



ACKNOWLEDGMENTS

The International Coordinating Group for the Tsunami Warning System in the Pacific of the Intergovernmental Oceanographic Commission of UNESCO, at its Thirteenth Session in Ensenada, Mexico (September 1991), encouraged the preparation of a book designed to inform young persons about tsunamis, the dangers which they present, and what should be done to save lives and property.

The authors of this book are Dr. George Pararas-Carayannis, Ms. Patricia Wilson, and Mr. Richard Silcox, and the illustrations were created by Mr. Joe Hunt.

To learn more about tsunamis and what you should do when a tsunami is coming, we encourage you to read *The Great Waves*.

This book was revised by the International Tsunami Information Centre in June 2005, and reprinted with the support of the Hawaii State Civil Defense and the U. S. National Tsunami Hazard Mitigation Program.

Bibliographic reference:

UNESCO-IOC. *Tsunami Warning!* IOC Information Document No. 1223 (IOC/INF-1223)

Printed by: Hawaii State Civil Defense

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United Nations
Educational, Scientific and
Cultural Organization

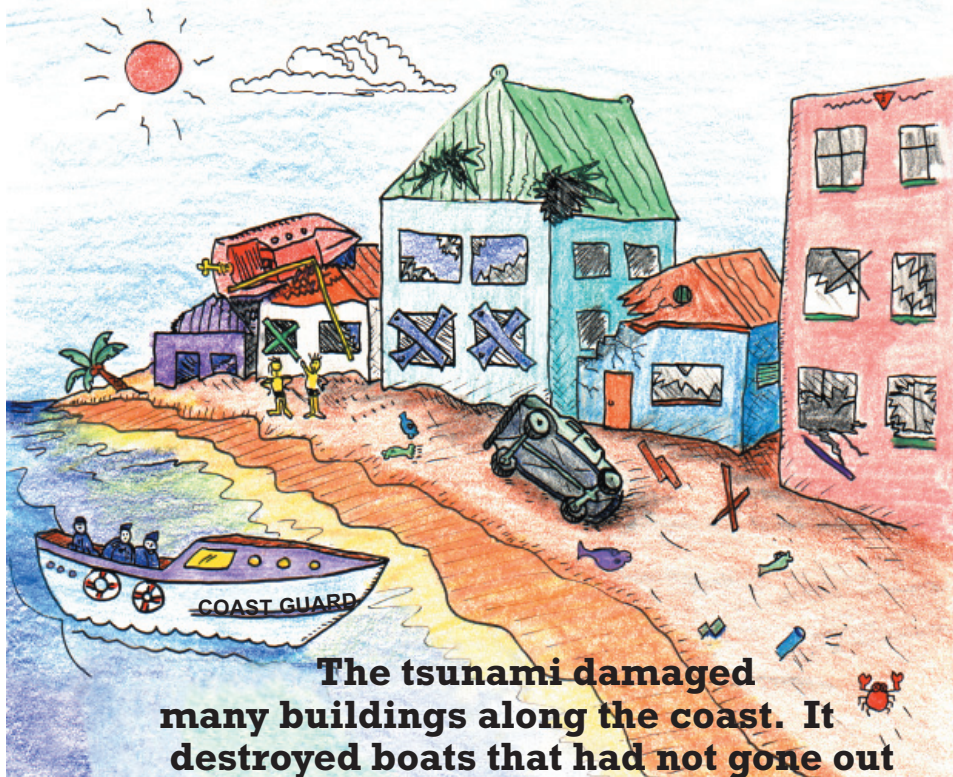


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It is nice to know that the scientists at tsunami warning centers are always on watch for the next sign of a tsunami to protect lives today and in the future.



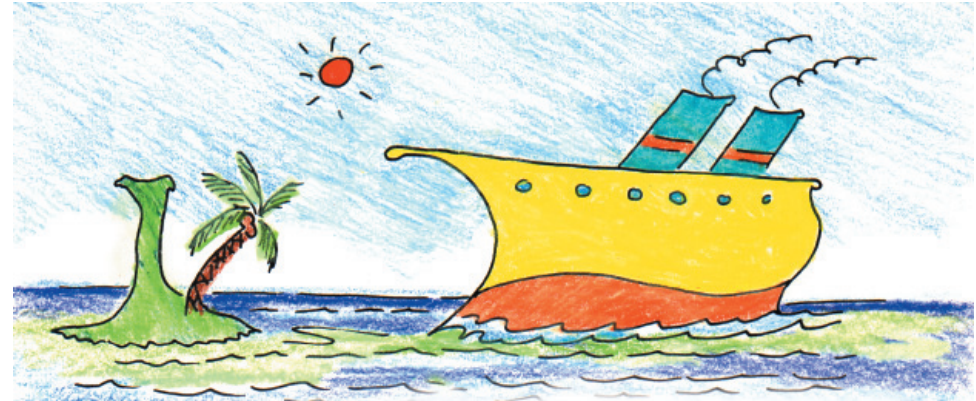
When the tsunami waves become small and do not cause any damage, the Pacific Tsunami Warning Center cancels the TSUNAMI WARNING. Everyone must still wait for the Civil Defense to sound the “ALL-CLEAR” signal to tell everyone it is safe to return to their homes and offices.



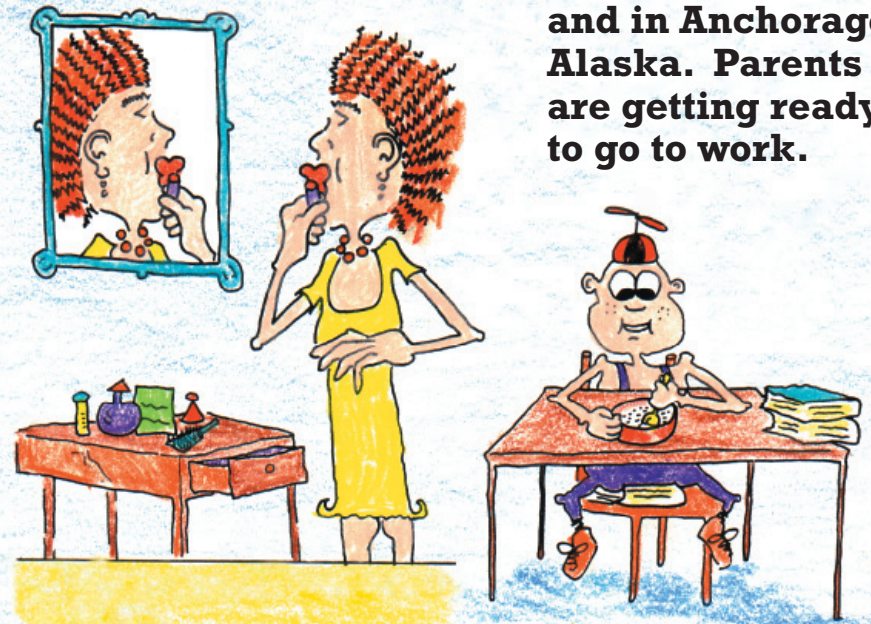
The tsunami damaged many buildings along the coast. It destroyed boats that had not gone out to sea. It tossed cars around like they were toys. It tore open walls and roofs of buildings and flooded all the inundation zones.

Everyone was glad that no one was hurt. They were prepared and knew what to do. Everyone left the inundation zones when they heard the tsunami warning. People now work to repair their buildings so life can return to normal.

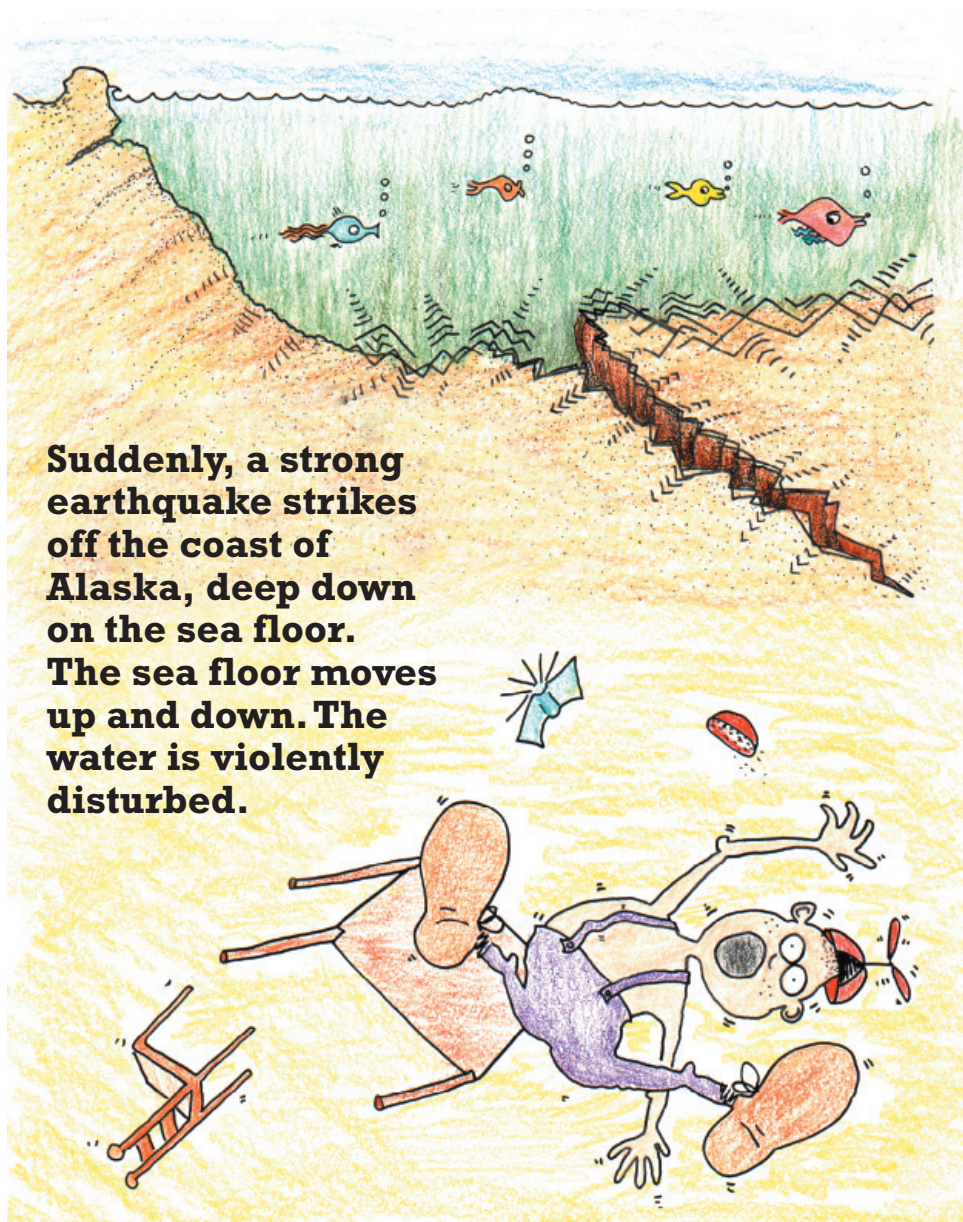
Over the blue, calm water of the Pacific Ocean, a cruise ship is sailing towards Hawaii. It is warm and sunny in Honolulu. A thousand miles away, in Alaska, it is snowy and cold.



It is breakfast time in Honolulu and in Anchorage, Alaska. Parents are getting ready to go to work.

