuation maps show high-hazard areas to evacuate when a tsunami is approaching and safe areas to congregate. Without clear maps of your community defining the tsunami hazard, emergency planning and education efforts are difficult. Maps that clearly define the threat faced by the community build interest in and support for tsunami preparedness. They also make it clear where you should focus education and evacuation planning efforts.

Education maps serve these primary purposes:

- An education tool for the public
- A planning tool for emergency responders
- A tool to involve and motivate all stakeholders

Evacuation maps are, at minimum, a simple map of hazardous and safe areas, but they often include additional relevant information. Useful information to include on an evacuation map is:

- Areas that are threatened by tsunami inundation,
- Locations that are designated "safe areas" where people should gather during a tsunami evacuation,
- The 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
- Information the public needs to know about evacuations.

**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. Be sure to include many government officials in every stage of the process. Government should ultimately take ownership of the maps.

If government officials in your community do not wish to participate in evacuation map planning, it may be best to prepare maps showing tsunami inundation hazard zones (step one of this chapter) and not to develop complete evacuation maps. Use these hazard zone maps to educate officials about the need to plan for evacuations.

[image: good example of an evacuation map]

This chapter presents the steps necessary to create an evacuation map. It compares technical analysis approaches, discusses how to make other decisions necessary for evacuation planning, and describes how to get community members involved in this process to develop maps and plans that reflect the best local knowledge.

## *Step 1: Identify Areas to Evacuate*

People need to evacuate any areas that could be inundated or flooded by tsunamis. They might also wish to evacuate areas that could be isolated by tsunami flood waters. There are a

variety of approaches to identify areas at risk of tsunami inundation. These approaches vary in their cost, accuracy, and 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 the beginning.

It is possible to develop a reasonable, life-saving evacuation 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 key stakeholders and focuses on the big picture: people need to evacuate low-lying areas. The technical accuracy of the areas that will be inundated by a tsunami can be improved later when resources become available.

Tsunami evacuation maps usually show a "worst case" scenario, meaning they identify areas that need to be evacuated if a very large tsunami occurs. It is also possible to define the likelihood of tsunami inundation for various locations in your community, but most people find this approach confusing for evacuation purposes. It is most useful for the public and emergency responders to have a simple boundary of areas that need to be evacuated any time a tsunami threatens to strike.

This chapter discusses two methods to determine areas that will be inundated by tsunamis: (1) tsunami inundation modeling and (2) selecting a reasonable elevation for evacuation purposes. The first method—tsunami inundation modeling—produces the most accurate results at the highest cost and takes the most time. The second method—selecting a reasonable elevation and evacuating all lower areas—requires very little cost and technical expertise and produces acceptable information for evacuation maps if more advanced options are not feasible. It requires knowledge of your community, advice from experts, good judgment, and decisions about acceptable levels of risk.

## Method 1: Tsunami Inundation Modeling

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 inundation maps for your community. There are various technical approaches to inundation mapping, some requiring more data inputs, technical skills and resources than others, but all require the involvement of highly trained tsunami inundation modeling specialists. The data and technical inputs required for inundation mapping are expensive and can be difficult to access. This expense and effort produces 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 identification of areas that could be flooded and estimated water depths, current strengths, wave heights, and wave arrival times. Generally this analysis is conducted for a "worst case" tsunami, but it can also indicate the likelihood of tsunamis of various sizes.

Emergency managers and decision makers are provided detailed technical results that can be simplified into tsunami hazard zones for evacuation maps.

[show output example: zones estimates of max inundation depth]

### Method 2: Select a reasonable elevation and evacuate all lower areas

The technical skills and data requirements for the first method of inundation mapping 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 as 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, although it is possible for very large tsunamis to be destructive above this elevation.
(2) Select a locally relevant elevation: This could be the maximum height of a historical tsunami in the community or be based on geological evidence of pre-historic tsunamis.
(3) 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.
(4) Base on storm surge experiences: If your community has experienced heavy flooding from the ocean due to coastal storms, cyclones, or hurricanes, areas flooded by these storms could be similar to areas subject to tsunami flooding. Designate areas flooded by past, large storms as tsunami hazard zones.

In addition to areas along the coast, low-lying areas along bays or inlets that connect to the ocean and up to three kilometers inland along rivers should also be designated as tsunami hazard areas.

