MACGILLIVRAY FREEMAN'S

DREAM BIG

ENGINEERING OUR WORLD

GRADE 2:

SURVIVING STORM SURGE

Grade level: 2

Lesson length: 80 minutes (can be broken down into multiple parts)

This activity gives students an understanding of how storm surges and rising waters affect people's homes and how important it is for engineers to design houses that withstand flooding. Students play the role of engineers as they build a model scene of a paper house on a playdough coast and inundate it with flood water to see if the house they made can withstand the rising tide.

In the Film

In the film *Dream Big*, we see how engineers create innovative ways for tall buildings like the tower of Shanghai to resist strong winds from typhoons. However, most of the damage occurs before and after the storm, when waters rapidly flood coastal areas. Buildings must have a strong enough base to resist the powerful, swiftly flowing water. In this engineering challenge, students investigate ways to engineer buildings that resist flood waters.

NGSS Disciplinary Core Ideas

2-ESS1-1 The History of Planet Earth

Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe.

2-ESS2.A Earth's Materials and Systems

Wind and water can change the shape of the land.

2-ESS2-1

Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

NGSS Engineering Practices

ETS1.C: Optimizing the Design Solution

Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

Key Words/Vocabulary

Storm surge: a bulge of water created by hurricane-type storms that moves along the surface of oceans.

Flooding: The rising level of bodies of water that invade areas that are otherwise dry.

Erosion: The slow breaking down of material by mechanical and chemical forces.

Typhoon: The name used in Asia for a hurricane-style storm.

Materials

Per class:

- ☐ Testing bin instructions (included below)
- ☐ Plastic tub, preferably 15" long x 12" wide x 6" high
- ☐ Jug or pitcher for water
- ☐ Playdough or clay
- ☐ Optional: hot glue at teacher station during the student CREATE phase.

Per pair of students:

- ☐ Popsicle Sticks
- ☐ Paper
- ☐ Glue Sticks
- ☐ Masking tape
- ☐ Beach home paper template
- ☐ Scissors
- ☐ Building a Flood-Safe Home handout

Teacher Prep Notes

Prepare to discuss why people throughout history have built their homes near bodies of water despite the dangers of flooding. Teach students about what causes flooding, including a simple, age-appropriate introduction to the science of global warming.
Tell students about the ways people have tried to prevent damage to their houses and communities from rising water and floods.

Be ready to show students how to cut out a house from the beach home template and how to put it together.

To Do

Determine the Problem or Question to Solve: 10 minutes

1. Before watching the IMAX movie *Dream Big*, give students an overview of what they are about to experience. This film is about engineering and the ways that engineering can inspire, challenge, and enrich our lives. Give students the following questions to think about as they are watching the film:
   - **a.** How did nature affect engineering projects in the film? For example, what did hurricanes, floods, and earthquakes do to the projects engineers were working on?
   - **b.** How did engineers deal with these storms, floods, and earthquakes? Did the engineers use some new and exciting material to build with? Did they change their design?
2. Debrief as a whole class after viewing the film. Allow students to reflect on the guiding questions you gave them.
3. Remind students of the obstacles the engineers faced in the film. Review how large a role nature played in determining the engineers' plans. Specific examples you could bring up: building storm-resistant towers, crossing dangerous rivers, and designing ways for cities to fight against the rising sea levels.
4. Introduce the design challenge. Students will create models of a community along a coast. They will design and build homes for this shoreline community that can withstand flooding from heavy rains, hurricanes, and even the melting of the polar ice caps.

Research and Gather Information: 20 minutes

1. Teach students about different types of flooding and the cause-effect nature that supports flooding. Students should understand that most forms of flooding are caused by bursts of rainwater from storms that increase the amount of water found on land and in bodies of water. Other forms of flooding take place over a longer period of time and are caused by events such as the melting of the polar ice caps via global warming.
2. Show students the images of homes built on shorelines and in flood prone areas in the "Building a Flood-Safe Home" handout. Talk about how those homes are built to withstand surges of water and what materials are used. Identify ways that humans add to or change the building of the houses themselves by adding support structures to raise the house. Also discuss ways that humans add shore-stabilizing structures like sea walls to prevent water and erosion from reaching their homes.

