



Investigating Factors That Affect Tsunami Inundation—A Science Inquiry

Students build tsunami wave tanks to learn about the affect that both near-coast bathymetry (submarine topography) and coastal landforms have on how far a tsunami can travel inland.

Objectives

In this four-part Science Inquiry activity students:

- Form a Question or Hypothesis,
- Design an Investigation around the topic,
- Collect and Present Data, and
- Analyze and Interpret their Results.

PART ONE: Forming a Question or Hypothesis

Based on observations and scientific principles, students propose questions or hypotheses that can be examined through scientific investigation.

PART TWO: Designing an Investigation

Design a safe and ethical scientific investigation to gather data to respond to a question or hypothesis.

PART THREE: Collecting & Presenting Data

Collect, organize, and display sufficient data to support analysis.

PART FOUR: Analyzing & Interpreting Results

Summarize and analyze data including possible sources of error. Explain results and offer reasonable and accurate interpretations and implications.

Materials

- List on Page 2
- Student worksheets on Pages 5-6

Possible Exploration Topics

- How does coastal bathymetry affect tsunami inundation? (i.e. gentle vs. steep slope bathymetry).
- How does coastal topography affect tsunami inundation? (i.e. river inlet vs. straight coastline).
- How does the amount of energy in a tsunami wave affect inundation? (i.e. lower energy vs. higher energy).
- Other related topics???

Science Standards (NGSS; pg. 287)

- From Molecules to Organisms—Structures and Processes: MS-LS1-8
- Motion and Stability—Forces and Interactions: HS-PS2-1
- Energy: MS-PS3-2, HS-PS3-2, MS-PS3-5
- Waves and Their Applications in Technologies for Information Transfer: MS-PS4-1, HS-PS4-1, MS-PS4-2
- Earth’s Systems: HS-ESS2-2
- Earth and Human Activity: HS-ESS3-1, MS-ESS3-2
- Engineering Design: MS-ETS1-1, HS-ETS1-1

Teacher Background & Instructions

Creating the Tsunami Wave Making Paddle

Make a paper pattern for the paddle by tracing the outline of the end of the container. (Figure 1) The sides have a slight taper. Test the paper inside the container and adjust to achieve a close but not tight fit. The paddle should be same height as the top of the container. (14 cm wide at the top, 13.9 cm wide at the base, 11.9 cm in height on the sides) Trace the paper pattern onto the heavy plastic sheet and cut out using scissors (Figure 3). To create the fulcrum on which the paddle will pivot, cut or break a skewer approx. 20 cm long. Center the paddle on the skewer and tape the top edge of the paddle onto the skewer. Cut or break 2 additional skewers approx. 15 cm. long and tape them vertically inside each edge of the paddle to reinforce the paddle so that it does not bend. The skewers extend above the horizontal bar at the top of the paddle. The extra height provides a lever to create the wave.

Creating the Tsunami Wave

Holding the horizontal skewer at the back of the container using both hands, pull the vertical skewers back with thumb or forefinger quickly and gently. The bottom of the paddle will pivot forward causing the water to push forward in a wave. Allow the water to return and calm before creating another wave. The goal is to create a consistent wave that travels over the land and up the river channel without hitting the back wall of the container. This will take some practice to get the right kind of wave, and to make the waves consistent for several trials.

Creating the landform topography

Cover half the container (8") in clay using thin slices to represent the coastline. Taper the clay from (0 cm thick) to the back of the container (1 cm thick). (Figures 2 & 4)

Creating the Investigative Design Element

To create a river: Cut an inlet out of the clay from water's edge to the back of the container (Figure 2).

Students may be encouraged to make their landform and inlet a more realistic representation.

Materials for Tsunami Wave Container

- Rectangular plastic storage container such as Linus™ Deep Drawer Binz Clear*
6" x 16" x 5" h product code: 10059915
(The Container Store \$16.99)
- Non hardening modeling clay
- Ruler
- Beaker for water
- Blocks of wood to tilt container
- Colored toothpicks to mark location of the wave inundation
- Knife to cut the clay into thin landform pieces and remove clay to create a river
- Tsunami wave making paddle

Materials for Wave-making Paddle*

- Heavy plastic such as a heavy plastic report cover to make the wave paddle
- Heavy bamboo skewers to make the paddle and the bar to limit the distance the paddle can pivot forward to make the waves of varying energy
- 6" Ruler
- Scissors to cut the plastic for the paddle
- Tape to attach the skewers onto the plastic paddle (narrow strapping packaging tape)

* If using the Linus™ Deep Drawer Binz Clear, use the pattern on Page 4.

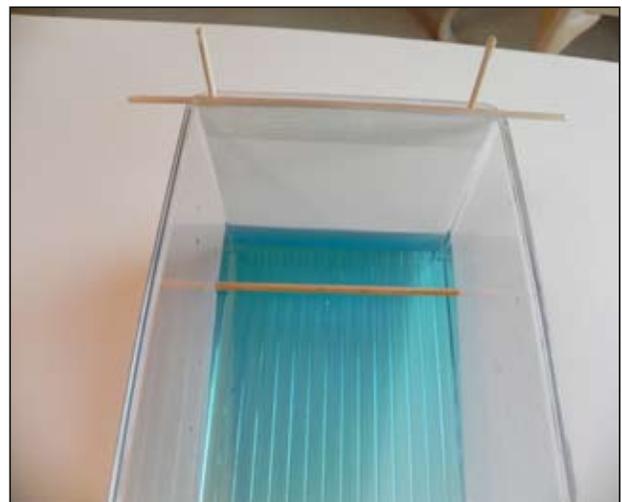


Figure 1: Lengthwise view into the wave "tank". Upper skewer rides along the top of the tank. Lower skewer fits just inside the bottom of the tank.



Figure 2: Green landform in the tank.

Change the slope of the near-coast bathymetry

Use pieces of wood such as 1 X 1 or paint stirring sticks. For a gentle slope, the back of the container was raised 5 cm, for a steep slope; raise the back of the container 8 cm. Adjust the water so that it just touches the edge of the clay at the mid-point of the container. The gentle slope used 8 oz. of water and the steep slope used 12 oz. of water.

To change the energy of the wave: Limit the distance the base of the paddle can pivot forward by wedging a skewer (14.3 cm) across the width of the container at water level. For a low-energy tsunami wave, the restraining bar was placed 2.5 cm away from the paddle standing vertically touching the front wall of the container. For a high-energy tsunami energy wave, the restraining bar was placed 4 cm from the paddle.

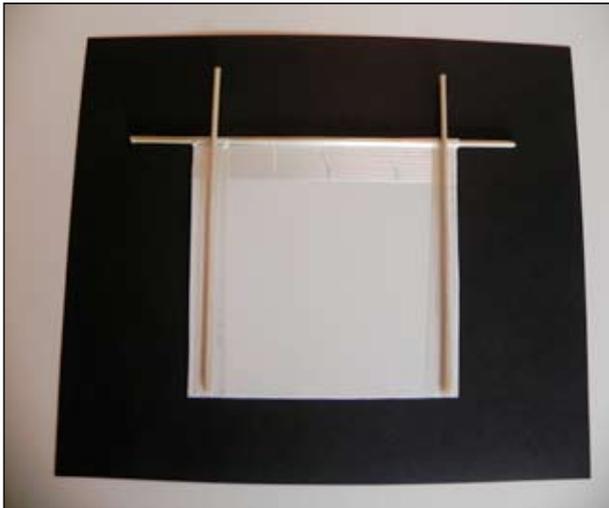
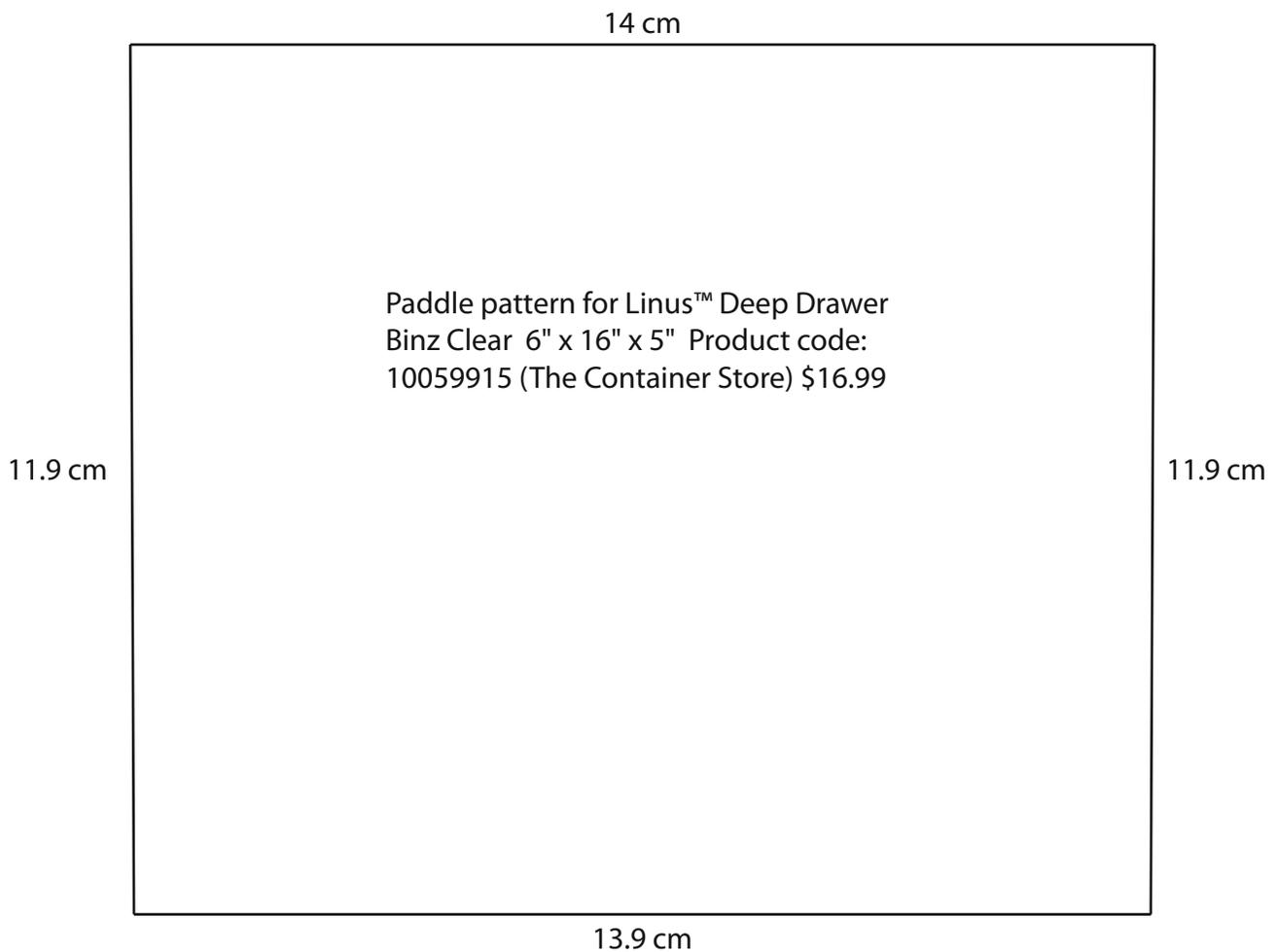


Figure 3: Making a pattern for the paddle.



Figure 4: Side view of the wave tank.



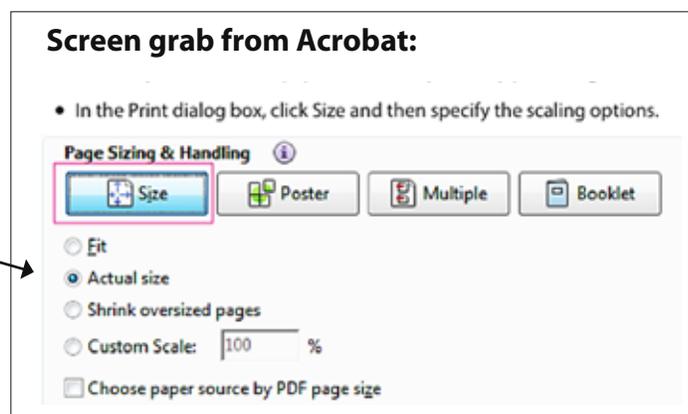
NOTE! This document MUST print at ACTUAL SIZE in order for the paddle pattern to be the correct size!

During Print:

Change the print settings to "Actual size" as shown in image at right

Measure twice; cut once:

Be sure to measure the printed pattern to check for accurate measurements





Name _____
Period _____

Investigating Factors Affecting Tsunami Inundation A Science Inquiry

Investigate how coastal landforms affect how far a tsunami travels inland.

PART ONE: Forming a Question or Hypothesis

Background information: Write a narrative paragraph that introduces and explains the importance of understanding tsunami wave inundation.

Questions:

Which tsunami inundation exploration topic would you like to investigate? (For example: I will explore how coastal topography affects tsunami inundation.)

What elements will you test for your exploration topic? (For example: For coastal topography, I will investigate how a river inlet affects tsunami inundation compared to a straight coastline.)

Hypothesis: What results do you expect to see that will answer your question?

PART TWO: Designing an Investigation

Materials: What materials will you use? Be specific!

Procedure: Provide instructions that are specific enough for someone else to recreate your investigation. You may draw a picture to aid your description. Use precise measurements. Your procedure should indicate *MULTIPLE* tests of each variable for greater accuracy with your results. Be sure to control variables in your investigation. Use the same wave energy and slope for each element of your exploration topic.



Supporting Evidence: What specific results (measurements) do you expect to observe that will be evidence supporting your hypothesis?

PART THREE: Collecting and Presenting Data

Data Table: Create a data table that will keep an organized record of your supporting evidence. This should be done in advance of your experiment.

Observations: Take notes during the investigation. What challenges have come up and what solutions have you tried?

Data Transformation: Transform your data into a graph that shows the patterns and relationships you addressed in your question and hypothesis.

PART FOUR: Analyzing and Interpreting Results

Science Terms: Identify the terms that are significant to this study. Be sure to use them correctly in the context of your conclusion. You DO NOT need to define them separately.

Conclusion: Restate your hypothesis and whether or not you were correct. Provide evidence (data and examples) to support your conclusion. Use the science terms and principles you identified above to correctly explain the results and to discuss the relationships you observed throughout the investigation.

What errors might have occurred in your investigation? Review the design, procedures and results and identify important limitations and/or sources of error. Explain how each error might have affected the outcome.