This method of classifying tsunami hazard zones requires judgment rather than technical skill. The boundaries of tsunami hazard areas can have serious implications for the safety of community residents. This type of risk decision may be best handled by a group that includes elected leaders, government officials, professors, engineers, and others including scientists knowledgeable about tsunamis who can help everyone understand the implications of their choices.

## *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 have the following characteristics:

- Out of reach of probable tsunami inundation,

- Reachable by foot by people in the community within a reasonable length of time, and
- Capable of holding the number of people who will need to evacuate.

In some communities, there are no natural hills or high elevation locations that are nearby. Communities with this situation can recommend people evacuate to the upper stories of tall, well-built buildings, generally the third story or higher. This is referred to as vertical evacuation (see box). 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.

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.

**Vertical Evacuations**

Tall buildings can be used for evacuation in tsunamis if they are well designed and well built. 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 above the tsunami waters.

Vertical evacuation can be a good choice in communities where ground at high elevation is too far away for people in some neighborhoods to reach. It is also a good strategy in densely populated cities where the number of people who need to evacuate would overwhelm road networks.

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 sound structural engineering;
- Constructed of reinforced concrete or steel; and
- Well maintained, with materials in good condition.

Buildings with an open first floor might be best for vertical evacuation, because buildings with solid walls trap tsunami waters and place great forces on the building structure.

In areas with risk of locally generated tsunamis, it is important that buildings designated for vertical evacuation are structurally able to withstand earthquake shaking as well as battering from tsunami waves. The most common types of 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.

## *Step 3: Recommend Evacuation Routes*

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 they are most familiar with. 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 rational, but they may not lead to the safest and most efficient evacuation routes in a tsunami warning.

Evacuation maps and plans should recommend the best routes for people to use in evacuations. These routes should keep in mind the natural inclinations of people, discussed above, but should also consider safety and efficiency factors. Evacuation routes should be wide streets that can accommodate many people. Avoid roads with choke points, such as narrow areas or complex merges. 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 that face a high risk of local tsunamis caused by earthquakes need to take special care in recommending evacuation routes. Large earthquakes that generate tsunamis can also cause damage to evacuation routes. Bridges could collapse and roads could be blocked by landslides. Buildings could collapse, blocking roadways, injuring people or trapping them in high risk areas. Power lines can collapse, blocking routes and causing hazardous conditions. Evacuation routes in these communities should have the following characteristics:

- Wide streets;
- No bridges, or bridges along route are structurally sound to survive earthquake shaking, as determined by structural engineers; and
- Limited overhead power lines or similar hazards.

Communities can take steps over time to improve their evacuation routes, such as widening routes, removing overhead hazards or reinforcing key bridges. This topic is discussed in more depth in Chapter Six.

**Walking is Best Way to Evacuate**

In most communities, it is best if people evacuate by walking and that they 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 many times 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. 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.

## *Step 4: Hold Workshop 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 including knowledge of and perspectives on the best evacuation routes and safe gathering locations of a wide variety of people. 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 help 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 subsequent preparedness and public outreach efforts.

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:

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

At this stage, it is probably most productive to limit discussions to community leaders and not invite the general public.

At this workshop, you might discuss the following topics:

- Present your analysis of areas to evacuate when a tsunami may be approaching, briefly and without using technical language;
- Explain characteristics of tsunamis that impact evacuation (multiple waves 10 to 60 minutes apart, first wave not largest, waves cannot be outrun, walking best way to evacuate, etc.);
- Suggest possible safe gathering locations and evacuation routes;
- Have the group discuss evacuation issues for different neighborhoods in your community; and
- Reach consensus on evacuation routes and safe gathering locations to recommend to the public.

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

## *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 schematic rather than detailed, precise maps.

The boundaries of tsunami hazard zones are the most important element of an evacuation map. The tsunami inundation 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.

Although maps are critical, 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 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.

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 "close up 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 with basic tsunami awareness information.

[image: include a few more examples evacuation maps.]