Plan a Solution: 15 minutes

Organize students into pairs. They will start by building a paper home as the base of their engineering and design challenge. We suggest that the teacher model for the class how to cut, fold, and assemble a home before allowing the students to do their own. A cut and tape template can be found later in this lesson or students may create their own.

As a team, they will collaborate on a design and drawing to plan what their house will look like and what their strategy will be to protect their new home. Will they raise the house on stilts or try to redirect the waves using a wall? Review from what they learned during the Research and Gather phase that engineers can change the way the home is built and/or add structures to the ocean and shoreline to prevent water and erosion from reaching their home. In addition to the paper house, provide a sample of the materials they will be allowed to use for their modifications, such as 2 popsicle sticks and 1 inch of tape, so that they can physically experiment. Note: only provide a limited amount of materials at this phase. This is NOT intended as a building phase.

Make It: 10 minutes

Once students have finalized their plan, allow students to build their home and/or flood protective structures using the materials you have provided. Optional: At one safe location in the room, the teacher or teacher's assistant can operate a hot glue gun for students to use in adhering materials together.

Visit each group and review how its research shaped the overall design and plan for the home. If students are making obvious mistakes based upon your experiences and knowledge, allow them to continue and learn from their mistakes. Avoid offering solutions and instead encourage students to develop a secondary plan that demonstrates the evolution of their ideas and experiences.

Test: 15 minutes

Using the provided graphic in the resources for this lesson, set the stage for the experiment. In a tub, add a playdough base to about ½–⅓ of the tub's base to represent the shoreline. Students should add a group's house and any additional structure to the shore. The teacher will then pour water steadily into the bucket to replicate flooding water.

Evaluate: 10 minutes

Allow students to reflect on the following questions:

1. Did your house stay erect?
2. Did it get wet or retain water?
3. Did it stay in the same location?
4. After viewing the flooding experiment, would you want to live there?

Taking It Further

Show videos of hurricane/storm surge/flooding.

Discuss the role civil engineers are playing within the arena of disaster prevention with special sub-disciplines such as hurricane engineering. Hurricane engineering aims to keep people and their property safe through the lens of our natural and constructed environments.

Can you build something in the water to prevent the flooding from impacting your house/property?

- Review the situations that face Venice, Italy, and the human-made barrier they are creating as a solution.

Document your students' work through our social media outlet: #dreambigfilm

BUILDING A FLOOD-SAFE HOME

Look at the pictures below of homes built in flood-prone areas. For each picture, what do you notice about how the homes are built? What shapes do you see? What materials are used?

