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Abstract

LOWER READING LEVEL

Did you know that a volcanic eruption can affect the entire world? The Hunga Tonga-Hunga Ha’apai volcano did! When it erupted on January 15, 2022, it produced a wave in the atmosphere that affected the ocean. It also caused a tsunami.

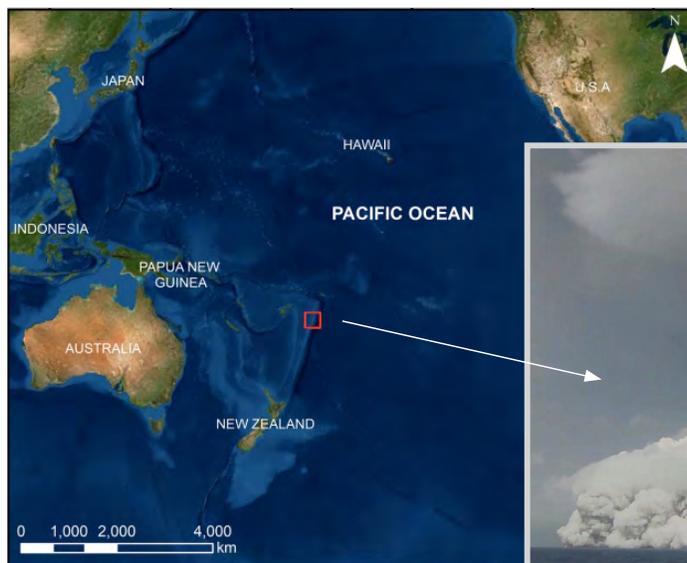
We analyzed weather station and tidal gauge data from Mexico. We learned that the atmospheric wave moved across

the world many times. We also learned that the tsunami reached heights of up to 2 meters (6.5 feet) along the Pacific coast of Mexico. But most people in Mexico were not told to stay away from the ocean! Based on our research, we recommend making changes to tsunami warning systems.

Introduction

On January 15, 2022, the Hunga Tonga-Hunga Ha’apai volcano erupted. It affected countries all over the Pacific Ocean. How? This volcanic eruption was so strong that it created a shock wave and a tsunami.

A shock wave is a type of wave produced by an explosion. Like a regular wave, a shock wave carries energy. When a wave moves through the air, some of the air particles get closer together. When this happens, there is high pressure.



The eruption of the Hunga Tonga-Hunga Ha’apai volcano happened in the Pacific Ocean.
Sources: Modified from Ramirez-Herrera et al., 2022/Tonga Geological Services

When an eruption creates waves that move very fast, the waves pile up. When waves pile up, the high pressure areas add up to have even higher pressure. People experience these areas of very high pressure as a **sonic boom**. The sonic boom from the Hunga Tonga-Hunga Ha'apai volcanic eruption was very loud. People heard it in Alaska and Canada!

The Hunga Tonga-Hunga Ha'apai volcano is underwater. That means when it erupted, it caused a lot of ocean water to move. A tsunami is a wave caused by a large movement of ocean water. These waves are different from regular

ocean waves. Ocean waves form when the wind moves the ocean's surface. In a tsunami, the wave moves both energy and water. When a tsunami reaches land, it can cause a lot of damage to buildings. It also floods the area with ocean water. The Hunga Tonga-Hunga Ha'apai volcano sent a tsunami in all directions across the Pacific Ocean.

We wanted to better understand the impact of this volcanic eruption on Mexico. We also wanted to learn what the tsunami warning system did to try to keep people safe.

Methods

We used three types of data to figure out what happened after the volcanic eruption. They include:

- air pressure data,
- ocean height data, and
- tsunami warnings and information.

The air pressure data came from weather stations. The ocean height data came from **tidal gauges**. A tidal gauge is a sensor that measures the height of the ocean. Using these

data, we tracked the size and timing of the shock wave and the tsunami.

What information and warnings did people get? What did they know about how to stay safe during these events? To find out, we looked at news and government websites. We also looked at social media.

Results

Shock wave:

The weather stations recorded the shock wave. They measured it on the Pacific Coast, in the Gulf of Mexico and in the Caribbean Sea. The shock wave reached Mexico about 7.5 hours after the volcano erupted. The stations recorded about eight **peaks** of high pressure.

Tsunami:

Many places on the Pacific coast of Mexico experienced a tsunami. Tidal gauges measured larger water heights 8.2 hours after the volcanic eruption (see Figure 1). Eight tidal gauges measured tsunami heights greater than 1 meter (3 feet). The largest height was more than 2 meters (6 feet). That means it was taller than the average person.