## *More resources for Making Evacuation Maps*

[This section incomplete]

### Tsunami inundation modeling

- NOAA Center for Tsunami Research
  This webpage gives an overview of tsunami modeling and research and includes examples of output and links to technical publications.
  http://nctr.pmel.noaa.gov/model.html

- about
- training programs for technical specialists
- Examples

Geologic evidence for pre-historic tsunamis

Topography data resources

Identifying shelter sites

Vertical evacuation

- building standards
- Resources for evaluating the earthquake safety of tall buildings

Evacuation routes

- modeling

Holding effective stakeholder workshops

Examples of evacuation maps from world communities

# Chapter 4. Involve the Community in Tsunami Preparedness

Public outreach programs are a critical component of efforts to get a community ready to evacuate before a tsunami strikes. When a tsunami is coming, people may find out about it in a variety of different 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. The many different ways 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.

Education programs are the *only* way to prepare community members to evacuate when they observe natural warning signs, and they help for all tsunami warnings. The goal of public outreach programs is not only to share basic information about when, how and where to evacuate but also to have people recognize tsunamis as a normal part of coastal living, something that can be prepared for and overcome. This chapter presents four steps to involve members of your community in public outreach programs to improve their tsunami safety:

- Step 1: Plan your approach
- Step 2: Make basic outreach materials
- Step 3: Conduct community outreach activities
- Step 4: Evaluate and improve your efforts

**Disaster Education Does Not Harm the Economy**

People 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 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 instead of facts to spread.

## *Step 1: Plan your approach*

A different public outreach approach makes sense for every community. The approach you plan for your community will depend on many things: the size of your community, the diversity of its population, the types of people and activities that occur in tsunami hazard areas, the current level of preparedness of the community, and the resources you have available, to name some. This step describes how to select the audience(s) you want to focus on and learn how to effectively community with them.

## Selecting your audience

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). If your community is a large city, you may want to focus on one hazardous neighborhood. If your community is small, you may be able to address all high-hazard areas and the groups living and working there.

Your efforts should be focused on groups where you can make a difference, which may or may not be those groups that face the highest tsunami risk. The ability to influence various groups depends on factors as varied as 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?), and the budget and resources for your outreach programs (can you communicate with this group adequately given the funding and people available?).

**Focus on Women**

In most cultures, men take more risks than women. This means that women are often more likely to respond to disaster preparedness education. Women are also more likely to respond to evacuation warnings than men, especially if they are caring for

The thought process necessary for people to evacuate can be a useful tool to help select the audience. When people notice a tsunami warning signal, natural or official, individuals need to decide to pay attention to that signal, remember that it indicates a tsunami might be approaching, remember that they should evacuate to higher ground, and then physically evacuate the area quickly. The individuals who take all of these steps will also probably try to convince their neighbors and loved ones to join them in the evacuation. Some will succeed in convincing others to evacuate, some will not, and some may be dissuaded by others from evacuating. If people begin to evacuate an area, their neighbors may see them evacuating and also choose to evacuate, even if they were unsure about the need to evacuate based on their own observations and knowledge. 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,

**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 they? They're different for every community and social group, but they usually have these characteristics:

- they test lots of new products, approaches and ideas but make careful choices before wholeheartedly adopting them
- they travel or communicate to places and with 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

religious leaders, employers or supervisors, or others.

It is also important to keep the size of the audience that you hope to influence realistic. Even the best education campaigns will not impact everyone in the community. Focusing on making a real difference in a small fraction of the population is a better approach than spreading efforts too thin trying to reach everyone.

## Learning about your audience

Your outreach efforts will be most effective if you understand the lives and attitudes of the audiences you want to focus on. When planning public outreach activities, it is helpful to understand the process most people use to absorb a new idea and take action on it. It is a multi-step and often gradual process. People first learn about the new idea, then recognize its consequences to their life, decide whether to take steps to change in response to this idea, and, if they do change, evaluate later whether these new changes should become a permanent part of their lives. 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 community leaders, peers, and neighbors.

**Things to Learn About Your Audience**

- Who is in a typical family or household? What roles do they play?
- What are typical household and work routines and habits?
- What levels of education and wealth do they have?
- What types of employment do they have?
- What are their ages?
- What are their cultural backgrounds?
- Are they literate?
- What volunteer networks or social groups are active in the area?
- What sources of information do they rely on and trust: television, newspapers, religious leaders, neighbors, others?
- What information sources do they not use or trust?
- How much do they know about tsunamis? What do they believe causes them?
- How much do they know about when, how and where to evacuate because of a tsunami?
- What information that they "know" is incorrect?
- How likely and how serious do they think tsunamis are?
- Do they think of tsunami risk as something they can influence?
- Have they taken active steps to prepare for tsunamis, such as discussing evacuation issues as a family? Have they taken steps to prepare for other types of disasters?
- What issues related to tsunamis and evacuation cause worry or confusion?
- What cultural characteristics will make preparing for evacuations difficult, such as religion, gender roles, family structure, hierarchy, fatalism, routines, etc.?

