



NATURAL HAZARDS IN THE OCEAN

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HAZARD

Anything that that can cause harm or damage to life or property.

Over 70% of the Earth's surface is covered by the oceans. The seafloor beneath the oceans is a dynamic, active environment, and is where we find several important natural hazards, including underwater landslides, earthquakes, and tsunamis. Some of the events that happen in the ocean can have a huge impact on land and are dangerous to people that live near coastlines. To understand how and why these natural hazards happen, we must know what is happening at the seafloor. Unfortunately, about 75% of the seafloor has still not been mapped. In this article, we will describe what causes these hazards and how we can find out more about them.

WHAT ARE NATURAL HAZARDS?

A **hazard** is any natural event that can be dangerous to people or can damage buildings, roads, or properties. Examples include storms, floods, hurricanes, landslides, earthquakes, and tsunami waves. Sometimes, more than one natural hazard can happen at the same time. For example, a hurricane can cause flooding and heavy

rainfall, which can then cause a landslide. Their effects on each other make natural hazards quite complicated, but this also means it is very important that we understand how and why natural hazards happen. This article looks at natural hazards that occur in the oceans.

The oceans cover over 70% of the Earth's surface, and over 40% of the world's population lives within 100 km of the coast (Figure 1). About 600 million people live in places that are <10 m above sea level. Because of this, things that happen in the oceans can have a big impact on people.

Figure 1

This map of the world shows underwater cables (purple lines) and tectonic plate boundaries (black lines). The blue circles show the locations of large cities. The orange stars show the locations of earthquakes from 2020 to 2021. As you can see, many people live in big cities in areas where large earthquakes happen, and many of them are near the oceans. This means that many people are at risk from the oceans' natural hazards.

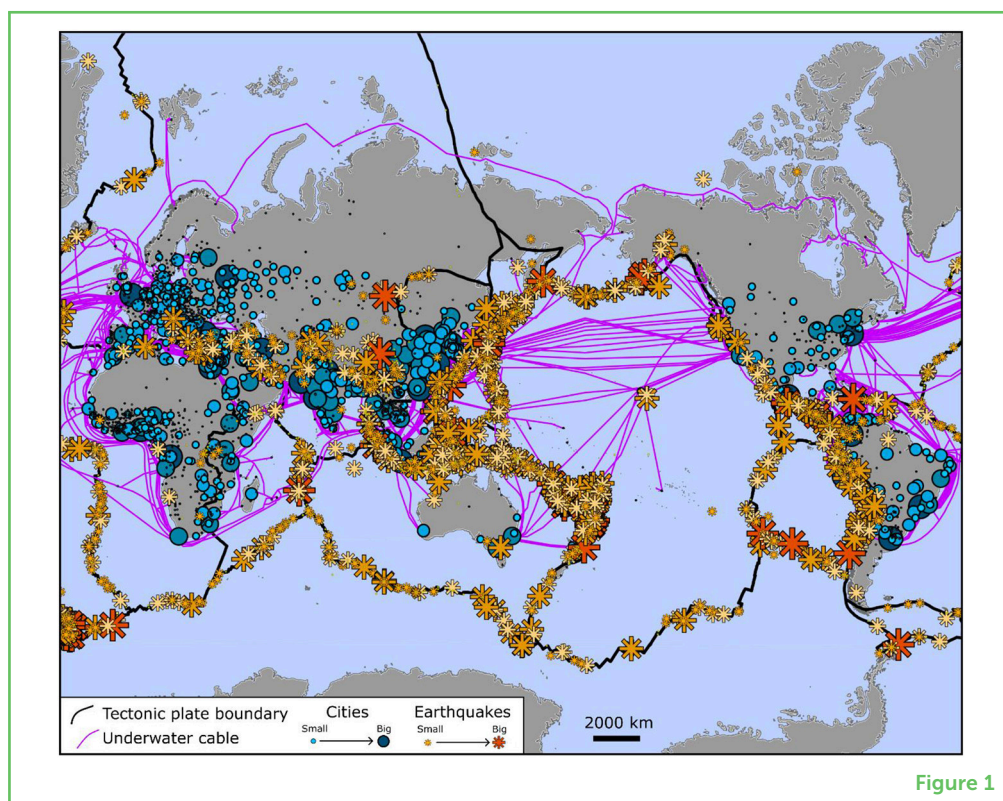


Figure 1

TECTONIC PLATES

Tectonic plates are gigantic, irregularly shaped slabs of solid rock that make up the Earth's outermost layer, the crust.