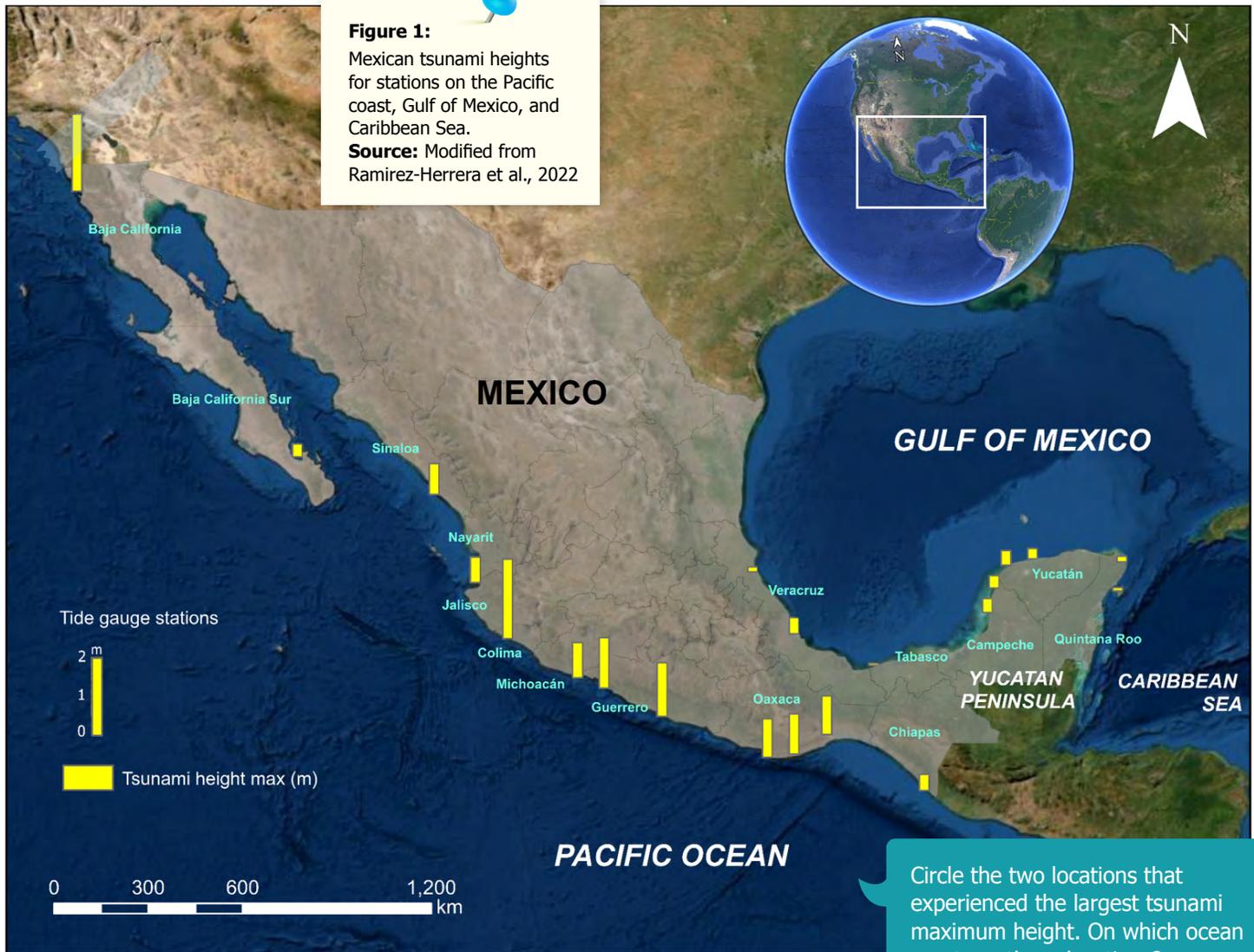
The tidal gauges also recorded ocean height changes in the Gulf of Mexico and the Caribbean Sea. The largest height change was less than 0.40 meters (about 16 inches). The changes in the ocean lasted for five days.

Warnings and information:

The Center for Tsunami Warning sent a message to people about a day and a half after the volcano erupted. The warning told people about the volcano. It also said that they didn't expect it to affect ocean height much. People received this information from social media and news websites.

In Mexico, the Civil Protection offices are in charge of public safety. Two offices told people to stay away from the ocean until they received another message that it was safe. Most offices told people to be careful. They said there might be higher water levels and stronger currents.

*Please see
Figure 1 on page 3*



Discussion

When the Hunga Tonga-Hunga Ha'apai volcano erupted, it produced a shock wave. This wave moved across the Earth many times. As it moved, it affected the ocean. The shock wave caused the height of the ocean to increase in the Gulf of Mexico and in the Caribbean Sea. In the Pacific Ocean, water levels changed because of both the shock wave and the tsunami. This created greater water heights.

Tidal gauge data showed that the height of the tsunami was not the same everywhere. That's because the shape of the land is different. When a tsunami reaches land, the ocean floor causes it to slow down. This makes the wave grow taller.

It is not common for a volcano to cause a tsunami. Most warning systems only tell people about tsunamis caused by underwater earthquakes. That's because earthquakes are the main cause of tsunamis. Hunga Tonga-Hunga Ha'apai reminds us that volcanoes do cause tsunamis. That means they should also be part of the warning systems! And when these systems send a message, they need to tell people to stay away from the ocean. We also think that scientists should watch underwater volcanoes.

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Conclusion

Being by the ocean comes with some possible dangers. If you live on the coast, check with your local government to find out about tsunami risks. Make sure that you have access to your local tsunami warning system. Also make sure you

have a plan on how to stay safe if a tsunami comes. And whenever you are by the ocean, make sure you follow all swimming and safety rules. Staying safe will make your time in the ocean more enjoyable!

Glossary of Key Terms

Peak - the highest point, for example of a wave or a mountain.

Shock wave - a high pressure wave created when a disturbance moves so fast through a medium that the waves pile up.

Sonic boom - a loud explosive noise caused by the shock wave. Aircraft create a sonic boom when they travel faster than the speed of sound.

Tidal gauge - a sensor that records the height of the ocean surface.

Tsunami - a giant wave caused by the displacement of water. They are typically caused by earthquakes and underwater volcanic eruptions.

Check your understanding

- 1 Not all volcanic eruptions cause a tsunami. Why did the Hunga Tonga-Hunga Ha'pai volcano cause one?
- 2 Why did the ocean levels change in the Gulf of Mexico and the Caribbean Sea?
- 3 Why don't most warning systems include volcanic eruptions?
- 4 How do we think tsunami warnings should be improved?
- 5 The Hunga Tonga-Hunga Ha'pai volcanic eruption is an example of a natural hazard. With a partner, identify a type of natural hazard that is common where you live. Then brainstorm ways that people can be prepared when this natural hazard occurs.

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