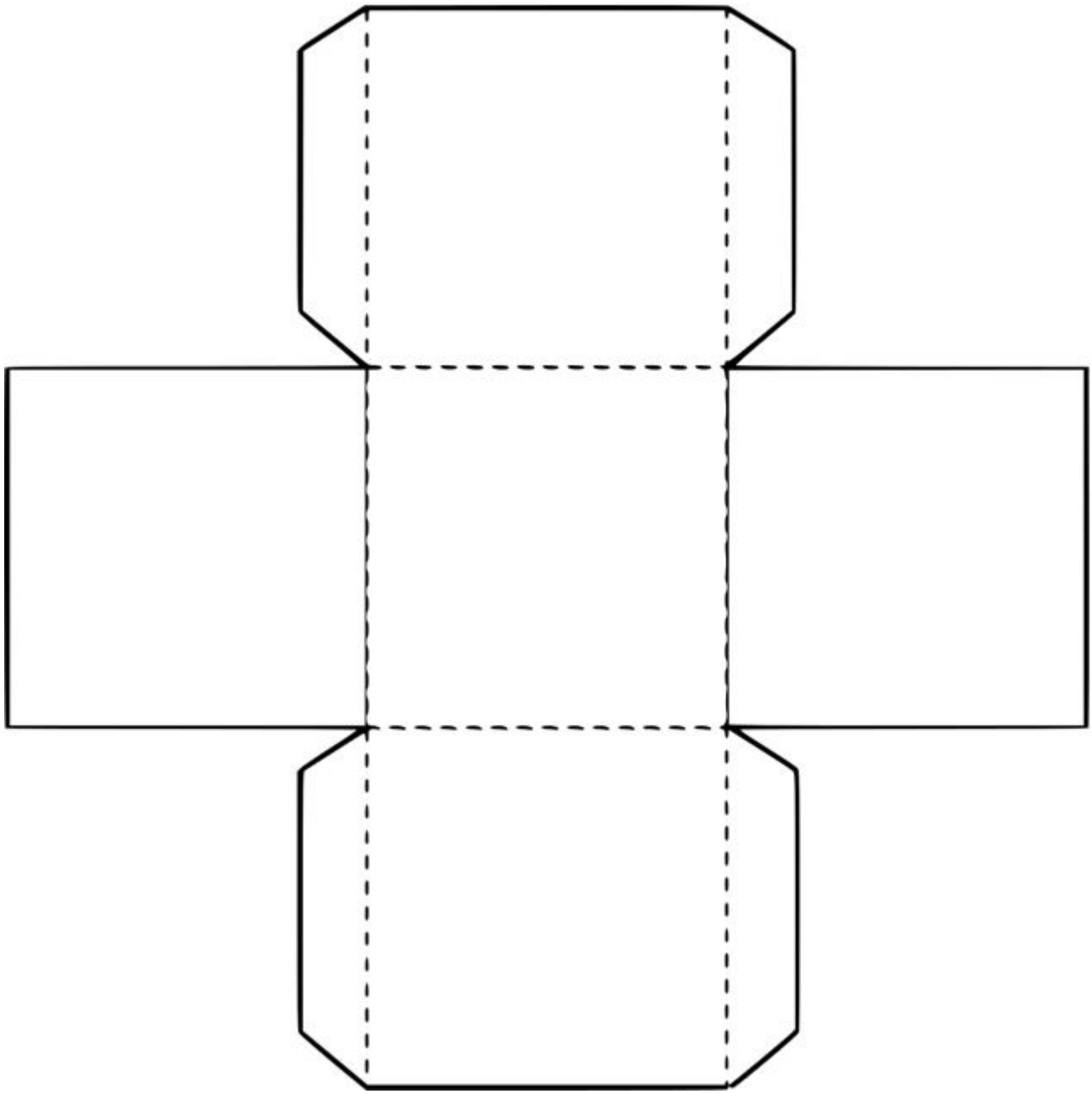
Source: "Free Image on Pixabay - Sheds, Houses, Stilts, River, Lake." Free Photo: Sheds, Houses, Stilts, River, Lake. N.p., n.d. Web. 10 Oct. 2016.

Source: Promoise, Alex. "Sunset at Newport Beach." N.p., n.d. Web. 10 Oct. 2016.

Source: "Free Image on Pixabay - Stalk, North Sea, Beach, Sun." Free Photo: Stalk, North Sea, Beach, Sun. N.p., n.d. Web. 10 Oct. 2016.