It is helpful to learn as much as you can about your audience before beginning outreach activities. This includes learning about who they are, what their lifestyles are like, what is important to them, and what they believe. 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. It is important to know how people understand language related to tsunamis, such as what they think the term *evacuation* means. The words that you use may be different from

those used by the audience you want to communicate with.

There are a variety of ways to learn more about your audience, including the following:

- Conduct interviews: talk with different types of people living in the high risk areas (women and men, different social groups, levels of wealth, levels of education, etc.)
- Observe people: understand their routines, practices, the power structure they operate in, 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 may have value.
- Conduct focus groups: Get a small group (8-10 people) of similar people together and have a moderator guide them through a discussion about issues you want to learn about.

## *Step 2: Make Basic Outreach Materials*

You will need some materials that explain the basics of tsunami preparedness to use in your public outreach activities. You might want this information in a variety of different forms, but many communities have found that a versatile public outreach tool is a pamphlet or flier that contains your community's tsunami evacuation map with basic information about tsunamis and evacuations printed alongside.

**Use a Group to Create Materials**

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

- 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
- Builds group cohesiveness that can help all of your tsunami preparedness activities

To develop outreach materials, you need to decide on the substance of the information to transmit to people and how to present that information so that people respond to it. After developing materials and messages that meet these needs, it is helpful to test them on a small portion of the audience to see if people understand and respond to them the way you intend.

### The Substance of the Message

In general, the information people need to know to prepare for evacuations is who should evacuate, when they should evacuate, how they should evacuate, where they should evacuate to, and what they can expect next. It is also necessary to include some basic information about what tsunamis are and the risk facing your community. It can also make sense to present information about risk reduction at this time, such as letting people know that removing beach front dunes can make future tsunamis more damaging. See box page XX for an overview of basic information the public should know about evacuations.

**People Need to Know High Hazard Areas**

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.

Source: XXXXX

The information presented should always include as much locally-relevant content as possible. This means that information about tsunami risk should be focused on where and how a tsunami will impact your community, 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. By focusing on local information, rather than tsunami issues in general, people will feel like outreach efforts are presenting information that is relevant to them and that they should pay attention to it.

Some messages for specific audiences are described below:

- Families: Tsunamis can happen at any time of day or night, and it is critical that each family member know exactly what to do if an evacuation warning occurs when they are at home, work, school, shopping or anywhere else. Each family member needs 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, beach-side restaurants and other businesses that rely on tourists can be trained to mobilize tourists when a tsunami might strike.
- Fishermen and Boaters: Tsunamis are barely noticeable in the deep ocean and only become destructive close to shore. Boats that are out at sea when a tsunami is coming should remain at sea in water at least 50 meters deep [confirm] until the tsunami is complete and currents in harbor areas have calmed. Boats that are in harbor may want to head out to deep ocean if there is adequate time. If a locally

**Natural Tsunami Warning Signs: Critical Information for All Audiences**

Before a tsunami strikes shore, one or more of the following natural warning signs may occur:

- Strong earthquake shaking that makes it difficult to stand or lasts more than 30 seconds
- The ocean withdraws to abnormally low levels
- A loud noise comes from the ocean, like a jet airplane, sudden downpour of rain, or explosions

People should immediately head to high ground if they observe any of these signals, without waiting for additional warning.

generated tsunami may be coming, 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.

**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 many lives.

Source: BBC

- 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 needs 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 arrangements. Education campaigns towards these groups should be focused on management and staff. The goal should be to get these institutions to create facility-specific disaster plans and to practice regular evacuation exercises.