PLATE BOUNDARY

The region where two or more tectonic plates meet. The plates can be moving toward each other, away from each other, or past each other.

EARTHQUAKE

An intense shaking of Earth's surface, caused by movements in Earth's outermost layer, the crust.

EARTHQUAKES

The Earth's crust (the outer, hard layer of Earth upon which we live) is made up of large, brittle **tectonic plates** that move and change over time. Where two plates meet, they form what is called a **plate boundary** (read more in [this *Frontiers for Young Minds* article](#)). Tectonic plates are continually moving, and at plate boundaries, they can get stuck due to friction. When the force along a plate boundary overcomes the friction, energy is released in waves that travel through the Earth and cause **earthquakes**. Earthquakes can happen on land and under the oceans, but mostly occur along plate boundaries, as you can see in Figure 1. Big earthquakes can cause a lot of damage and, in the oceans, they can also cause other hazards such as tsunamis and underwater landslides.

LANDSLIDE

The movement of a large amount of rock, debris, or sediment down a slope.

SEDIMENT

Solid material made up of rocks, minerals, and the remains of plants and animals. It can be as small as a grain of sand or as large as a boulder.

TSUNAMI

A giant wave caused by movement of the seafloor.

UNDERWATER LANDSLIDES

A **landslide** occurs when a large amount of **sediment** (mud, soil, and rocks) becomes unstable and falls down a hill or slope. On land, landslides are sometimes known as “slips” but they can also happen underwater.

We do not fully understand why underwater landslides happen. There are lots of things that can trigger a landslide in the oceans [1]. For example, a large volume of sediment might be quickly dumped onto the seafloor from rivers, due to a flood on land. This extra sediment can make the seafloor unstable, and a landslide might occur. You can think of this as a bit like building a sandcastle. If you add too much sand at the top, the sides will collapse because they cannot support the weight of all that sand.

Earthquakes are a common trigger for landslides. Imagine if you had a pile of sand in a bucket. If you shake the bucket, does the sand stay where it is or does some of it fall down the sides? In the same way, landslides can happen because the seafloor is shaking during an earthquake.

Underwater landslides can be all sorts of shapes and sizes. Some of them are very small and hardly noticeable in seafloor maps, about the size of a football pitch or just a bit bigger (100 m²). Others can be really huge. The biggest underwater landslide that we know of happened off the coast of South Africa and is called the Agulhas Slide [2]. When this landslide happened, around 20,000 km³ of sediment went cascading along the seafloor, traveling over 750 km. This is about the volume of 800 billion Olympic-sized swimming pools!

Sediment moving across the seafloor during an underwater landslide can damage the homes of living things as well as underwater cables and pipelines [1]. Did you know that over 99% of internet data is sent around the world through cables on the seafloor? These cables are very important for helping us communicate with people around the world, and they are difficult and expensive to repair.

Underwater landslides can also form tsunami waves, which are very dangerous for people living near the coast.

TSUNAMI WAVES

Tsunami is a Japanese word that means “harbor wave.” Tsunami waves are unusually large waves that get bigger as they approach the shallower water of the coast, and they can cause a lot of damage. There have been several large tsunami waves recorded in the past 20 years. Tsunami waves that are large enough to cause damage or injury happen about twice a year. In the Indian Ocean on December 26, 2004,

waves as tall as buildings hit the coast of Indonesia, Sri Lanka, India, and Thailand, causing a huge amount of damage and resulting in the loss of 227,898 lives [3]. More recently, in 2011, a 40 m high wave damaged the coast of Japan, where more than 450,000 people lost their homes and 15,500 people were killed [4]. This tsunami wave also hit a nuclear power plant, damaging the emergency power generators and leading to a series of explosions and the release of radioactive material.

Both earthquakes and underwater landslides can create tsunami waves because they can move the seafloor, which displaces the water in the ocean above (Figure 2). Think about what happens when you throw a stone into a pond—the stone causes ripples that travel across the surface of the pond. Tsunami waves can travel long distances across oceans, sometimes traveling as fast as a jet plane! Unlike normal waves

Figure 2

(1) Under the seafloor, there are layers of sediment. (2) A landslide is triggered, in this case by an earthquake. (3) Water fills the space where the landslide happened, creating a tsunami wave. (4) The tsunami wave gets bigger as it moves into shallow water near the coast.