Beach Home Template and Instructions

1. Cut along the solid lines.
2. Fold along the dotted lines to create a box.
3. Tape or glue the flaps to secure.



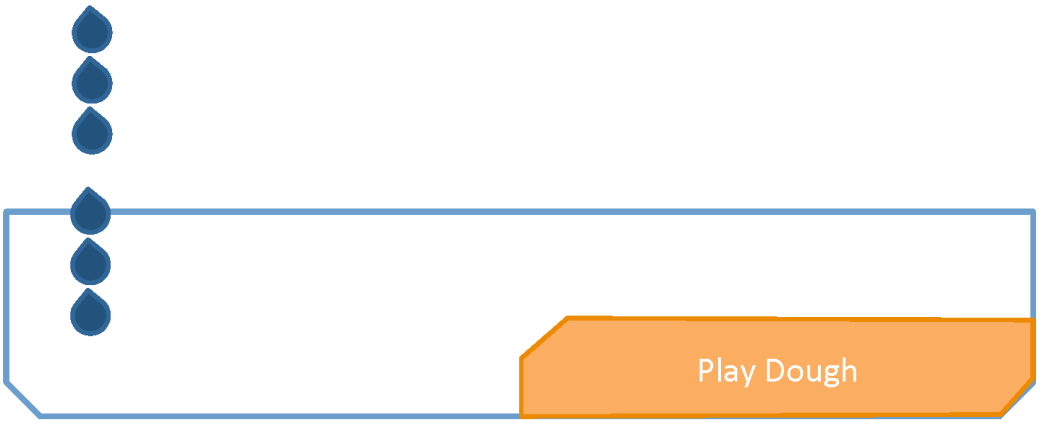
TESTING BIN INSTRUCTIONS

Assembly Directions:

1. Obtain a medium-sized plastic storage bin. (Preferably a clear and shallower bin.)
2. Fill half of the bin with playdough or soft clay until it is about halfway full.
3. Obtain a gallon jug and fill with tap water.

Directions for Use:

1. Have students place their structure on the land portion of the device.
2. Once you are ready, pour the water into the opposite side of the plastic bin and allow the water level to rise until it is 1–2 inches above the playdough level.



DREAM BIG VIDEO SERIES

WATCH *QUAKE TAKES: EARTHQUAKE ENGINEERING*

Nobody wants an earthquake or tsunami to hit while they're in a building that can't keep them safe. In the specially controlled settings of a giant shake table in San Diego and a tsunami wave basin in Oregon, engineers study the impact of these natural forces. Watch how engineers are making buildings stronger and safer to protect people from nature's powerful punch. Go to discovere.org/dreambig/media-assets and visit Educational Webisodes.

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NCEES advancing licensure for engineers and surveyors

ASCE American Society of Civil Engineers

BECHTEL

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DREAM BIG

ENGINEERING OUR WORLD

GRADE 2: CROSS-CURRICULAR SUPPLEMENT

In the *Dream Big* Surviving Storm Surge lesson, students design a house that can withstand a flood. The engineering challenge is to get a paper house on a playdough coast to withstand as much flooding as possible before succumbing.

This lesson addresses natural events that occur over long spans of time and the ways in which wind and water change the shape of the land. It also discusses innovations that protect human structures from flooding and those that minimize or eliminate the impact of water and wind on the land.

This cross-curricular supplement contains a math activity, an English language arts activity, and some additional ideas in both subject areas for exploring the topics and concepts introduced in the Surviving Storm Surge lesson.

Grade 2 Math: Measuring Rising Water

Estimated class time: 50 minutes

Summary

In the *Dream Big* Surviving Storm Surge activity, students create model houses that can withstand a storm surge. This lesson gives them a chance to perfect their house designs and put them to the storm surge test again—only this time, they will measure exactly how much water their house can withstand. Students explore answers to these questions:

- What changes can we make to our house so that it can better survive a flood?
- How many cups of water will make our house collapse in a flood?

Learning Objectives

- Predict the number of cups of water a paper house can withstand
- Evaluate previous house designs in terms of their flood-proof qualities
- Design a house to better withstand a flood than previously designed houses

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Materials

Per class:

- ☐ A supply of water that groups can draw from, such as very large bins that students can dip their cups into
- ☐ Tarp or plastic drop cloths to protect surfaces (optional)
- ☐ Towels

Per groups of 4 students:

- ☐ Surviving Storm Surge activity supplies, including 1 tub with a playdough coast per group and various house-making materials
- ☐ Dixie cup or 1 cup measure
- ☐ Pencil and paper

Preparation

Ask students to recall how they designed their houses to withstand a flood during the Surviving Storm Surge activity. If a great deal of time has elapsed since completing the activity, refresh students' memories with specific questions about their design choices and the outcomes. Then lead a short discussion reflecting on outcomes and brainstorming ideas for improvement. Ask questions such as, "How well did your house design work?" "What problems did you run into?" "What do you think would work better?"

Tell students that engineers continuously work to improve their designs. In this activity, they will have a chance to improve on their first designs and to find out exactly how much water it will take to make their houses float away or get too soggy to stand. Their objective is to make the most flood-proof houses they can.