**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 needs to evacuate.
- Tsunamis generally impact low-lying areas near the coast and along rivers and bays that connect to the ocean.
- Families should develop a plan so that every member of the family knows to evacuate, even if they are not together at the time a tsunami warning occurs. This includes identifying a safe location where everyone will gather after they evacuate.
- 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. A tsunami surge could arrive in minutes or seconds. Natural tsunami warning signals include:
  - Strong earthquake shaking that makes it difficult to stand and/or lasts more than thirty seconds.
  - The ocean withdraws to abnormally low levels.
  - 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 safe evacuation sites if necessary. It is always better to leave the tsunami hazard zone if time permits.
- If there is no high ground nearby, evacuate as far inland as possible. Even without climbing in elevation, it is safer further 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 sometimes survive 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 have lethal debris and contamination 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.

## The Style of Presentation

The way that information is presented strongly affects how people respond to it. Your materials should use simple and clear language. Avoid technical language and jargon. Most people do not respond well to detailed numerical information, such as probabilities of a disaster event occurring, but think about disasters in more simple terms: tsunamis are or are not something I need to worry about. Limit the amount of scientific and technical information included in basic education programs to avoid overwhelming people.

Education programs and materials should focus on telling people what they can do to protect themselves. Fear tactics are not an effective education tool. 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.

**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, ranging from changing illustrations to look like people in your community to carefully editing the language to reflect local beliefs, behavior, and conditions.

As much as possible, people should hear consistent messages from all sources and over time. If there are any changes to the message a campaign is giving people, perhaps from an error or from new technical studies, it should clearly explain why the message has changed. If people hear multiple, differing messages—especially if they hear conflict among "experts"—they may get confused and disregard all of the information. Partnerships among many community groups can help keep communication consistent. There will 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.

Partnerships with and endorsements from a wide array of community groups can also increase how receptive people are to your message. It is important to both maximize positive reactions and minimize negative ones with these choices: if people mistrust the person or groups associated with your outreach efforts, they will not succeed.

**Test Your Materials Before Using Them**

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 the way you intend them to?
- Do they understand the main points you are trying to make?
- Did anything 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?
- What things about the message do they like or dislike?

[image: an example tsunami public education flier that we like. ]

## *Step 3: Conduct Community Outreach Activities*

There are endless options of ways to educate members of your community and involve them in tsunami preparedness activities. 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 continually remind people 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 to your community and be ready to respond to it.

Some of the activities or methods you could use to educate your community and motivate them to prepare include the following:

- Community meetings
- Workshops for tourism based businesses
- Workshops for fishing industry
- Emergency planning for schools
- Emergency planning for hospitals
- Community evacuation drills
- School evacuation drills
- Neighborhood preparedness teams
- Rallies or marches for preparedness
- Presentations to community clubs and organizations
- Street 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 including tsunami preparedness
- Web pages
- Disaster risk information center

This section discusses a small number of these ideas and presents examples of how world communities have implemented them.

### Community Meetings

Public meetings or forums are a good way to introduce 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

**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 posted 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 phone directory, which is distributed free to everyone with a telephone.

[image of map from Hawaii phone book]

basic information such as what tsunamis are, the location of hazardous areas in your community, and basic information the public needs to know about evacuating (see box page XX). Leave plenty of time for the public to ask questions to the speakers and for general discussion of tsunamis. Distribute evacuation maps to everyone who attends.

This type of event not only educate the public but 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.

## Community Evacuation Drills

Evacuation drills simulate a tsunami warning at a pre-scheduled time. They range from internal exercises only for emergency responders to community events that have residents move to higher ground, just as they would during a real tsunami evacuation. Different types of drills have different advantages and risks, and not all types make sense for all communities.

| *Type of Drill* | *Does it Make Sense?* |
|---|---|
| "Table Top" exercises for emergency responders only | Recommended for all communities |
| School or specific facility evacuation drill | Beneficial in almost all communities |
| Community evacuation drill of a small community | Often beneficial: many communities have done successfully |
| Community evacuation drill of a small neighborhood in a large community | Often beneficial: many communities have done successfully |
| Community evacuation drill of a large community | Risks may outweigh benefits: challenging to organize, many things can go wrong |

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

Evacuation drills are complicated to organize well, so it is critical to plan for them carefully or they can discredit plans and officials. A badly run drill can create a negative public impression of emergency planning that will be difficult to overcome. Officials often express worries that an emergency drill will scare residents, tourists and investors. In reality, people generally feel safer and more prepared for disasters after a well-run evacuation drill.