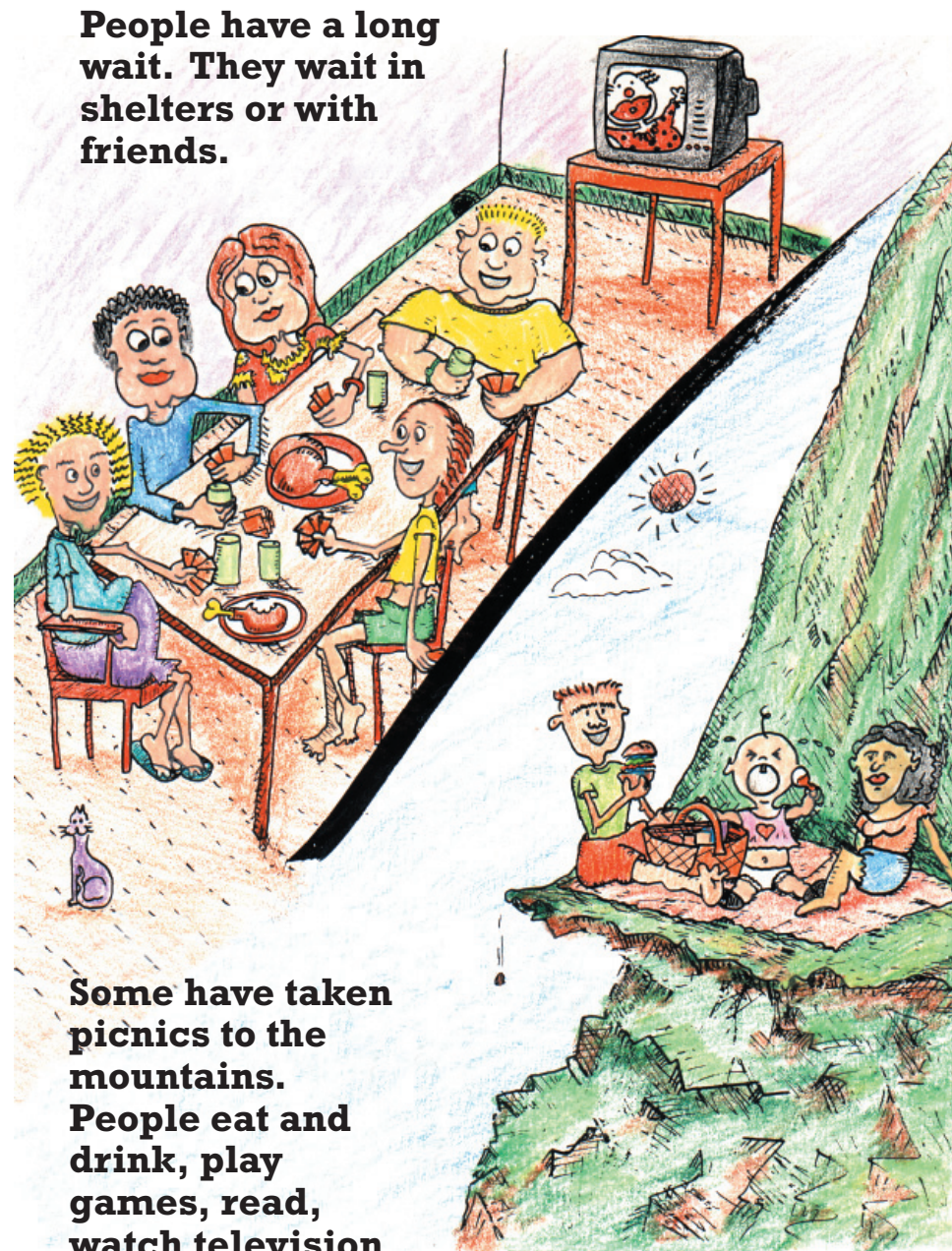


Children are getting ready to go to school.



Suddenly, a strong earthquake strikes off the coast of Alaska, deep down on the sea floor. The sea floor moves up and down. The water is violently disturbed.

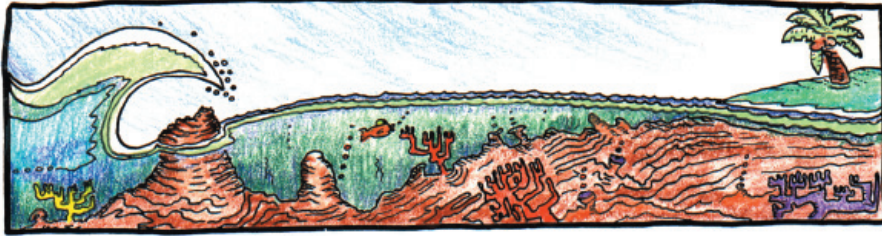
In Alaska, the walls and floors of the houses suddenly start to shake. Chairs topple over. Things rattle and break. Dishes crash to the floor.



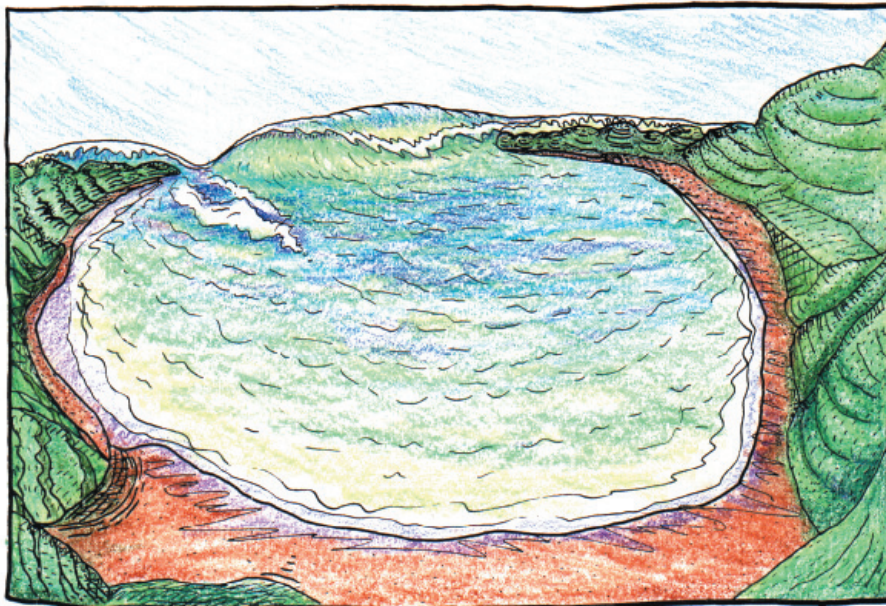
People have a long wait. They wait in shelters or with friends.

Some have taken picnics to the mountains. People eat and drink, play games, read, watch television or listen to the radio. They wait anxiously for the Civil Defense to sound the "ALL-CLEAR" signal.

At 12 noon, the first tsunami wave arrives. Around some parts of Hawaii, coral reefs help to break the force of the tsunami

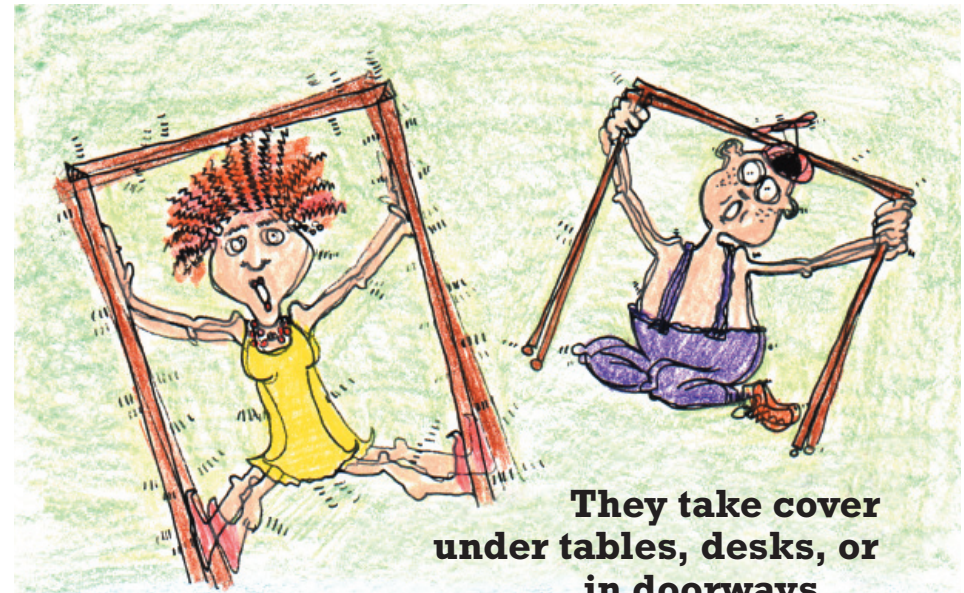


.. Some shores are protected by trees and mangrove forests which lessens the wave force even more. But the waves in these areas can still be large and dangerous.

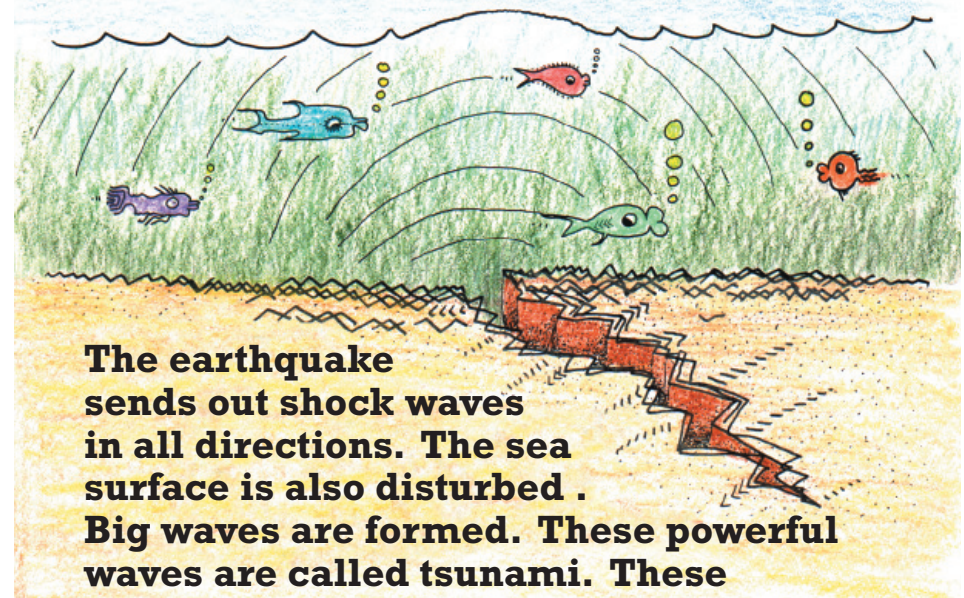


But at bays, the waves can be very big because the sides of the bay shorten the length of the wave and push it upwards. There are six waves in this tsunami and they come every hour for the next six hours.

It is an earthquake! People know what to do. They do not run outside.



They take cover under tables, desks, or in doorways.