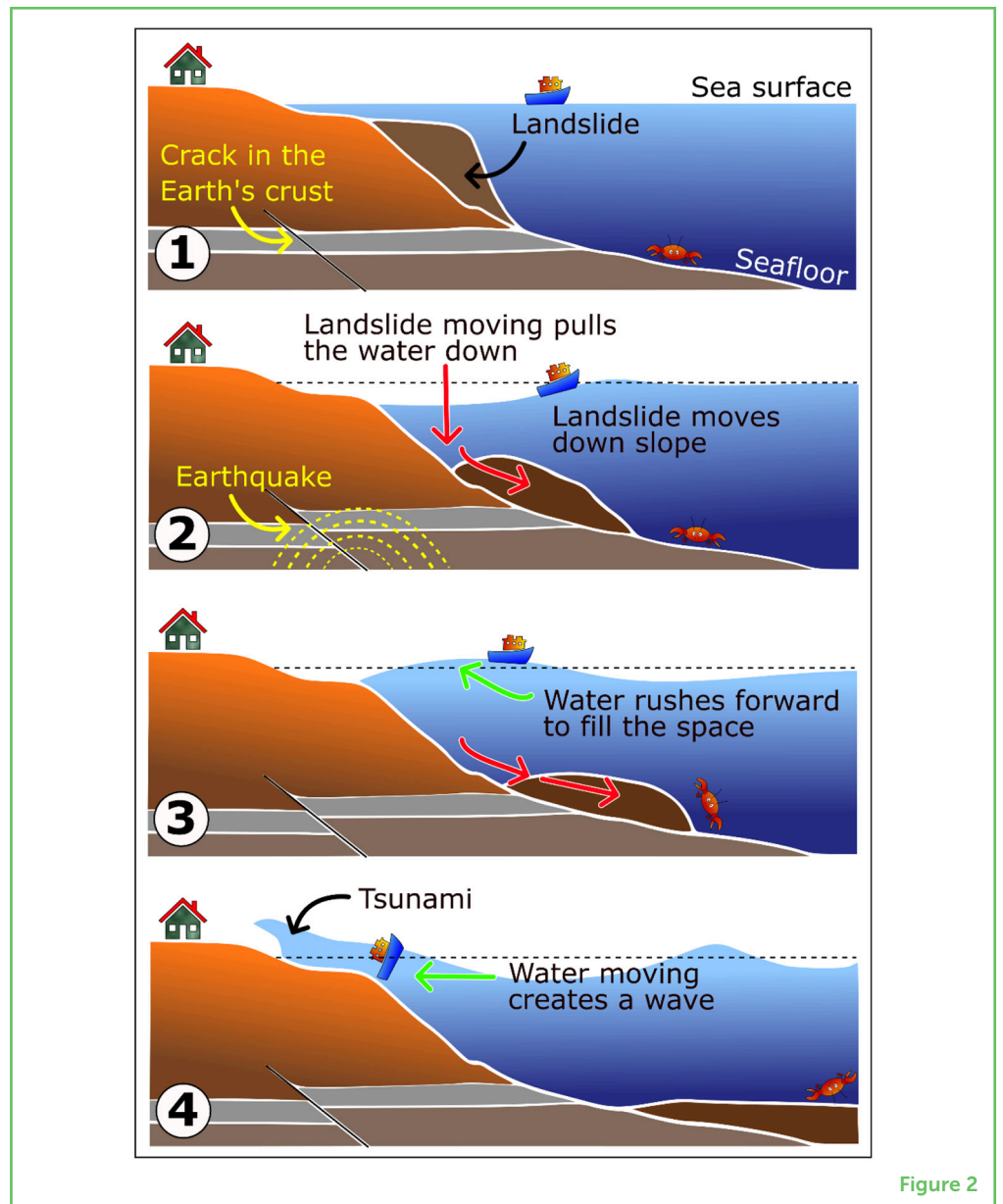


Figure 2

you might see at the beach, which only affect the water close to the surface, tsunami waves occupy the entire water column, from the seafloor to the sea surface. Because of this, when these powerful waves reach the coast and move into shallower water, the waves' energy becomes more concentrated, increasing the wave height and allowing the waves to travel a long way onto the land.

HOW CAN WE STAY SAFE FROM FUTURE HAZARDS?

Large areas of the seafloor have still not been mapped in detail (see [this *Frontiers for Young Minds* article](#)). So, there are probably lots of underwater landslides that we have not found yet. Mapping more of the seafloor in detail will help us to better understand where landslides are and why they happen. Over the last 5 years, seafloor maps have improved a lot, and we now have detailed maps covering about a quarter of the seafloor worldwide. But we cannot stop here! If we have complete maps of the entire seafloor, we can be better prepared for all hazards in the oceans. Most seafloor mapping is done by people on ships, and it can take a long time and cost a lot of money. But new remote-controlled robots are now available that can help us map more of the seafloor, faster. This is especially important in places near plate boundaries or where hazards might impact people living near the coast. In many areas of the world, there are large projects investigating natural hazards underwater, including off the coasts of New Zealand, Japan, and the USA. Hazards in the oceans can impact many countries. For example, tsunami waves from the January 2022 volcanic eruption in Tonga traveled all the way across the Pacific Ocean to Peru. So, it is important for scientists from many countries work together to help keep us safe from ocean hazards.

WHAT SHOULD YOU DO IF YOU EXPERIENCE THESE HAZARDS?

It is not possible to predict exactly when or where these hazards will occur, but they are more likely to happen in certain places, such as along plate boundaries. It is always best to be prepared so that you know what to do in the event of a hazard.

Earthquake—If you feel the ground shaking or moving, drop to the ground, get under cover (under a desk or table is a good place to be), hold on to something to support yourself, and protect your head and neck ([Figure 3](#)). Just remember, drop, cover, and hold!

Tsunami—If you notice the water retreating unusually far back from the beach or coast, move immediately inland to high ground and stay there until you know the threat has passed. If you are near the coast and you experience a long or strong earthquake, in which the ground moves so much that it is difficult to stand or the shaking lasts for

Figure 3

If you feel an earthquake, drop to the ground, get under cover, and hold on! If you are by the coast and you see the water level change suddenly, hear strange noises from the sea, or feel a long, strong earthquake—remember—get gone! Move to high ground as quickly as you can.

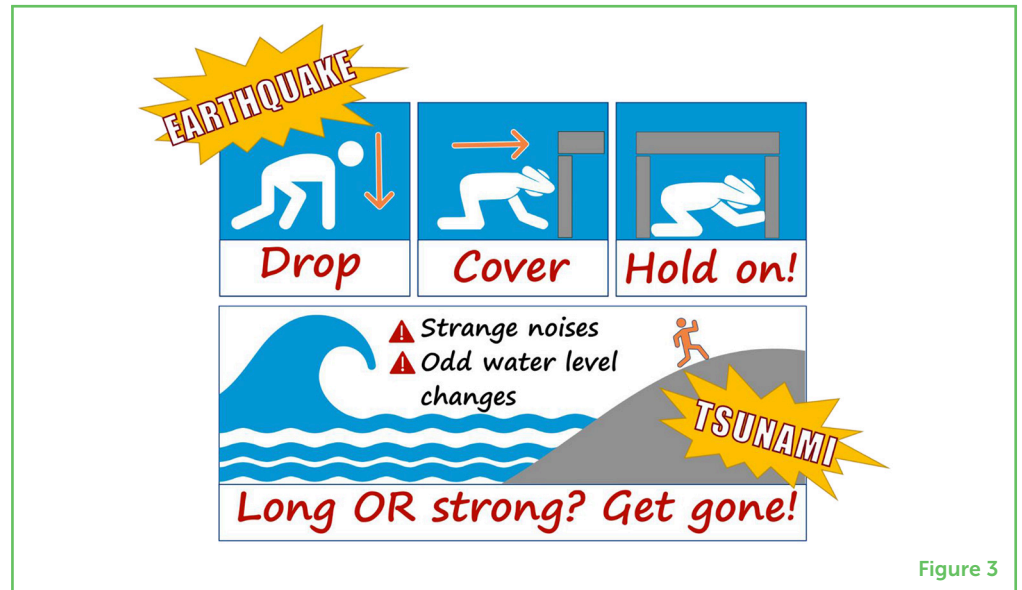


Figure 3

longer than a minute, you should again move to high ground as quickly as possible (Figure 3). This is because strong earthquakes can trigger tsunamis. So, remember, if it is long OR if it is strong, get gone!

Landslide—It is unlikely that you will experience an underwater landslide directly (unless you happen to be in a submarine), but you might experience a tsunami caused by an underwater landslide. Remember, if you are near the coast, follow the same guidelines as outlined for a tsunami wave. But do not forget that landslides are not always caused by earthquakes, they can occur without warning.

Natural hazards in the ocean, including earthquakes, landslides, and tsunami, affect large areas of the world, and can have devastating impacts on people that live close to the coast. Better understanding these hazards can help us to educate people on how to prepare for possible hazards, before they become disasters.

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LAUREL, AGE: 11

Hello, I like mechanical engineering and Lego. I like to making things and tinkering. I like learning science.



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