Instructions

1. Organize students into groups of four. Give each group its own tub with a playdough coast. Distribute house-making materials, the water measuring method you have chosen, and writing supplies.
2. Instruct each group to make a list of the strengths of their first design and its potential flaws. Then tell each member of the group to write down at least one idea for how they can improve their design. Once they are done, students should share their idea or ideas with their group.
3. Each group should then decide on the design of their new house based on what they learned from their first efforts and the ideas of each group member.
4. Ask students to construct their new houses.
5. On the board, write the question: How many cups will it take to flood your house?
6. First, as a class, determine the signs that the house has flooded. When it topples? Crumples into a soggy mass? Starts to float away? More than one of these possibilities? Write these signposts on the board.
7. Second, ask each group to come up with a prediction in response to the question. Ask each group to first think of amounts that they believe are too low—that they know their houses can withstand. Then tell them to think of amounts that are too high—that they are certain would destroy their house. They should use those numbers to select a number in between that they think is most likely.
8. Then, make a three-column chart on the board under the question. In the left column, write the name or number of each group. Label the center column “Predictions.” Label the right column “Results.”
9. Call on each group to share their prediction and record it in the chart on the board.
10. Then, tell students it is time to test their predictions. Direct each group to designate one person in the group to record on their paper how many cups of water they use.
11. Tell students that groups must all pour into the same area of the simulation for their results to be comparable. So, all groups must pour the water into the area of the tub that represents a body of water, rather than on the house or the playdough coast. Each member of the group should take a turn filling the cup and pouring it into the tub.
12. Have all of the members of each group raise their hands at the moment their house floods. Note each house as it falls. In the “Results” column of the chart on the board, record the time at which the house failed and the reason for failing (floating away, falling over, and so on).
13. Once all of the houses have succumbed to a flood, ask each group to report on how many cups it took. Write these down in the “Results” column and circle or star them.

Closure

As a class, create a bar graph of the results, showing the number of cups of water it took for the houses to fail. Discuss the graph with the class, exploring any conclusions that can logically be developed from it.

Activity Extensions

- As time allows, ask students to think about what other improvements they'd make to their designs to make their houses even more flood-proof.
- Give students a wider array of materials to work with to make their houses flood-proof; graph the results of different types of house construction and materials.
- Turn the activity into a timed competition and graph the results. The house that stands the longest is the winner.

Other Ideas for Math

Here are a few more ways to connect the Survive the Storm Surge lesson with your math curriculum.

- Ask students to measure how far from the water they set their house. If they set their house back further from the shore, how many cups of water do they think it would take to make it flood? Record predictions and actual results.
- If you live in an area that expects some rain or snow, set the tubs outside with a rain gauge. Ask students to predict how much rain, sleet, or snow they think it would take to make their houses flood. Teach students how to read a rain gauge and record the results.
- Research the history of flooding in your community. Is there a nearby creek, river, lake, or other body of water? How high does it rise on a yearly basis? Did it flood and wreak havoc? Research these incidents and note the height that the water rose before it became a hazard. Schedule a field trip to the areas that flooded and show students how high the water rose so that they connect the numbers that they researched with the reality.
- Research the average rainfall for your area. Students can graph the past 10 years' data. The National Weather Service, weather.gov, has a variety of information about weather, rainfall, and flooding.

Grade 2 English Language Arts: Disaster Poster

Estimated class time: 90 minutes

Summary

In the *Dream Big* Surviving Storm Surge activity, students experimented with designing houses that could withstand a storm surge. This activity provides ample opportunity to learn about a natural disaster that interests them and the efforts of engineers to help mitigate the effects. Students create a poster displaying what they think is important to understand for their classmates. Students think about these questions:

- What do I want to know about the natural disaster I've chosen?
- How are engineers helping people to survive this natural disaster?
- What information about this natural disaster is important to share on my poster?