Generally, it is not a good idea for hospitals and the elderly to participate in evacuation drills because of health risks. Emergency officials will be blamed for any injuries, such as heart attacks, that occur during a drill, whether they were related to the drill or not. Hospitals and institutions caring for vulnerable populations should be encouraged to do

mock drills, where their staff practice what they would do during an evacuation, but the vulnerable population do not physically participate.

A necessary first step is for emergency officials to conduct an internal, table-top evacuation exercise before holding one that involves the public. A table-top evacuation exercise would have every important emergency agency practice how it receives tsunami warnings, communicates with other agencies, alerts and warns the public, and mobilizes 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 identify major problems in evacuation planning and train personnel. It is a valuable exercise whether drills involving the public are planned or not.

School evacuation drills are a good first step involving the community. These drills help 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 as well as delaying the parents' evacuation to safety. Schools should involve parents in planning drills so they understand exactly what will happen to their child during an emergency.

**Tips for a Successful Community Evacuation Drill**

- Plan for the drill 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 drill more effective.
- Schedule the drill 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 drill widely. Everyone should know the event is a drill. 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 advertising the event widely.
- Develop a plan to manage traffic. Have 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 drill effectively. Traffic control officers should stay in place for awhile after the drill ends while people slowly return.
- Make the warning as real as possible. To trigger the drill, make the alert signal as close as possible to they way it will occur in a real tsunami warning. People will expect a real evacuation to happen in the same way as the drill.
- Provide information about what to do in the drill. Prior to the event, use as many methods as possible to tell people what to do in the drill, including what time the drill will occur, what alert signal to listen for, where to go, route recommendations, whether to go by foot or car, what to expect when they arrive, and what to do after the drill.
- Train volunteers and emergency officials before the drill. Volunteers and emergency officials should know what to do, what to say to the public, and should wear identifiable clothing.
- Actively work with the media. They can mobilize people at the time of the drill, make sure people know it is a drill and not a real emergency, and 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 drills that happen during work hours. These employees can report back to their workplace on what to do.
- Involve tourist industry. Hotels and other tourism related businesses should have signs or employees informing visitors about the drill to avoid confusion. Tourists need not participate.
- Distribute evacuation maps. Before and during the drill, 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 people ready to inform and reassure people.
- Ask people about their experiences in the drill. Ask people who evacuate in the drill to complete a written survey or speak to a volunteer interviewer and explain their experience. This is a great opportunity to learn how to improve emergency plans.
- Have a public discussion about the drill after it is over. A community discussion of what was learned during the drill, open to the public and media, is a good way to get opinions, improve emergency plans, and make the public feel like their concerns are heard.

## Neighborhood Preparedness Teams

Many communities have had success organizing neighborhood or community emergency response teams. These teams can be focused not only on tsunami issues but on all types of disasters that could affect your community. The basic idea is to organize volunteers in a small neighborhood area that are willing to take responsibility for specific tasks to prepare their neighborhood for a disaster and help their neighbors survive and cope during an emergency. These teams should work in coordination with official emergency responders. Programs can be designed specifically to train the volunteers. 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 they 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 evacuate.
- Develop neighborhood-level systems to spread tsunami evacuation alerts and warnings and make sure everyone evacuates, such as bicycle messengers.
- Conduct neighborhood-level evacuation drills

All of 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 understand and take ownership of their neighborhood's risk and what they can do to be ready for it.

**Mother Develops Program to Help Her Community's Vulnerable 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 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, personal communication

**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 run up maps and guidance on what to do during a tsunami. Volunteers reported 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 in the event of this tsunami warning.

Source: Darci Connor

## Tsunami Signs

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

[insert images of tsunami signs from around the world – US, Japan, Thailand]

## Memorials to Past Tsunamis

If your community has experienced a tsunami in historic or prehistoric times, memorials or activities that remind people of that event can be powerful tools to educate them about tsunamis and convince them to prepare. Prehistoric tsunamis can be identified by geologists looking at layers of sediments deposited in the ground. High water marks, showing the depths of tsunami flooding in a past event can help people visualize damage from future tsunamis. Stories or legends about past tsunamis can also help people connect to lessons learned by their ancestors. This happened in Simuelue Island, Indonesia (see box page XX), where nearly all island residents survived the mega-

tsunami of 2004 because they had learned from a folktale to head to high ground if they felt earthquake shaking.