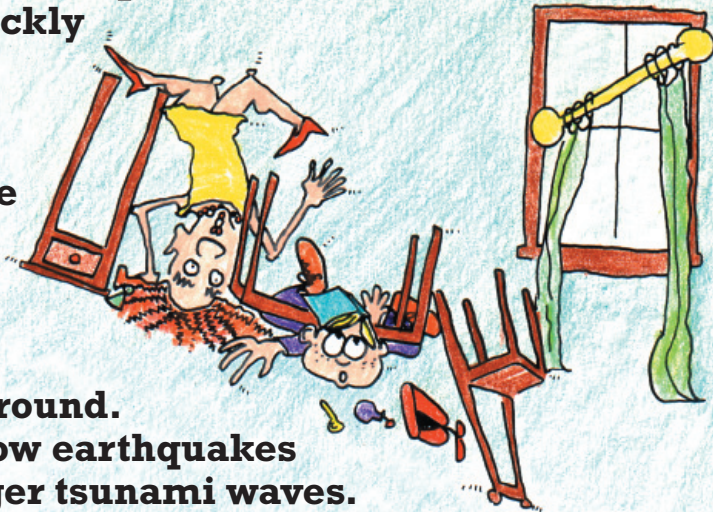


The earthquake sends out shock waves in all directions. The sea surface is also disturbed. Big waves are formed. These powerful waves are called tsunami. These waves travel fast across the sea. They are dangerous and they can kill.

When the shaking stops, people living by sea know what to do. They do not start to clean up the mess.

They quickly leave their homes and move inland away from water to higher ground.

They know earthquakes can trigger tsunami waves.

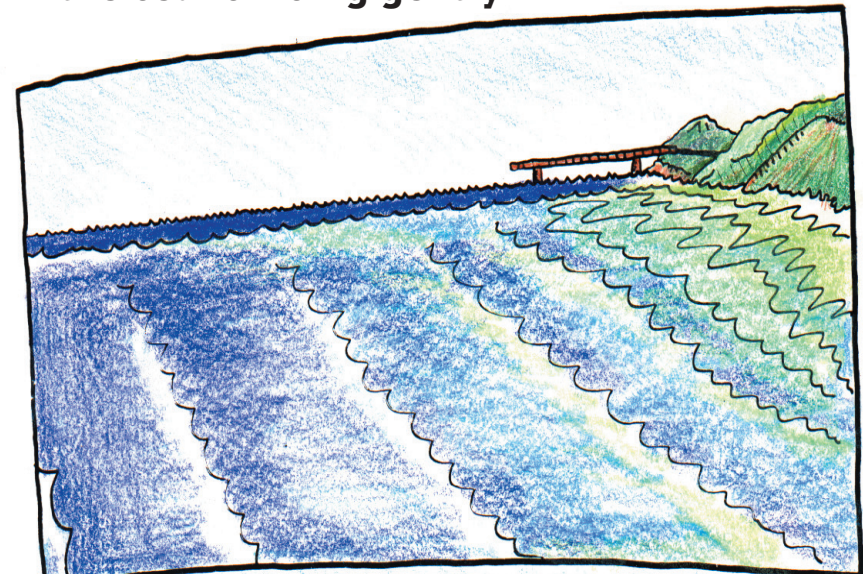


The Tsunami Warning Center in Alaska issues a tsunami warning.

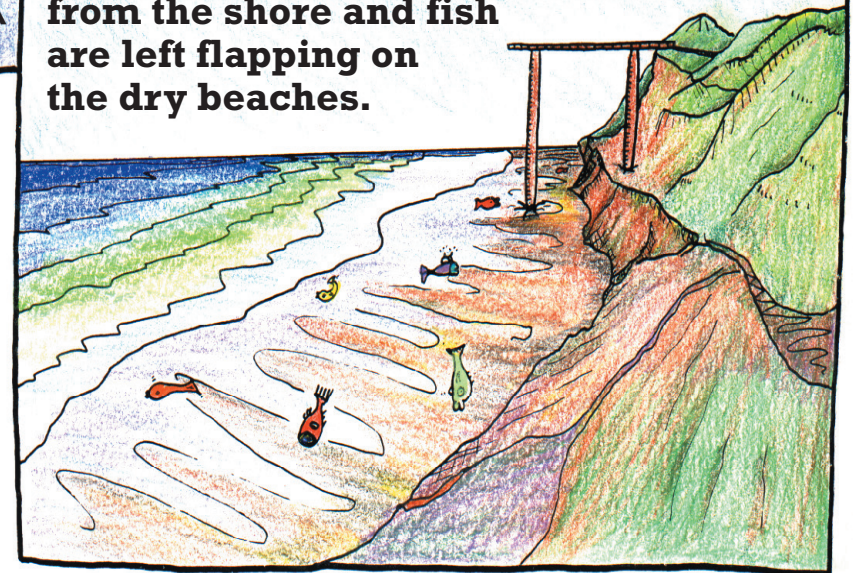


Then the Alaska Emergency Operations Center sounds sirens to warn people a tsunami is expected. There is not much time. People hurry to safety, away from the shore and wait for the tsunami to come.

A few minutes later something strange happens at the beaches. In some places, the sea is rising gently.



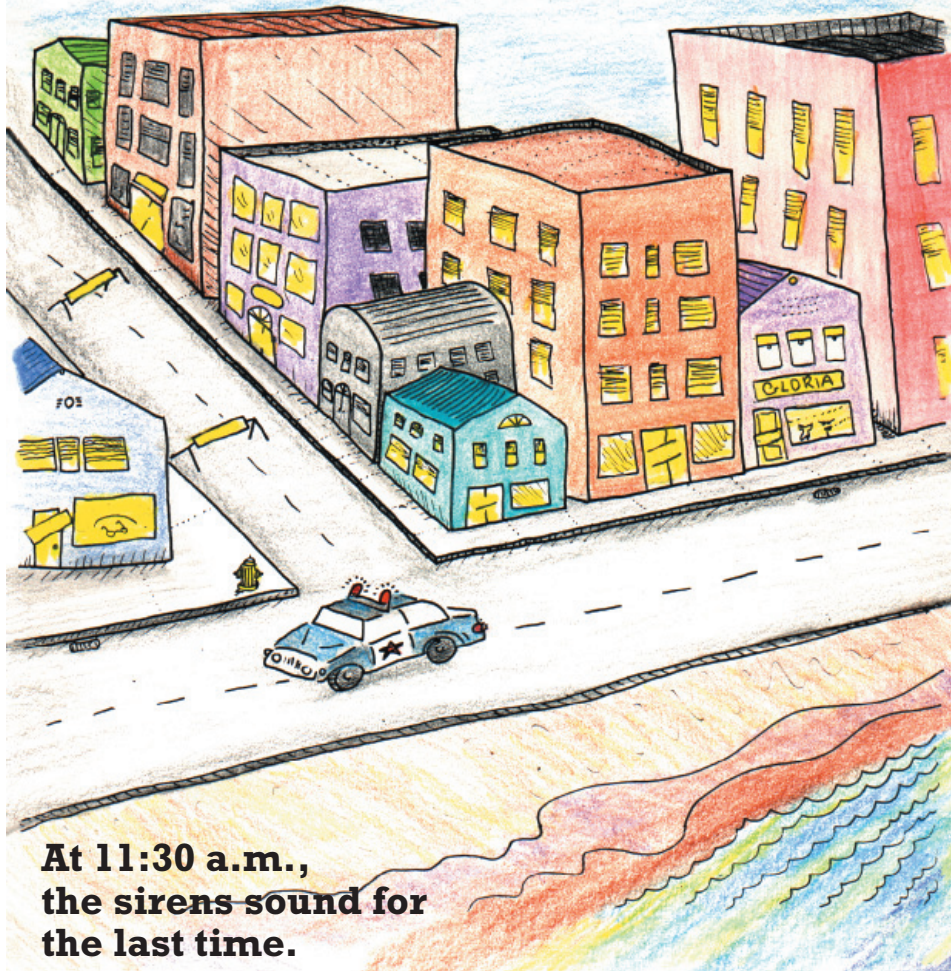
At others, the water is moving back from the shore and fish are left flapping on the dry beaches.



Both rising water and receding water are sure signs that a tsunami is arriving soon.

At 11 o'clock, the sirens wail again. The first tsunami wave is expected in less than one hour. Police are busy checking that everyone has evacuated.

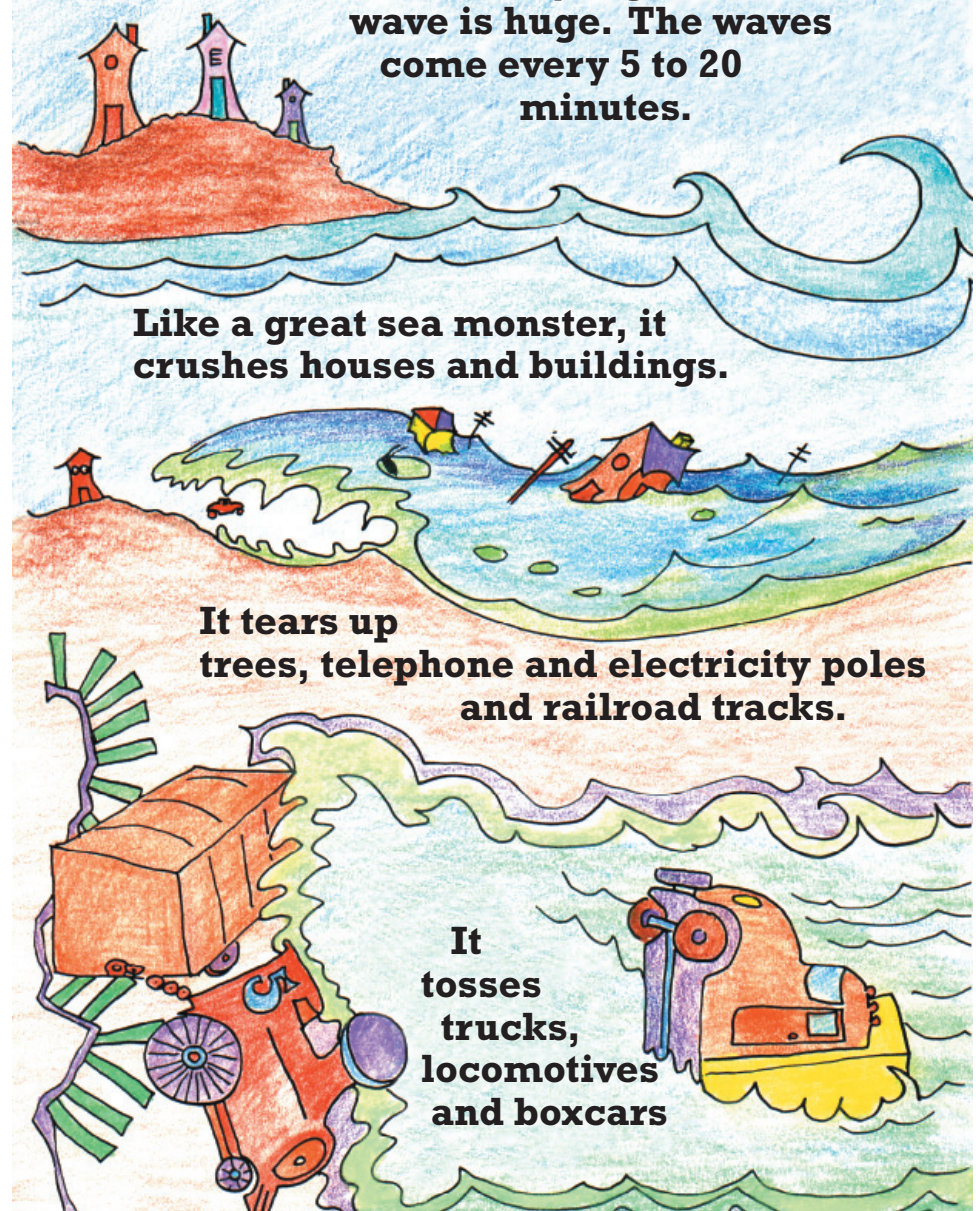
They make sure no one has been left behind in the inundation zones. Then they block off the roads so no one can return to the dangerous areas.