Learning Objectives

- Display understanding of the causes and effects of a type of natural disaster
- Characterize the efforts of engineers to prevent or mitigate the effects of this natural disaster
- Create an informative poster about a type of natural disaster

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Materials

Per class:

- ☐ Books and magazines that are appropriate for second grade on a range of natural disasters, such as floods, cyclones, fires, and earthquakes.
- ☐ Printouts of webpages on natural disasters (at second grade level). The Department of Homeland Security (at Ready.gov/kids) has kid-friendly tips covering a variety of natural disasters.

Per pair:

- ☐ Disaster Notes student handout
- ☐ Poster board
- ☐ Poster-making supplies: markers, scissors, glue, magazines to cut up

Preparation

Help students to recall what they learned about natural disasters and what engineers are doing about them in the *Dream Big* film. Then ask students to define what a storm surge is; use this time to make sure students have the basic idea. Finally, ask students their thoughts about what kind of houses withstand storm surges best. Encourage them to extrapolate based on the storm surge activity that they just completed.

Tell students that to begin this activity, they are going to do some research about natural disasters and then pick one to become an expert on.

Instructions

1. As a class, come up with a list of different kinds of natural disasters and write them on the board.
2. Indicate the collection of written materials that students can use to explore different kinds of natural disasters. Tell the undecided students that they have 5 minutes to look through some books, magazines, and web printouts, and pick one kind of natural disaster that interests them the most to learn a lot about. While students are looking through the books, write their names on the board with space next to each for filling in the type of natural disaster they want to study.
3. Ask each of the remaining students to make a choice and write it on the board. Then form pairs of students who are interested in the same disaster. Tell them that they will research their disaster and take notes. Then they will decide what they most want their classmates to know about and create a poster that showcases this information.
4. Have each student write down 3–5 questions they have about their disaster. Then have pairs share their questions and select the 3 best ones to research. If students have trouble, provide the following questions as suggestions:
    - What happens when my natural disaster strikes?
    - Where does my natural disaster usually happen in the world?
    - What is a time when this natural disaster happened? Where did it happen?
5. Distribute the Disaster Notes student handout, one per student. Direct pairs to copy their research questions onto the notes sheet.
6. Help students choose the written materials that will be most helpful for learning about their chosen disaster. Help students find the information they need.
7. Distribute poster supplies. Tell students to use the notes they took to guide them as they make their posters. Provide guidance on what makes a good, interesting poster:
    - Make a heading so people know which natural disaster you're talking about.
    - Make the writing big so people can read it easily.
    - Use pictures.
    - Don't put too much stuff on the poster. Keep it simple. Provide 3–5 interesting facts.
8. Display finished posters and have students walk around the classroom to see each other's work.

Closure

Engage in a brief class discussion around what students learned, asking questions such as:

- What interested you the most about the natural disaster you studied?
- What is one new thing you learned about a natural disaster from the posters of classmates?
- If you were an engineer, which natural disaster would you like to help protect people from, and how?

Activity Extensions

- Organize pairs into groups of six. Have pairs explain their posters to their group mates and then answer questions.
- Write short stories about a character that survives a natural disaster.
- Tell students to ask family members about any natural disasters that they survived. These can include especially bitter winter storms, landslides, and even long-term droughts. How did people make it through?

Book Connections for English Language Arts

The following books relate to the Surviving Storm Surge activity. They can be incorporated into your ELA curriculum or used as a warm-up for the activity provided in this supplement.

Otis and the Tornado by Loren Long

Twister on Tuesday by Mary Pope Osborne

Earthquake in the Early Morning by Mary Pope Osborne

Can You Survive an Earthquake? by Rachel Hanel and April Kelcy

The Flood: The Dangerous Exploits of Three Girls, a Cat, and a Boat by Wendy Bartlett

Flood by Alvaro Villa

STUDENT HANDOUT: DISASTER NOTES

Name:

Natural disaster:

Directions:

Take notes on what you learn about your natural disaster. From these notes, pick 3–5 facts to put on your poster. Also find 2–3 pictures to put on your poster. The pictures should show something about your natural disaster. You can draw pictures instead of finding them!

1. What happens when my natural disaster strikes?

2. Where does my natural disaster usually happen in the world?

3. What is a time when this natural disaster happened? Where did it happen?

Information I want to put on our poster: