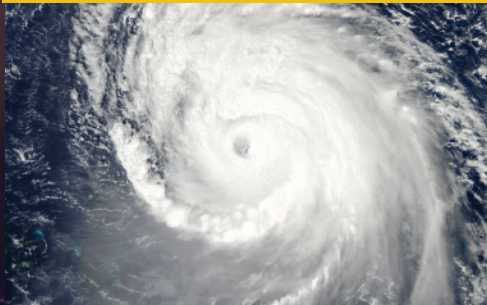


EDUCATOR'S GUIDE

NATURE'S FURY

THE SCIENCE OF
NATURAL DISASTERS

amnh.org/naturesfury/educators



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MAP OF THE EXHIBITION

Earthquakes. Volcanoes. Tornadoes. Hurricanes. *Nature's Fury: The Science of Natural Disasters* explores the causes and effects of our planet's most powerful natural disasters, and how humans study and prepare for them.

EARTHQUAKES

- 1a. Rocks showing faulting
- 1b. Tsunamis
- 1c. Seismology

VOLCANOES

- 2a. Subduction interactive
- 2b. Mt. Pelée lava specimens & artifacts
- 2c. Models of volcano shapes
- 2d. Build Your Own Volcano interactive

TORNADOES

- 3a. Tornado theater
- 3b. Greensburg artifacts

HURRICANES

- 4a. Hurricane Sandy interactive map
- 4b. Tree rings specimen



ESSENTIAL QUESTIONS

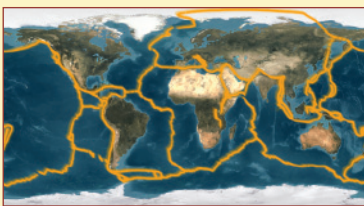
Use the Essential Questions below to connect the exhibition's themes to your curriculum. Identify key points that you'd like your students to learn. Bolded words in **red** are defined in the Glossary.

What are natural disasters?

These are natural events — such as volcanic eruptions, earthquakes, hurricanes, and tornadoes — that have catastrophic consequences. Although their effects can be sudden and violent, these events are the result of processes that have been at work for billions of years, and operate over vastly different scales of time and place.

What causes natural disasters?

Volcanoes and **earthquakes** are phenomena of the solid Earth. Moving as slowly as fingernails grow, the vast rocky **plates** that make up our planet's surface separate, collide, or grind against each other at plate boundaries. When strain builds up, the rocks eventually give way, sending the stored-up energy surging through the earth and causing earthquakes. Most volcanoes also occur along plate boundaries, where molten rock rising from Earth's interior escapes through openings in the **crust**.



Earth's surface is broken into plates.

Hurricanes and **tornadoes** are atmospheric phenomena. The forces that cause them are set into motion by the atmosphere and ocean, which transport heat from the tropics towards the poles. These currents move around the planet, causing changes in air pressure, humidity, and temperature that make **weather**. This includes tornadoes — swirling, funnel-shaped columns of wind that stretch from thunderstorm clouds down to the ground — and hurricanes, vast, rotating tropical storms with winds of at least 74 mph.

What are the effects of natural disasters?

The effect of a natural event depends on its location, its scale, and whether people have warning and are able to escape. Earthquakes can topple buildings, and quakes on the seafloor can generate surges of water, called tsunamis, that descend on a coastline. Explosive volcanic eruptions can bury cities in debris and inject sulfur dioxide gas into the high atmosphere, which can cool the planet by reflecting sunlight back into space. This can disrupt agriculture and cause famine. Tornadoes can wreak havoc, hurling cars and leveling towns, while hurricanes generate massive winds and flooding that can devastate entire communities.

How do scientists study natural disasters?

Earthquakes: Scientists use a global network of **seismometers** to measure seismic activity. To calculate the probability that an earthquake will occur, they consult records of past events and use the Global Positioning System (GPS) to track plate movements.

Volcanoes: Geologists monitor active volcanoes to determine whether magma is moving beneath them and is likely to erupt. They use satellites, GPS, and seismometers to detect shaking and changes in the shape of volcanoes, and they analyze volcanic gases and materials.

Tornadoes: Meteorologists gather weather data and use radar to observe pre-thunderstorm environments, and send probes into storms.

Hurricanes: Meteorologists use satellite photos of cloud movement and instruments on airplanes to track developing storms.

How do we assess the risk of natural disasters?

Risk is assessed by multiplying the probability that an event will happen by the severity of the consequences. We can manage the risk by mitigating the severity of the consequences. The risks posed by different kinds of natural phenomena vary widely, and similar events in different locations can have very different consequences. Different metrics are used to measure the consequences. For example, the 2004 tsunami that crossed the Indian Ocean caused \$15 billion in property damage but the death toll was over 230,000, while Hurricane Sandy killed approximately 150 people and caused \$50 billion worth of property damage in the United States.

How do people prepare for natural disasters?

Scientists closely monitor Earth systems to provide as much warning as possible. We know when hurricanes are on the way, and volcanic eruptions rarely come as a surprise, but tornadoes occur with very little warning and earthquakes with none. Individuals can inform themselves about local risks, prepare disaster plans, and practice them. Communities can develop warning and evacuation plans, enforce building codes, and construct barriers and levees. Nations can share technology and data to track global events, and share resources when disasters hit.

TEACHING IN THE EXHIBITION

GUIDING QUESTIONS

Use the following questions to guide students' explorations of the four types of natural events: **earthquakes**, **volcanic eruptions**, **tornadoes**, and **hurricanes**.

- 1 What do we know about this type of event?
- 2 How do scientists study them?
- 3 How do they affect people?
- 4 How can communities and individuals prepare for and respond to them?

OUTSIDE THE ENTRANCE

Inside View: In this brief video, Museum scientists share their understanding of natural disasters and the challenges of predicting and preparing for them.

INTRODUCTION

Theater: We can't prevent natural disasters. But as this short film shows, we can assess the risk — the likelihood that an event will occur combined with the consequences if it does — and help people, communities, and nations prepare wisely.

Other things to look out for in the Earthquakes and Volcanoes sections:

Scientists at Work:

Watch videos and explore interactives on current research into earthquakes and volcanoes.



researchers at Mount Etna, Sicily



EARTHQUAKES

1a. Rocks showing faulting: The massive rocky plates that make up Earth's crust grind slowly against one another along surfaces called faults.

Pressure builds up along these faults until the rock breaks, releasing energy in the form of a seismic wave, or earthquake. Have students examine the samples of faulted rocks.



See how the black layers on either side of the fault do not match up? That tells us how much they've moved over time, and in what direction.

1b. Tsunamis: Earthquakes can cause the ocean floor to move. This movement generates waves that travel across the ocean and grow taller as they approach land, becoming a tsunami. Have students explore ways that communities in the Samoan island chain of the South Pacific cope with the effects of tsunamis.



Ceremonial events, like passing a ritual drink called 'ava around a group of leaders, reinforce family and community ties that help Samoans cope with natural disasters like tsunamis and cyclones.

1c. Seismology: Earthquakes are unpredictable. But the scientists who study them, called seismologists, can calculate the probability of future quakes based on how often they've struck a region in the past. Here students can explore the tools scientists use to measure, record, and study Earth's movements.



VOLCANOES

2a. Subduction interactive: Most explosive volcanoes occur above subduction zones, where one tectonic plate dives beneath another. Students can turn the crank to make an oceanic plate move beneath a continental one.



The “Ring of Fire” is a horseshoe-shaped arc of explosive volcanoes around the Pacific Ocean.



a stack of melted glasses

2b. Mt. Pelée lava specimens and artifacts: The effects of volcanic eruptions can be felt all over the world and persist for many years. Tiny particles of rock and glass released in ash can damage human health and infrastructure, while sulfurous gases ejected into the high atmosphere can form particles that reflect sunlight back into space and cause global cooling. Students can get a sense of the devastating local effect of an eruption by examining artifacts from a Caribbean city that was completely destroyed in 1902.

2c. Models of volcano shapes: Lava is molten rock on the Earth’s surface. Different types of lava erupt from different types of volcanoes — shield, cinder cone, lava dome, and stratovolcano — and their shapes vary from rounded domes to jagged cones. Have students use these models to explore the relation between types of lava and the shapes of volcanoes.

2d. Build Your Own Volcano interactive: Magma — molten rock below Earth’s surface — is usually less dense than the solid rock around it, so it rises and collects. Pressure builds up as magma and gas accumulate, sometimes causing eruptions. In this interactive, students can explore factors such as the amount of gas and the composition of the molten rock that determine how explosively a volcano might erupt.



TORNADOES

3a. Tornado theater: These violently rotating columns of wind arrive with little warning and last for just minutes. Students can step inside this theater to see and hear what it’s like to be inside these storms.

3b. Greensburg artifacts: More than 75% of all tornadoes in the world take place along “Tornado Alley” in the central United States, where warm, humid air from the Gulf of Mexico collides with cool, dry air from the Arctic. By observing these artifacts, students can get a sense of the catastrophic effect of the 200-plus-mph winds of a tornado that hit a small Kansas town in 2007.



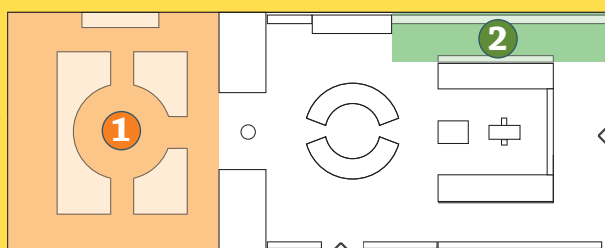
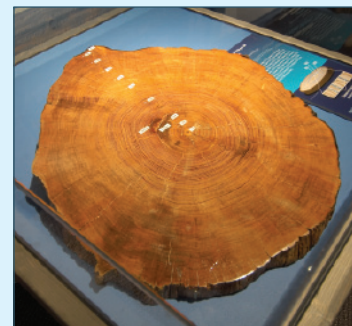
street sign bent by a tornado’s powerful winds



HURRICANES

4a. Hurricane Sandy interactive map: The effects of the 2012 megastorm on the Mid-Atlantic Coast varied widely. Students can explore the science behind Sandy, its human impacts, and proposals to mitigate the effects of future storms.

4b. Tree rings specimen: Our climate records only go back some 150 years. But scientists have discovered a surprising “database” containing hundreds of years of hurricane history: really old trees. Students can find out what tree rings tell us about hurricanes and their possible link to climate change.

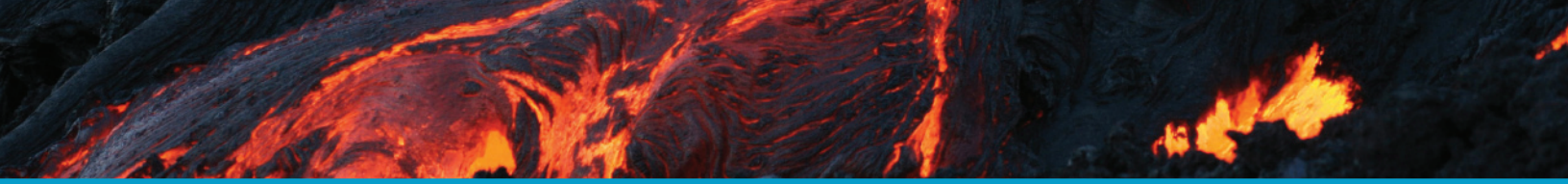


Connections to the Gottesman Hall of Planet Earth (1st floor)

Visit these sections to explore Earth processes related to *Nature’s Fury*:

- ① Why are there ocean basins, continents, and mountains?
- ② What causes climate and climate change?

For a detailed guided exploration through these sections, download the hall’s educator’s guide at amnh.org/education/hope



COME PREPARED CHECKLIST

- Plan your visit.** For information about reservations, transportation, and lunchrooms, visit amnh.org/plan-your-visit/school-or-camp-group-visit.
- Read the Essential Questions** to see how themes in the exhibition connect to your curriculum.
- Review the Teaching in the Exhibition section** for an advance look at what your class will encounter.
- Download activities and student worksheets** at amnh.org/naturesfury/educators. They are designed for use before, during, and after your visit.
- Decide how your class will explore the exhibition:**
 - You and your chaperones can facilitate the visit using the Teaching in the Exhibition section.
 - Students can use the worksheets and/or maps to explore the exhibition on their own or in small groups.

WHAT YOU CAN DO

Find out about the risk of natural disasters in your area, and how to prepare for them.

USGS: Earthquake Hazards Program
earthquake.usgs.gov

USGS: Volcano Hazards Program
volcanoes.usgs.gov

FEMA: Plan, Prepare, Mitigate
fema.gov/plan-prepare-mitigate

NOAA: Weather Ready Nation
nws.noaa.gov/com/weatherreadynation

National Flood Insurance Program
floodsmart.gov/floodsmart

Business & Home Safety
disastersafety.org

GLOSSARY

crust: Earth's outermost solid layer, consisting of a continental crust averaging 45 km (28 mi) thick and an oceanic crust averaging 8 km (5 mi) thick

earthquake: a shaking of the ground caused by the abrupt release of accumulated energy when a fault ruptures

hurricane: a rapidly rotating storm with strong winds and heavy rain and typically several hundred to a thousand kilometers across

seismometer: an instrument that detects seismic waves that shake the ground

tectonic plates: averaging 100 km (60 mi) thick, the pieces of Earth's rigid outer shell that move slowly on Earth's mantle and carry the continents and ocean basins with them

tornado: a violently swirling, funnel-shaped wind extending from a thunderstorm to the ground

volcano: a vent in Earth's surface through which magma and associated gases and ash erupt

weather: the state of the atmosphere at a specific place and time. **Climate** is the weather of a particular region averaged typically over ten or more years.

NEXT GENERATION SCIENCE STANDARDS

Scientific & Engineering Practices • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematics and computational thinking • Constructing explanations and designing solutions • Obtaining, evaluating, and communicating information

Crosscutting Concepts • Patterns • Cause and effect: Mechanism and explanation • Scale, proportion, and quantity • Systems and system models • Energy and matter: Flows, cycles, and conservation • Stability and change

Disciplinary Core Ideas • PS2.C: Stability and Instability in Physical Systems • PS4.C: Information Technologies and Instrumentation • ESS2.A: Earth Materials and Systems • ESS2.B: Plate Tectonics and Large-Scale System Interactions • ESS2.C: The Roles of Water in Earth's Surface Processes • ESS2.D: Weather and Climate • ESS3.B: Natural Hazards • ETS1.A: Defining and Delimiting an Engineering Problem • ETS1.B: Developing Possible Solutions • ETS2.A: Interdependence of Science, Engineering, and Technology • ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

CREDITS

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