At 11:30 a.m., the sirens sound for the last time.

There is nothing left to do but wait. Everyone expects the first wave to come soon.

The waves of the tsunami start to roll in 10 minutes after the earthquake. This time the first few waves are not very big, but the fourth wave is huge. The waves come every 5 to 20 minutes.



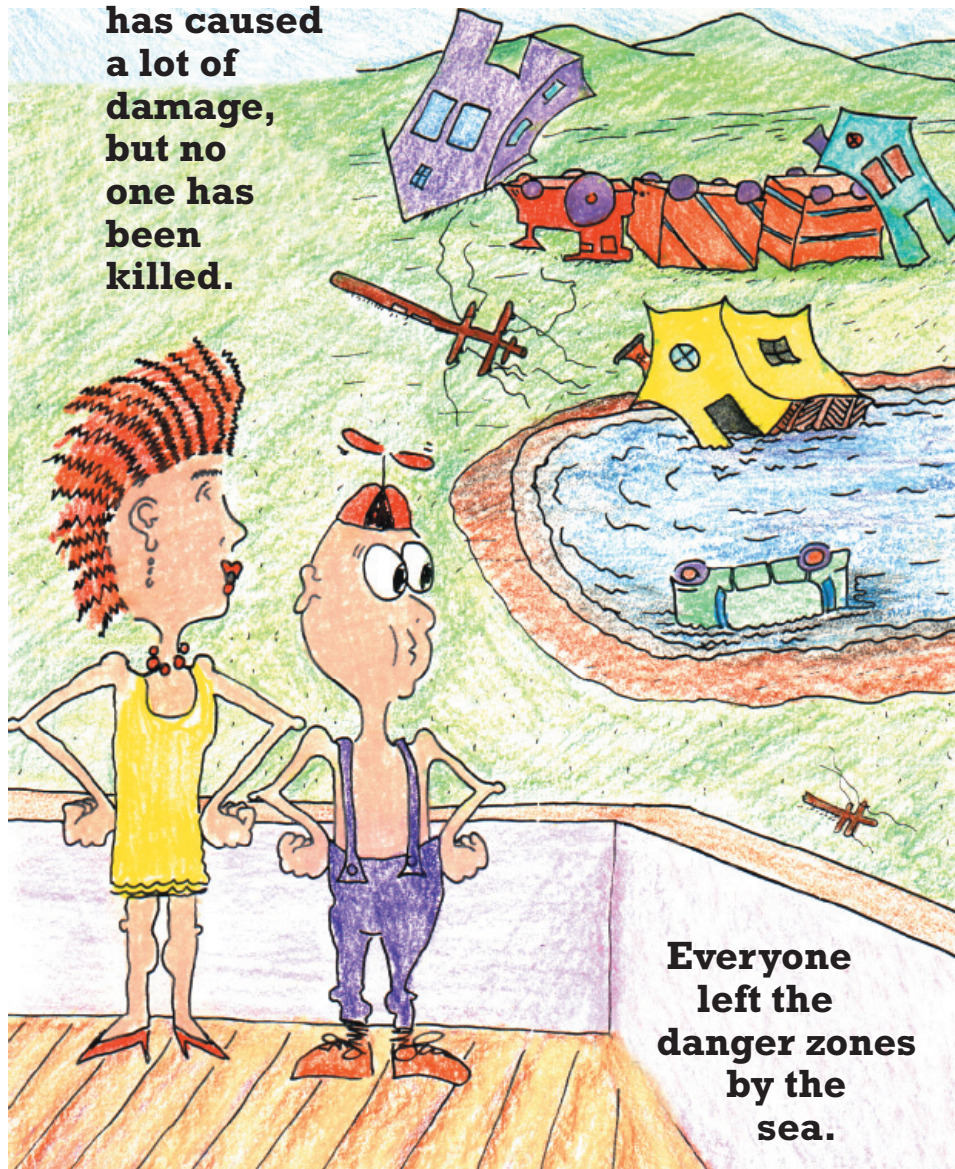
Like a great sea monster, it crushes houses and buildings.

It tears up trees, telephone and electricity poles and railroad tracks.

It tosses trucks, locomotives and boxcars

as it sweeps over the land for about a kilometer (km). It pushes and floods everything over a kilometer from shore.

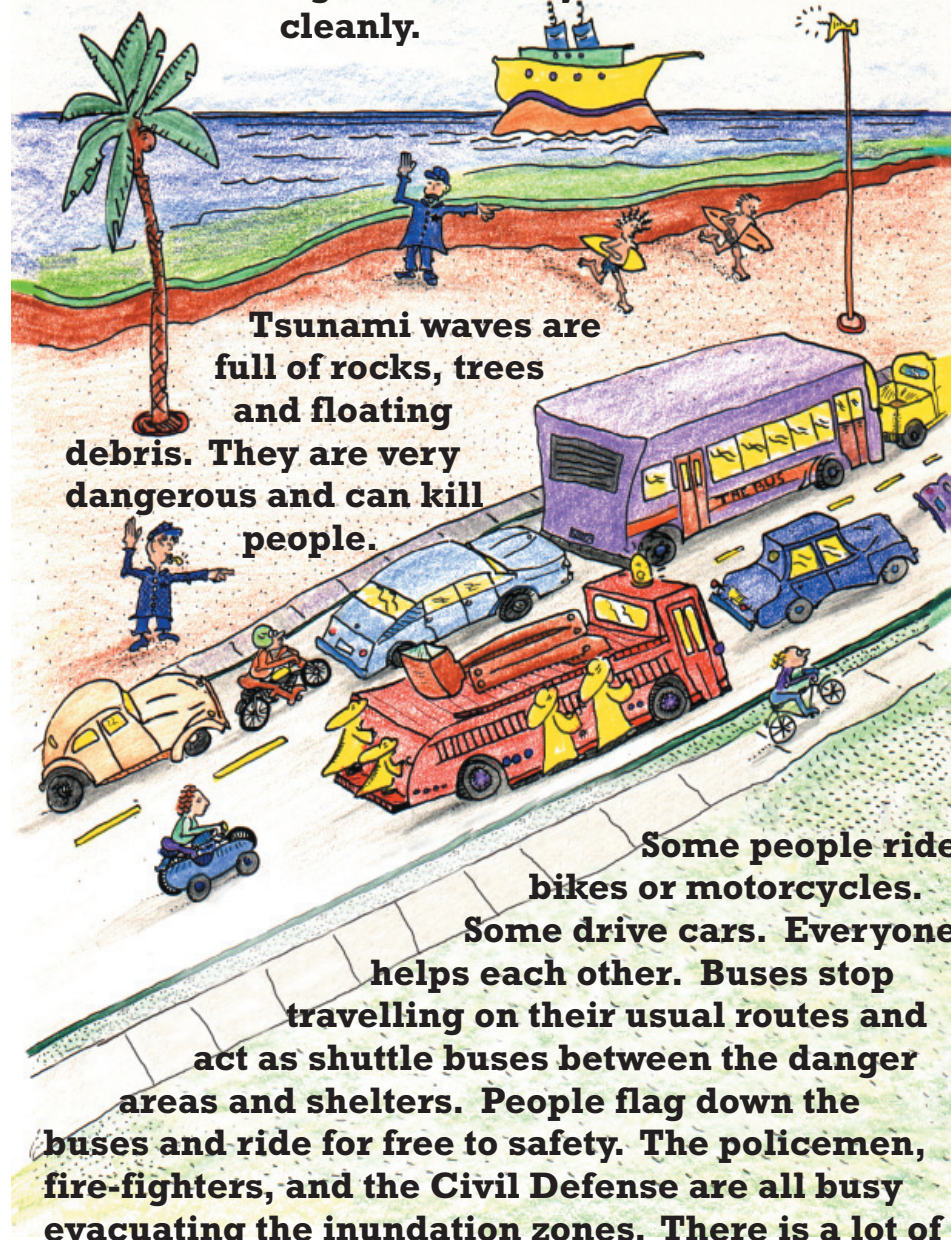
The tsunami waves keep coming but they grow smaller until the danger is over. The tsunami has caused a lot of damage, but no one has been killed.



Everyone left the danger zones by the sea.

Everyone rushed to safety and higher ground. They evacuated the area and were saved.

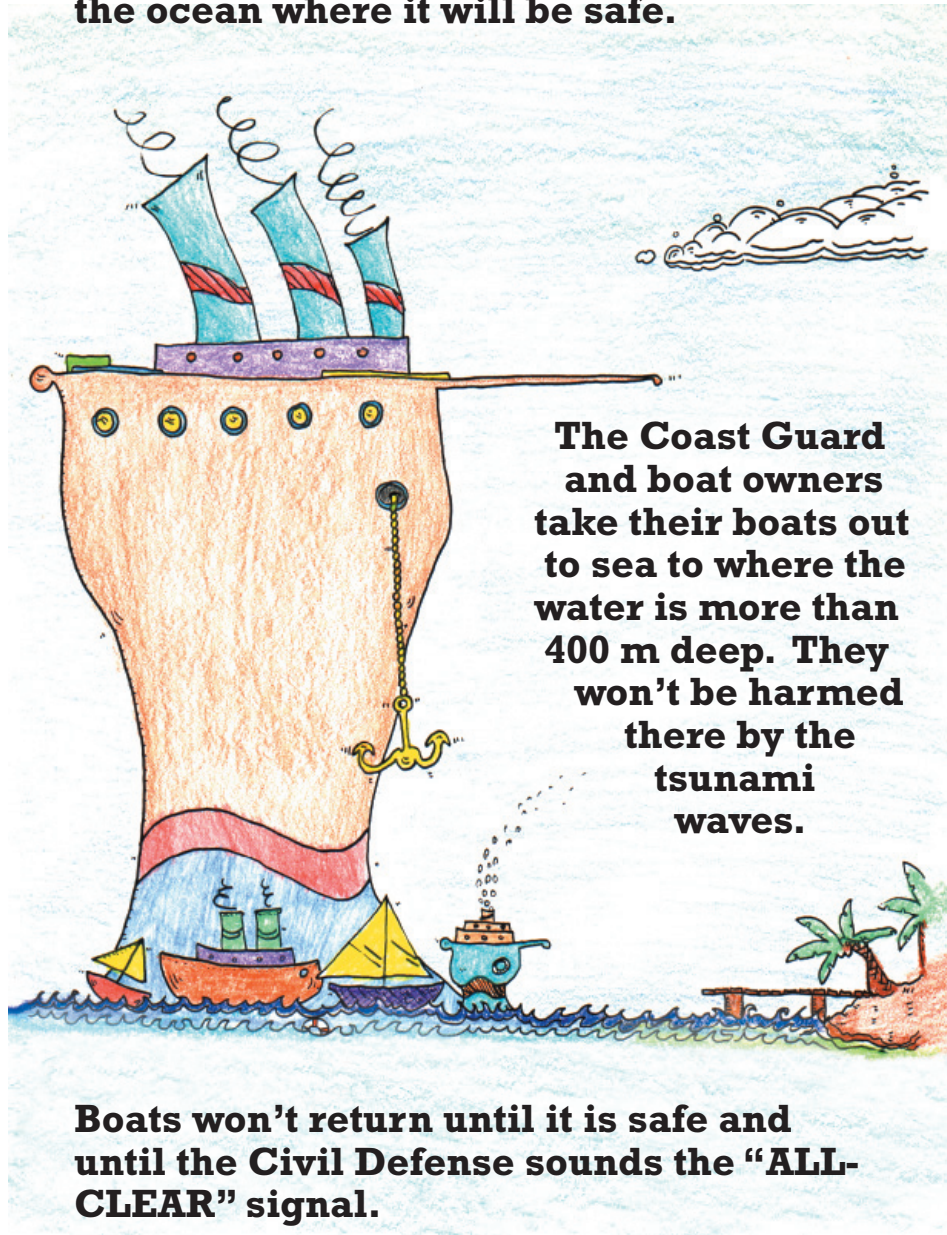
It is 10 o'clock. The tsunami will arrive in two hours. The sirens wail again as a warning. People are leaving the inundation zones. Surfers get out of the water. They know tsunamis are not surfing waves. They do not break cleanly.



Tsunami waves are full of rocks, trees and floating debris. They are very dangerous and can kill people.

Some people ride bikes or motorcycles. Some drive cars. Everyone helps each other. Buses stop travelling on their usual routes and act as shuttle buses between the danger areas and shelters. People flag down the buses and ride for free to safety. The policemen, fire-fighters, and the Civil Defense are all busy evacuating the inundation zones. There is a lot of traffic on the roads.

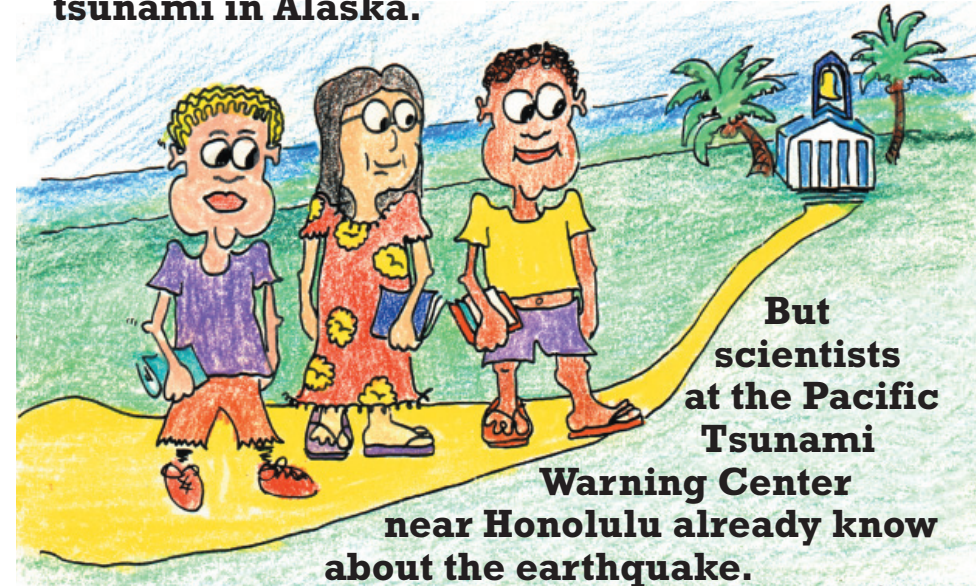
The cruise ship does not pull into the harbor at Honolulu. It will remain out on the ocean where it will be safe.



The Coast Guard and boat owners take their boats out to sea to where the water is more than 400 m deep. They won't be harmed there by the tsunami waves.

Boats won't return until it is safe and until the Civil Defense sounds the "ALL-CLEAR" signal.

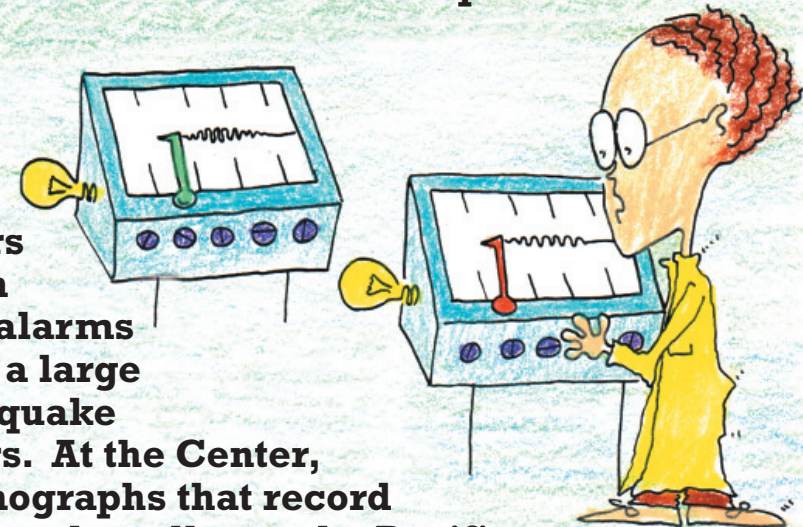
In Honolulu, Hawaii breakfast is finished and parents and children leave home. They have not yet heard about the earthquake or tsunami in Alaska.



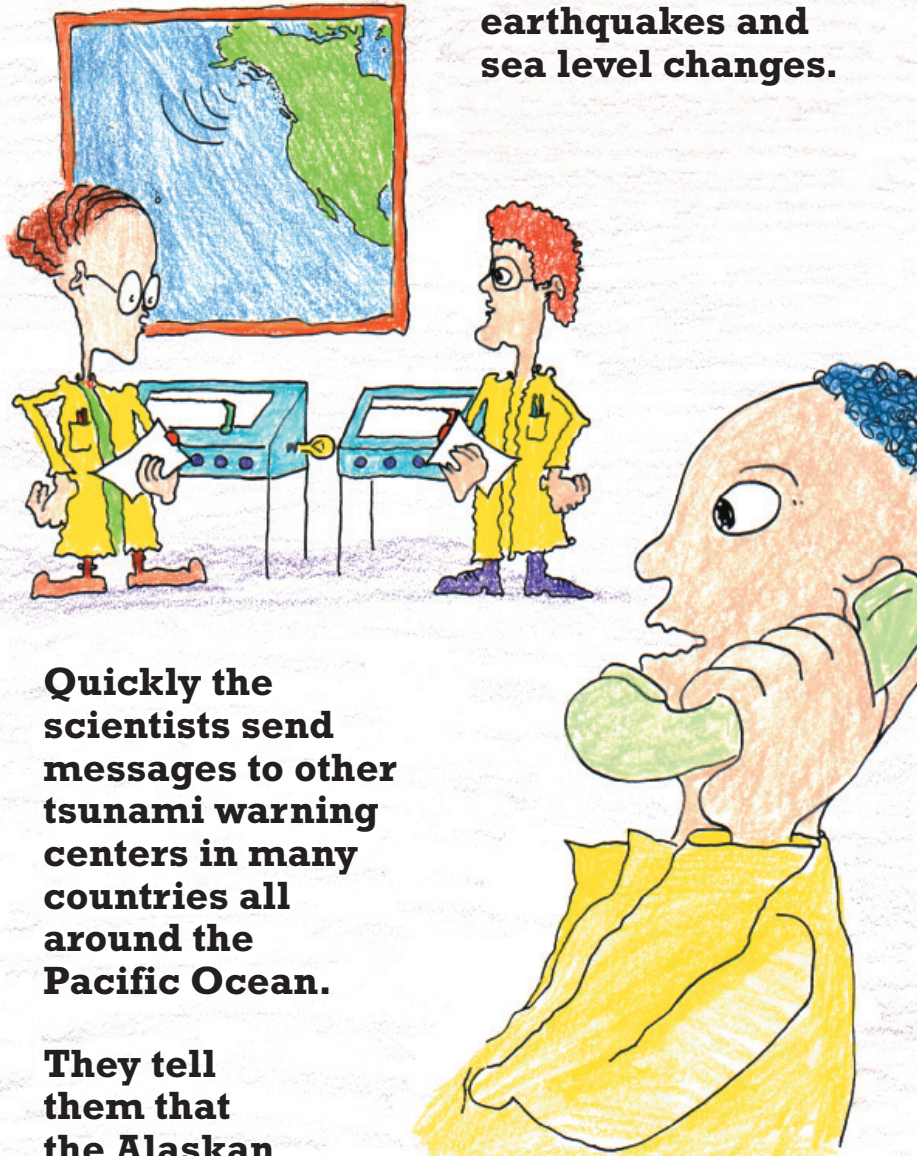
But scientists at the Pacific Tsunami Warning Center near Honolulu already know about the earthquake.

They carry pagers which send alarms when a large earthquake occurs.

At the Center, seismographs that record earthquakes all over the Pacific are sending data. The seismographs tell the scientists exactly where the earthquake took place off Alaska and how big it was.



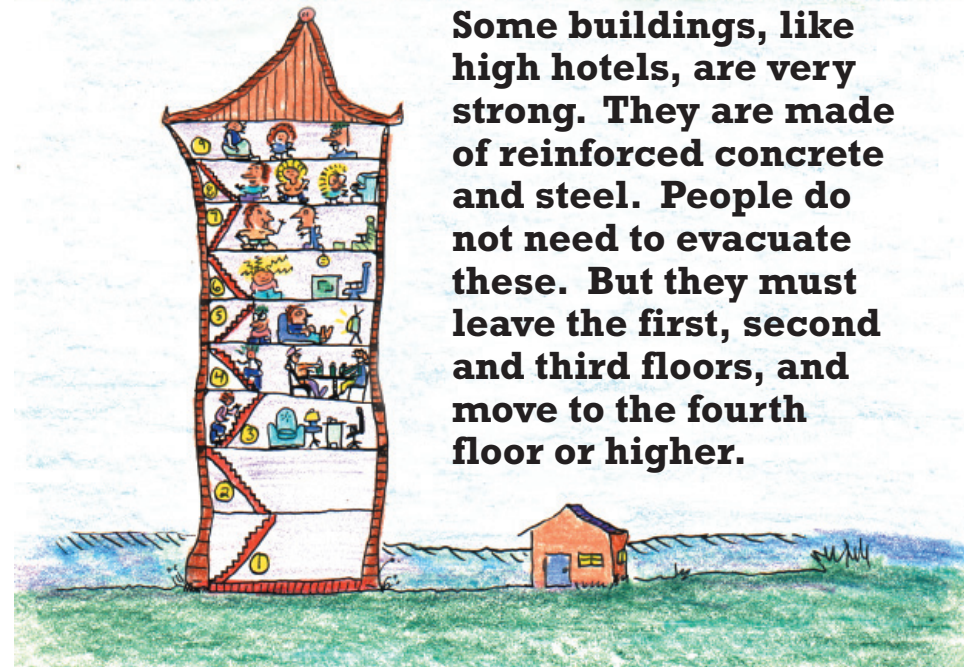
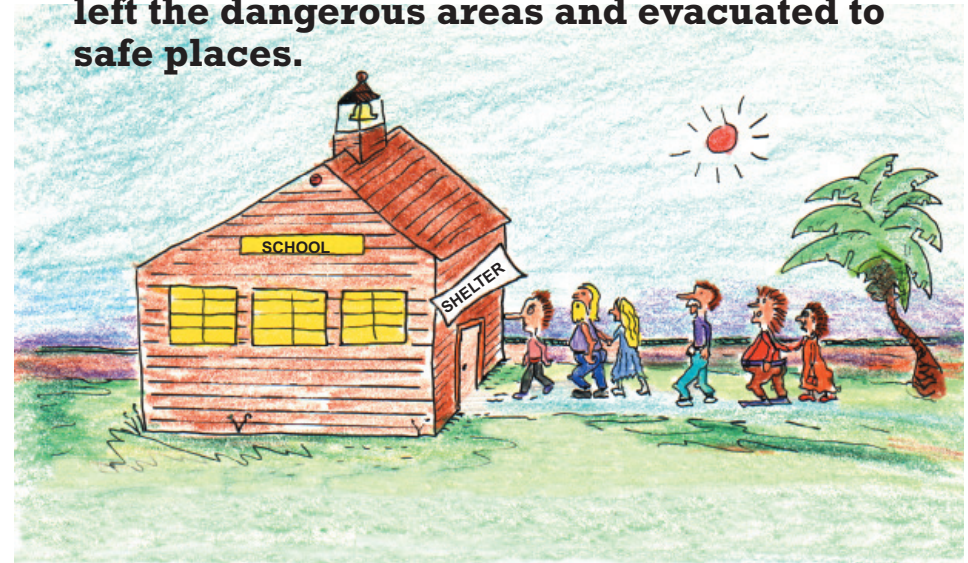
The scientists at the Center work all day and all night in shifts. There is always someone on duty checking for earthquakes and sea level changes.



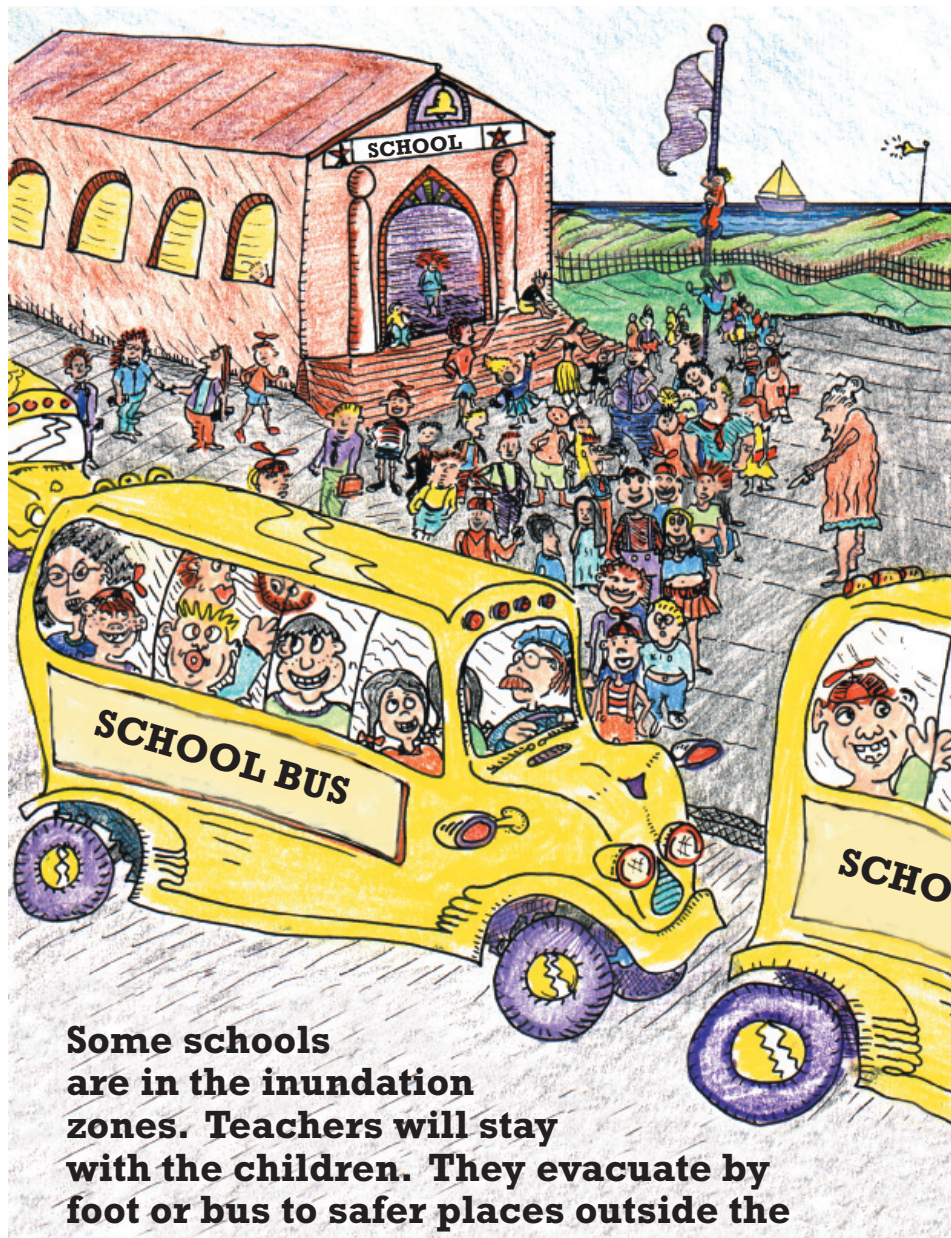
Quickly the scientists send messages to other tsunami warning centers in many countries all around the Pacific Ocean.

They tell them that the Alaskan earthquake was big and a tsunami is now crossing the Pacific Ocean in all directions.

People move from the inundation zones to safe areas or shelters. Schools outside the danger areas are used as shelters. Anyone can go there to wait. People have left the dangerous areas and evacuated to safe places.



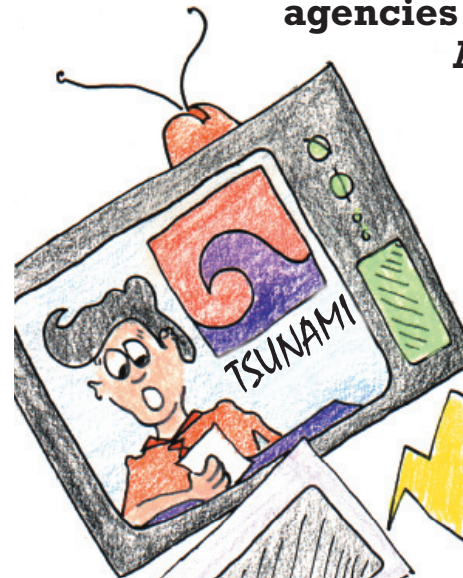
Some buildings, like high hotels, are very strong. They are made of reinforced concrete and steel. People do not need to evacuate these. But they must leave the first, second and third floors, and move to the fourth floor or higher.



Some schools are in the inundation zones. Teachers will stay with the children. They evacuate by foot or bus to safer places outside the inundation zones. They will look after the children until the tsunami danger has passed. Then the parents will come to get the children.

The scientists at the Pacific Tsunami Warning Center issue a Tsunami Watch. The Hawaii State Civil Defense and County Civil Defense agencies prepare for a tsunami.

All radio and television stations broadcast news about the tsunami.



A tsunami watch is in effect for the State of Hawaii...

Now everyone in Hawaii knows about the Alaskan earthquake and tsunami. Everyone is told that a tsunami may be on its way across the Pacific Ocean.



During the Tsunami Watch, the scientists at the Pacific Tsunami Warning Center

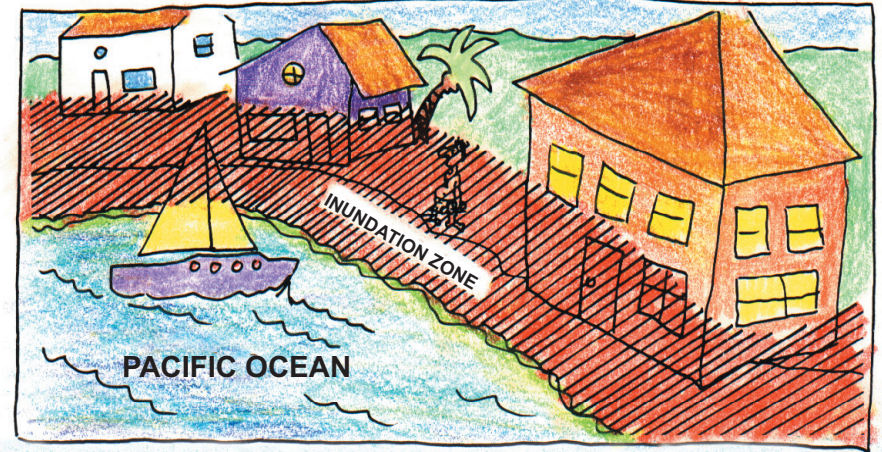
are in contact with scientists all over the Pacific trying to assess the size of the tsunami.

They talk to each other by telephone.

They send messages by satellite, e-mail, and fax.

They ask for information about sea level heights. They check on their instruments to see if a big tsunami has been recorded, and if the sea levels are rising or falling. They want to know if tsunami waves are seen in other places like Washington, California, Canada, or Russia.

Beaches and low-lying areas along the coast that get flooded are in the tsunami inundation zone.

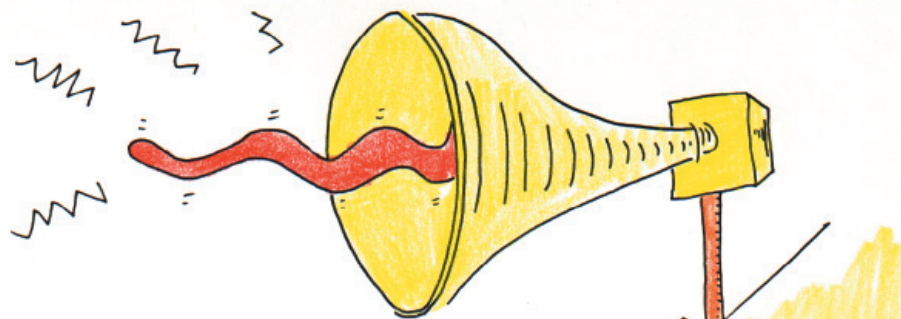


These are the places where the tsunami may hit and cause flooding and damage.

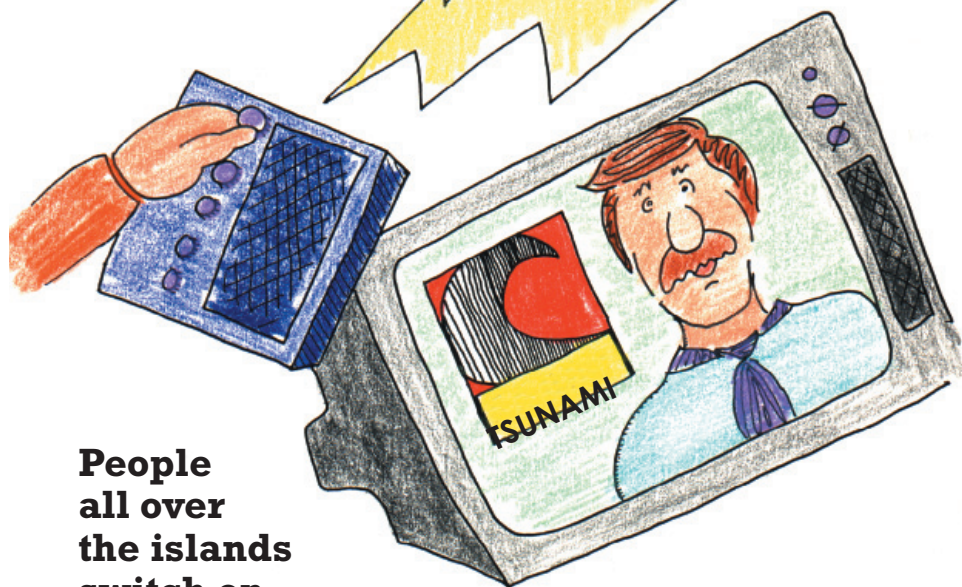
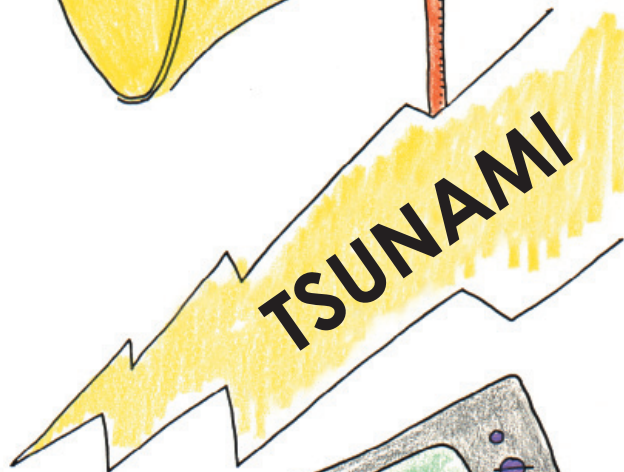


Swimmers and people on vacation start to leave the beaches. People who live in the inundation zones must evacuate their homes. They switch off water, electricity and gas at the main valves. Hotel staff help their guests to evacuate their rooms. People in shops and offices in the inundation zones must evacuate their places of work.

At 9 o'clock, three hours before the tsunami will arrive, the Civil Defense sounds all the sirens in Hawaii.

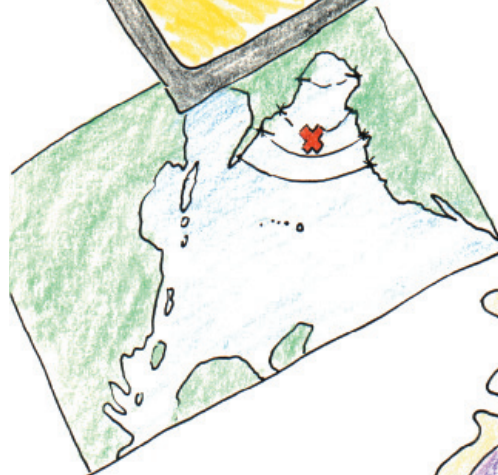
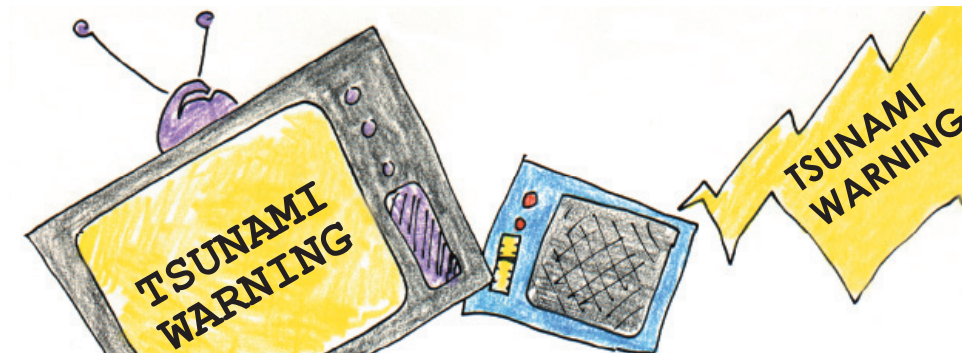


They wait for three minutes.



People all over the islands switch on their radios and televisions to listen to the latest news and learn what to do.

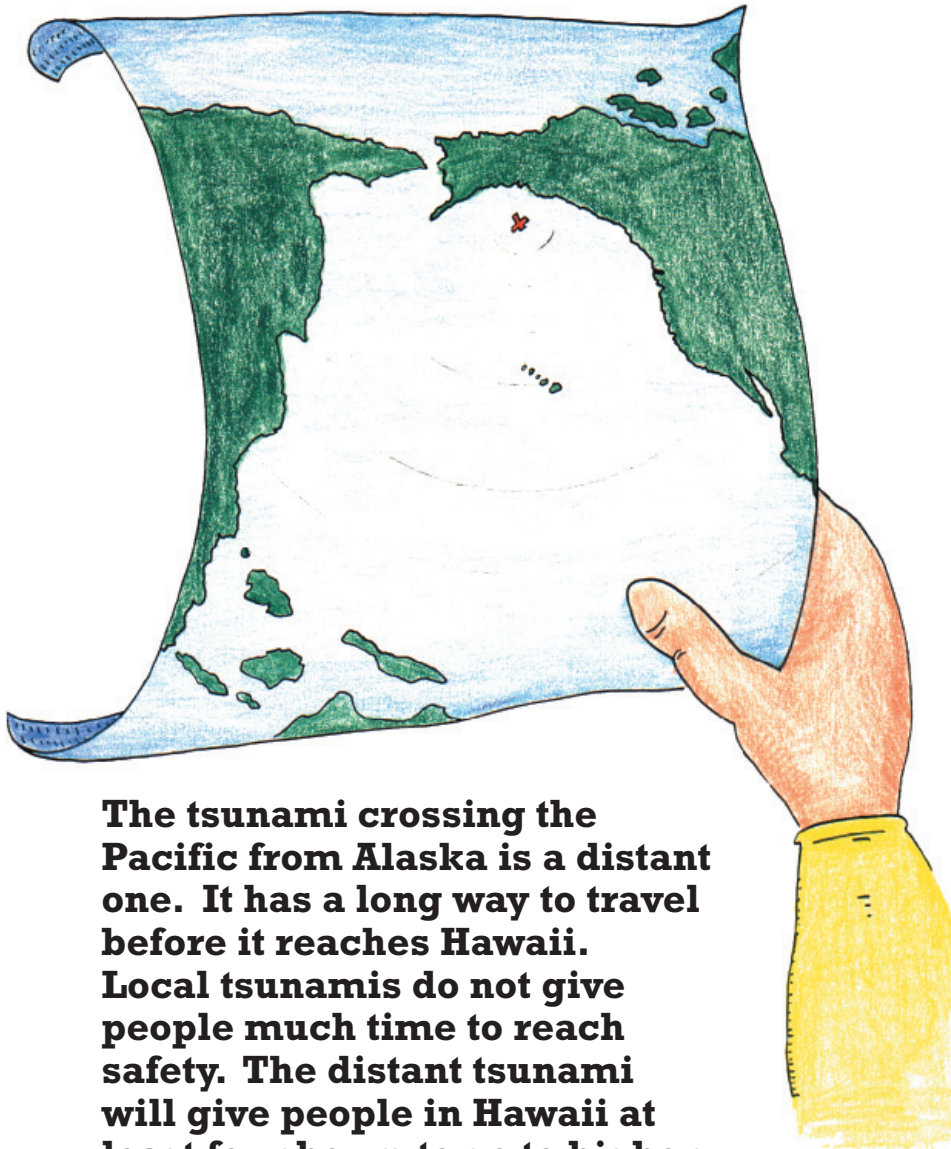
By now the scientists have a lot of information. They know that a tsunami is coming across the Pacific.



They must warn everyone. They issue a TSUNAMI WARNING.



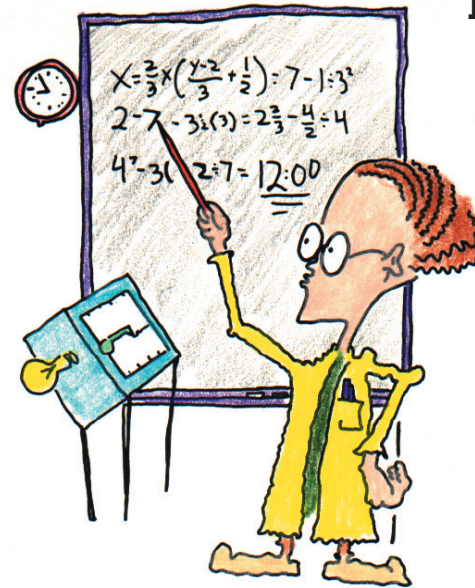
The tsunami that damaged Alaska was a local one because it happened in the same place as the earthquake and soon after the ground began to shake.



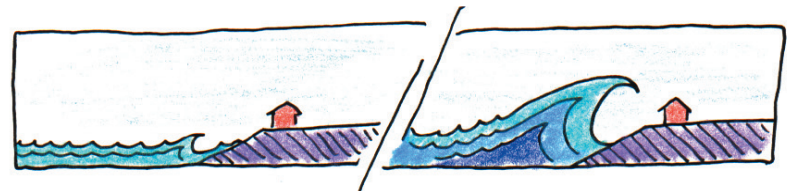
The tsunami crossing the Pacific from Alaska is a distant one. It has a long way to travel before it reaches Hawaii. Local tsunamis do not give people much time to reach safety. The distant tsunami will give people in Hawaii at least four hours to go to higher ground and seek shelter.

The scientists at the Pacific Tsunami Warning Center can calculate when the first wave of the tsunami will reach Hawaii. It will reach

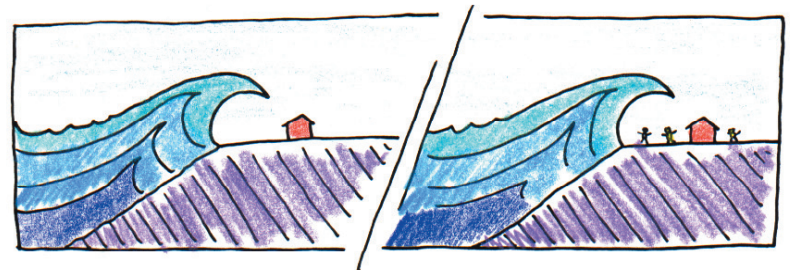
Hawaii at 12 o'clock lunchtime, just five hours after the earthquake took place in Alaska.



Although the scientists can tell when the tsunami will arrive, if it is a distant one, they cannot tell how big and how dangerous the waves will be.

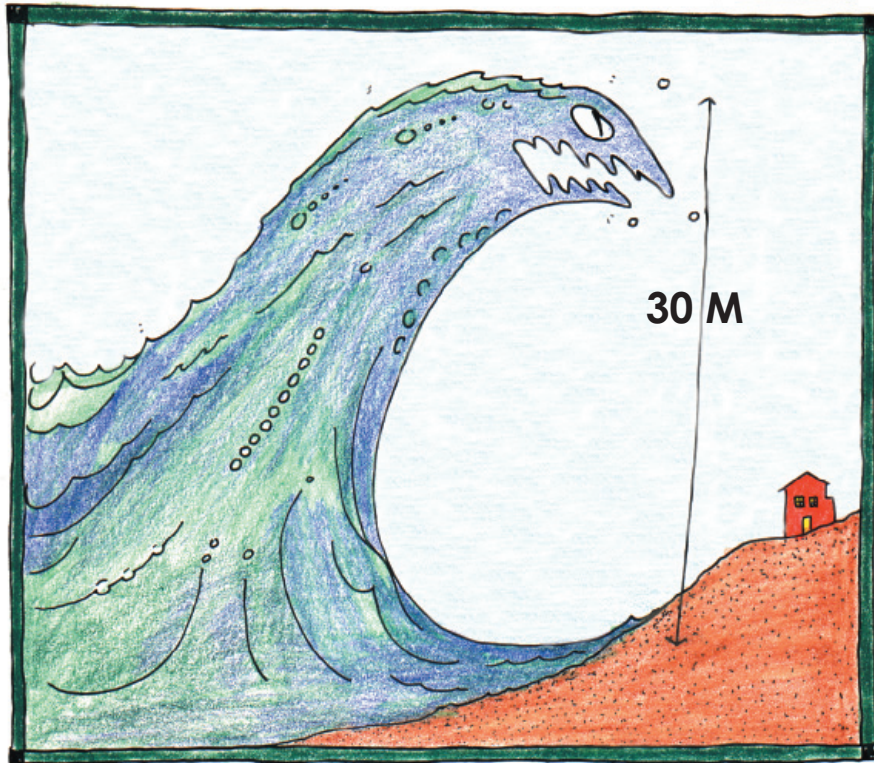


They could be small. They could be gigantic.