[image: Banda Aceh tsunami monuments]

**Obi's Story**

This folk story from the native American Hoh Tribe in Washington State, USA, is used to educate primary students about tsunamis. It is based on a story passed down about a large tsunami that struck the Washington coast in 1700.

A boy, Obi, noticed a canoe up in a tree. He asked his father about it, who told him that many summers ago they had heard the bears howling, then the earth shook, and then a huge wave came that carried that canoe high up into the tree where it got stuck.

Later, Obi heard the sound of bears howling in winter, when all of the bears should have been asleep. He ran to tell his father. His father did not know whether to believe Obi, a little boy. But when the chief of the village came, Obi told him about the bears. The chief, knowing Obi to be an honest boy, gathered all of the villagers together and told them to run to high ground if the earth shook. Very soon thereafter, the ground shook violently for a long time. Everyone in the village ran to high ground, as the chief had told them to do. Then they watched as a large wave destroyed everything in their village. The chief held a special ceremony to honor Obi for saving the lives of everyone in the village.

Source: Washington State Emergency Management Division, as told by Viola Riebe

## *Step 4: 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 all of your programs at preparing community members to evacuate safely and quickly when a tsunami might be approaching will allow you to learn from your mistakes and increase the effectiveness of future endeavors. Some ideas for how to evaluate your programs include:

- Distribute questionnaires at events such as community meetings or evacuation drills. How did people learn about the event? This is an easy way to find out which publicity messages people listened to and responded to. 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 of 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.

## *More resources for Involving the Community in Tsunami Preparedness:*

[This section incomplete]

Designing outreach campaigns

Formative research tools

Guidelines for hazard education

Developing outreach materials

Preparedness for tourism industry

Preparedness for fishing industry

Emergency planning for schools

School curricula for tsunamis and other hazards

Conducting evacuation drills

Neighborhood preparedness teams (CERT)

Tsunami signs

Evaluating outreach campaigns

# 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 let people in areas that might be struck by a tsunami know to evacuate in advance. Since the 2004 Indian Ocean tsunami disaster, considerable effort has been placed on 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 have a high likelihood of failing to adequately warn people to evacuate when a tsunami is approaching. This is partly because official warning systems are very complex and it only takes one part of the warning system working improperly to make the whole system fail. It is also partly because official warning systems usually do not have time to warn communities for 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, in case official systems fail. 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 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 you know weak links that need improvement. If your outreach efforts emphasize natural warning signals, you need to explain to the public why this emphasis is important.
- **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 that people respond to, and
E. Ongoing maintenance and testing to make sure the systems works in an emergency.

Each of these elements plays an important role in mobilizing the community to evacuate before a tsunami strikes. An effective warning system will determine when the chance of a tsunami striking the coastline is high enough to warrant an official evacuation; grab people's attention while they are going about their daily lives; inform them about the potential approaching tsunami; instruct them to leave low-lying coastal areas and evacuate to safer, high elevation locations; and let them know whether and when it is safe to return to their homes.

**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 around the world, 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 characteristics.

## 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:

- roles and responsibilities of each organization and people within each organization;
- communication between organizations, including which organizations communicate with others and how the communication is conducted (e.g. special telephone lines);
- 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
- path to transmit technical information about the tsunami threat from international or national scientific warning centers to emergency managers and political decision makers.

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 local level officials responsible for mobilizing an evacuation. 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 that could have generated a tsunami. 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.

**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.

Panic can occur in some disaster situations, typically when people are trapped in a space with limited exits.

It is important that officials think through 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 not need to have specialized technical knowledge to interpret the risk information they are receiving from scientists. Those decisions should be made in advance, and decision makers should know that if a certain type of message arrives, they should behave in a certain way. Doing this in advance allows these critical decisions to be made in a logical and consistent way that maximizes community safety.

If individual officials need to make evacuation decisions on their own during an emergency, 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. In many cases, warnings will be issued too late because emergency officials often err on the side of doing nothing.

**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 undamaging 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

**Example 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
- Banners/signs

An alert system allows officials to interrupt people's daily lives and 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 seeking local authorities, 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 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 technical functioning of equipment and practicing any actions that people need to take to make the system work.

**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: Based on Atwater et al, 1999

## D. Warning Messages

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

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 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.

There are many aspects of how an evacuation warning message is presented that determine whether people find it credible and follow its urging to evacuate. The most important characteristic of a message is consistency. 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 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.

**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."

Evacuation warning messages should be written in advance as much as possible. Officials should then customize the message for each specific event. It is important to use very simple language that everyone, including the very young and the very old, can understand. No technical language of any sort should be used. It is an excellent idea to test an example evacuation warning message 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 by 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 the community should be evaluated to determine which methods of communicating a warning would be absorbed 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 is 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 be functioning.
- 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 is likely to fail. It is essential to regularly test, drill 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 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.

**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. 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. Without information, people may return home before it is safe to do so.

## *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—a critical part of tsunami preparedness discussed in the previous chapter—need to inform people 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 changes.

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 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 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 investing in.

## *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 on their agenda. They may not have time or ability to learn about tsunami warning systems. You can help them 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 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 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 children, disabled people or others who need assistance evacuating.
- **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 by assisting to plan for, conduct and fund these critical activities.

## *More resources about Official Tsunami Warning Systems:*

[This section incomplete]

### Overview of official warning systems

- Tsunami Teacher
  This web resource covers many topics about tsunamis, including describing the international tsunami warning system and discussing needs for newly established warning systems.
  http://ioc.unesco.org/TsunamiTeacher

- An Introduction to Public Alert and Warning
  This document provides a brief overview of what makes warning systems effective, including warning system, warning messages, and alerts.
  http://www.partnershipforpublicwarning.org/ppw/docs/handbook.pdf

Alert signals

Warning messages

Conducting table-top evacuation exercises

# Chapter 6. Prevent Tsunami Damage

Evacuations save lives, but all of the buildings, roads, property and everything else in your community that gets hit by a tsunami is likely to be damaged or destroyed. Tsunamis can cause devastating economic harm that is difficult to rebound 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.

**Tsunami Risk Reduction: Politically Tricky?**

It is predictable that many powerful forces will oppose efforts to educate people about tsunami risk reduction practices, such as changing land use and building practices. Development of beachside areas is often highly politically charged, and companies or individuals with great wealth and political clout may be firmly opposed to any education messages that tell people that removal of beach dunes or construction near beaches is unadvisable. Identify people who are likely to oppose this message and try to include them in early planning. By including them in discussions, it may be possible to identify compromise approaches that work for everyone.

## *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 to accommodate 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, strengthened.

**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 steep cliff sides to help people climb to high ground.

[image: photo of ladders]

Source: Costas Synolakis

### 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 page XX). 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 the locations that face the highest hazard from 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 encourage or provide incentives for relocating critical uses, 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 significantly reduce tsunami risk 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. Typically, reinforced concrete and steel buildings 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 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, 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, 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 resisting 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 they are politically unpopular because they completely change the look of and access to the waterfront.

## *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 law makers, 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, 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.

## *More resources about Preventing Tsunami Damage:*

[This section incomplete]

### Mitigation for tsunamis

- Designing for Tsunamis: Seven Principles for Planning and Designing for Tsunami Hazards
  This guidebook describes how to build communities that are resilient to tsunamis. http://www.oes.ca.gov/Operational/OESHome.nsf/PDF/Tsunamis,%20Designing%20for%20/$file/DesignForTsunamis.pdf (There must be a shorter web link??)

### Building Codes

- At Risk: The Seismic Performance of Reinforced Concrete Frame Buildings with Masonry Infill Walls
  This resource describes the risk of one of the world's most common and deadly type of high rise buildings to earthquake shaking. It describes how to design and build RC frame buildings properly, and how to retrofit existing structures. http://www.world-housing.net/Tutorials/Complete_WHE_RC_Tutorial.pdf

Site specific walls or berms

Advocating for mitigation

# Chapter 7. Keep Preparedness Going Long-Term

Convincing people to take steps to prepare for tsunamis takes time. An effective program to truly change the preparedness of your community for tsunamis will require years, 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 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.

Many different issues will impact 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 with 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 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 conduct community awareness events.

Communities can survive tsunamis if they prepare. Someday a tsunami is likely to strike your community, although no one can predict when. It may be years, decades, or generations before it comes. When it does come, hopefully the families, businesses, government, and everything else that matters in your community will 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.

# Citations