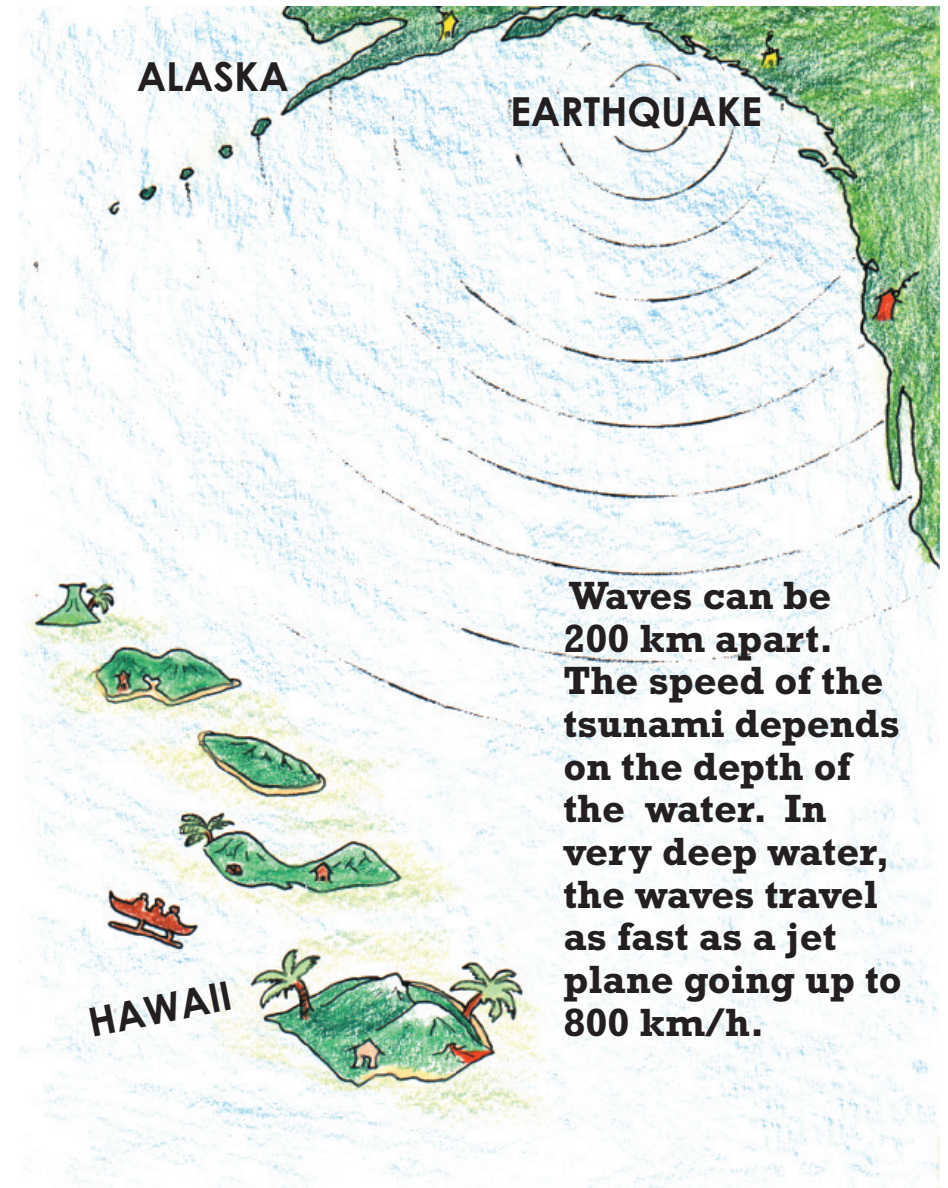


They could be harmless. They could be killers. People must be prepared for the worst and hope for the best.

This is when the tsunami waves can become very dangerous. A small wave only 30 centimeters (cm) high in the deep ocean may grow into a monster wave 30 m high as it sweeps over the shore.

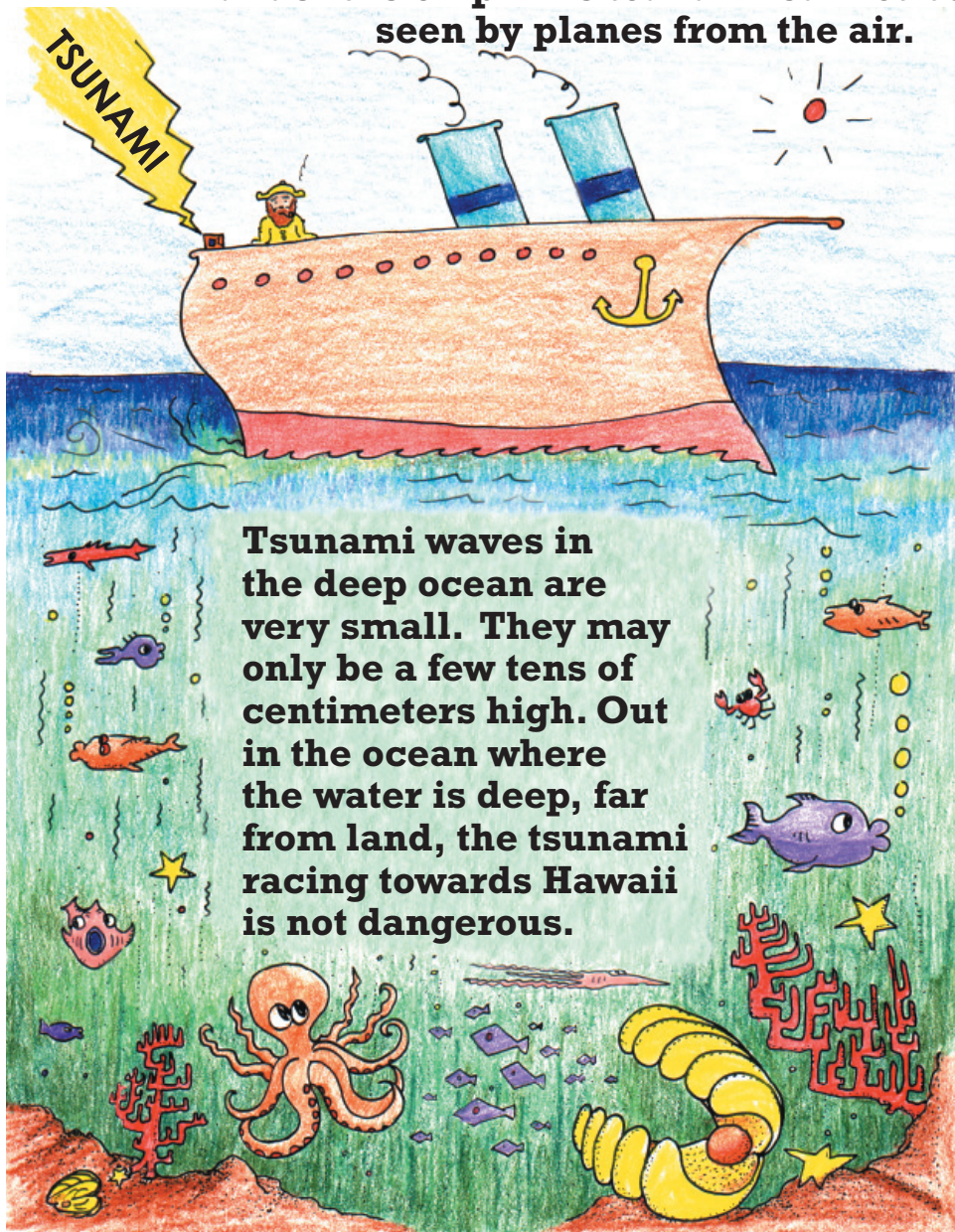


The tsunami that is on its way to Hawaii is made up of a series of very long waves. A tsunami is made up of many individual waves that can keep hitting the shore for hours.



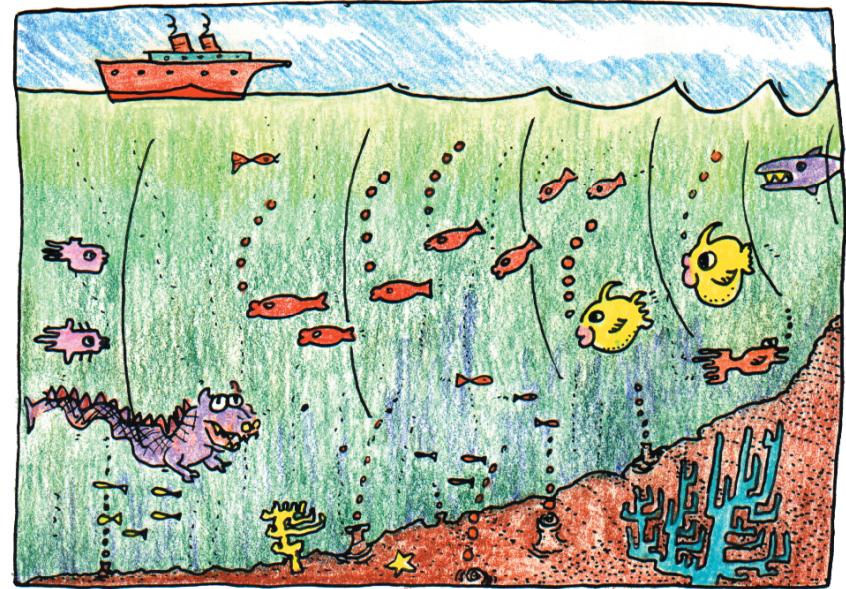
Waves can be 200 km apart. The speed of the tsunami depends on the depth of the water. In very deep water, the waves travel as fast as a jet plane going up to 800 km/h.

Tsunami waves cannot be felt or seen by ships at sea. The captain of the cruise ship has heard about the tsunami on his radio, but nobody on the ship can feel the waves as they pass under the ship. The tsunami cannot be seen by planes from the air.

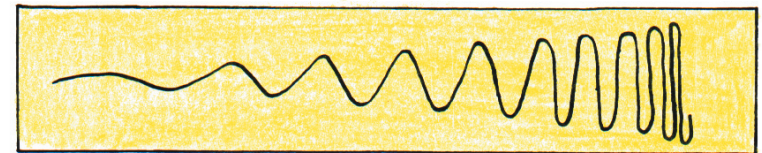


Tsunami waves in the deep ocean are very small. They may only be a few tens of centimeters high. Out in the ocean where the water is deep, far from land, the tsunami racing towards Hawaii is not dangerous.

But as the tsunami approaches land, it becomes dangerous. The waves slow down when they hit shallow water.



In 10 meters of water, a tsunami travels at 40 km/h. That is the speed of a slow car but it is still faster than a person can run.



Although the first wave slows down when it enters shallow water, the second wave is 200 km away, and still travelling faster. It catches up to the first wave. The result is that the distance between the waves does not remain at 200 km. It gets smaller. The waves bunch up. This squashing together makes the waves taller.